Analysis of relationships between carcass traits of Polish Large White and Polish Landrace pigs and belly meat content*

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A total of 120 Polish Large White and Polish Landrace gilts were studied at the Pig Performance Testing Station in Rossocha. During the test, the animals were maintained and slaughtered in accordance with testing station methodology. Measurements were made of backfat thickness over individual ribs along the line separating belly and loin; weight of tenderloin and loin; weight of ham; carcass length; backfat thickness over shoulder; fat thickness on the back; and length of sides and belly diagonals. Correlations were calculated between individual slaughter traits and belly meat content. The correlations between measurement of backfat thickness over ribs and belly meat percentage ranged from r=−0.51 to r=−0.62. The correlations between measurements of the cut were low (r=−0.10 to 0.04). Of the measured traits other than belly, the highest correlations with belly meat content were found for fat thickness on the back (r=−0.43), weight of loin (r=−0.39) and backfat thickness over shoulder (r=−0.32).

KEY WORDS: pigs / belly / meatiness / slaughter performance

Improvement of meatiness in the Polish pig population and maintaining a high quality of carcasses is one of the conditions for competing with European Union countries [4]. To achieve this result without becoming dependent on foreign commercial companies supplying breeding and reproductive stock, the Polish pedigree population of pigs should be constantly improved and, importantly, the genetic progress obtained should be skillfully and efficiently incorporated into the production sector. The high genetic potential of pig breeds and lines used in Poland, which often matches that found in many Western European countries, may guarantee required parameters, especially the appropriate meatiness of pigs produced in Poland [8, 9, 18]. Not only the overall carcass meatiness but also the muscling of most valuable cuts should be considered when carrying out breeding work. Changes in

*** Supported by the State Committee for Scientific Research within the project No N311 163637**

the muscle and adipose tissue content of carcass cuts have their impact on consumer preferences for individual carcass parts and the products obtained from them [2]. This situation, in turn, influences the methods used to evaluate the quality of carcasses and cuts [6, 7, 11, 20, 21]. In addition to using different types of modern equipment, it is also necessary to develop meatiness estimation methods, especially those accurate and straightforward enough to be implemented not only into breeding but also production practice [1, 2, 3].

The consumer interest in particular carcass cuts and the associated increase in marketing makes it necessary to develop methods for evaluation and classification of these cuts for both pedigree breeders and the consumer market [3, 19]. When undertaking these activities, it would be appropriate to take into account recommendations made in the directives developed and implemented in the European Union countries. Considering that improvements in carcass quality are paralleled by sometimes unwanted changes in tissue composition of individual cuts, it is necessary to undertake research on the elaboration of methods for evaluating valuable carcass parts popular with consumers and to include the results obtained in the genetic improvement models for pigs.

In many European Union countries, intensive work has recently been done to improve belly meat content and to develop regression equations that estimate this content [23]. This parameter is often included in models used to calculate the breeding value of pigs, and the economic weights given to belly meat content are high [10]. Some EU countries also develop and routinely use different scales of belly evaluation, which serve as a basis for determining appropriate grades and prices. These methods must be fast and easy to use because the classification is conducted in meat processing plants [14]. Belly evaluation is most often based on measurements of cross-sectional area of overlying loin and fat, and of backfat thickness at locations that show highest correlations with belly meat content, often at the location separating belly and loin [15].

Under Polish conditions, it is very difficult to find carcasses with belly that is very well muscled. This may be due to the fact that for many years this trait has been ignored in studies on improvement of meatiness in pigs. In light of European trends resulting from market demand, it seems appropriate to undertake studies aimed at defining the relationship between backfat thickness determined *post mortem* at different half-carcass locations and belly meat percentage and using these results in breeding work on improvement of belly muscling [2]. Therefore, the objective of this study was:

– to estimate the relationship of slaughter traits (determined *post mortem* after cutting of half-carcasses) with carcass meatiness and belly meat percentage;

– to determine optimum measurement points for belly obtained from cutting of half--carcass, which could be used as a basis for developing a method for estimation of belly meatiness.

Material and methods

The study was conducted with Polish Large White and Polish Landrace pigs originating from Polish pedigree farms. Because these breeds are the maternal component in the breeding programme implemented in Poland, they were treated as one group in the experiment. Animals were kept and slaughtered at the Pig Performance Testing Station in

Rossocha. A total of 120 animals were used in the experiment. The choice of the experimental site was dictated by the possibility of using breeding pigs tested at the performance station, which ensured that the results were free from the error resulting from the effect of environmental conditions [17].

The experimental animals were slaughtered at about 100 kg body weight in accordance with testing station methodology. Left half-carcasses were dissected according to the EU reference dissection method [22]. Following dissection, evaluation was made of some carcass slaughter traits, in particular backfat thickness over individual ribs along the line separating belly and loin. The locations were numbered from 1 to 11, beginning from the rostral end of the cut. Linear measurements of the belly were also made to determine the length of all edges and diagonals, which were designated by the letters A to F according to the schematic diagram.

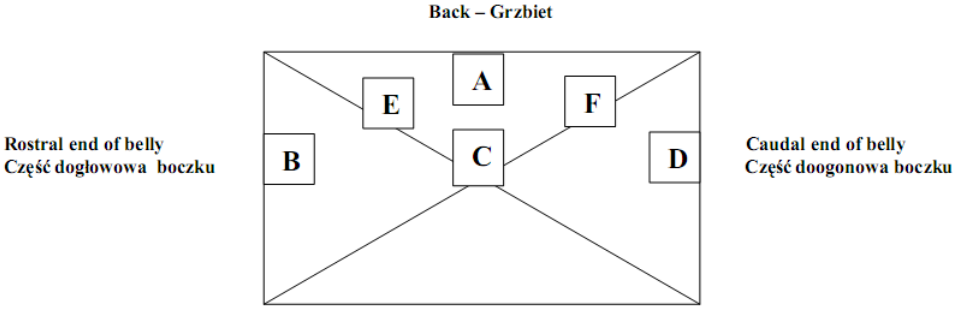

Fig. Schematic representation of the linear measurements of the belly
Rys. Schemat pomiarów liniowych boczku

The other traits analyzed during the study included:
– weight of tenderloin,
– weight of loin,
– weight of ham,
– carcass length,
– backfat thickness over shoulder (acc. to Pig Testing Station methodology),
– fat thickness on the back (acc. to Pig Testing Station methodology).

The choice of the carcass slaughter traits was dictated by the fact that they were easy to determine in meat processing plants, without disrupting the continuity of tissues in components such as ham and loin. Detailed dissection of the belly was performed to determine the exact content of adipose tissue with skin, meat tissue and bone tissue in the belly.

Mean values of the analyzed traits (x), standard deviations (σ), standard error (SE) and coefficients of variation (V) within individual traits were calculated. Correlations were estimated between individual slaughter traits and carcass and belly meatiness. The coefficients of simple correlation were used to determine optimum measurement locations on the belly, which could be used as a basis for developing a method for estimation of belly meat content. Statistical analyses were performed using Statgraphics Plus 6.0 package.

Table 1 – Tabela 1

Characteristics of the test material (n=120)
Charakterystyka materiału badawczego (n=120)

Trait Cecha	x	σ	SE	V(%)
1	2	3	4	5
Weight of belly (kg) Masa boczku (kg)	4.30	0.51	0.05	11.9
Belly – subcutaneous fat (kg) Boczek – tłuszcz podskórny (kg)	0.97	0.28	0.03	28.9
Belly – intermuscular fat (kg) Boczek – tłuszcz międzymięśniowy (kg)	0.42	0.26	0.02	61.9
Belly – meat (kg) Boczek – mięso (kg)	2.45	0.32	0.03	13.1
Belly – meat (%) Boczek – mięso (%)	57.27	7.03	0.07	12.3
Belly – bone (kg) Boczek – kości (kg)	0.47	0.06	0.01	12.8
Backfat thickness 1 (cm) Grubość słoniny 1 (cm)	1.66	0.56	0.05	33.7
Backfat thickness 2 (cm) Grubość słoniny 2 (cm)	1.63	0.52	0.05	31.9
Backfat thickness 3 (cm) Grubość słoniny 3 (cm)	1.53	0.49	0.05	32.0
Backfat thickness 4 (cm) Grubość słoniny 4 (cm)	1.42	0.47	0.04	33.1
Backfat thickness 5 (cm) Grubość słoniny 5 (cm)	1.33	0.45	0.04	33.8
Backfat thickness 6 (cm) Grubość słoniny 6 (cm)	1.30	0.46	0.04	35.4
Backfat thickness 7 (cm) Grubość słoniny 7 (cm)	1.33	0.47	0.04	35.3
Backfat thickness 8 (cm) Grubość słoniny 8 (cm)	1.39	0.51	0.05	36.7
Backfat thickness 9 (cm) Grubość słoniny 9 (cm)	1.49	0.56	0.05	37.6
Backfat thickness 10 (cm) Grubość słoniny 10 (cm)	1.53	0.55	0.05	35.9
Backfat thickness 11 (cm) Grubość słoniny 11 (cm)	1.55	0.54	0.05	34.8

1	2	3	4	5
Length of edge A (cm) Długość krawędzi A (cm)	40.08	2.86	0.28	7.1
Length of edge B (cm) Długość krawędzi B (cm)	21.59	2.00	0.19	9.3
Length of edge C (cm) Długość krawędzi C (cm)	39.46	3.25	0.31	8.2
Length of edge D (cm) Długość krawędzi D (cm)	23.36	2.12	0.20	9.1
Diagonal E (cm) Przekątna E (cm)	43.84	2.74	0.27	6.3
Diagonal F (cm) Przekątna F (cm)	44.69	2.69	0.26	6.0
Tenderloin (kg) Polędwiczka (kg)	0.40	0.05	0.00	12.5
Loin (kg) Polędwica (kg)	7.69	0.67	0.06	8.7
Ham (kg) Szynka właściwa (kg)	8.96	0.49	0.05	5.5
Carcass length (cm) Długość tuszy (cm)	81.1	2.53	0.24	3.1
Backfat thickness – shoulder (cm) Grubość słoniny – łopatka (cm)	2.45	0.60	0.06	24.5
Fat thickness – back (cm) Grubość słoniny – grzbiet (cm)	1.19	0.38	0.04	31.9
Carcass meat (%) Mięso w tuszy (%)	57.57	3.83	0.37	6.7

Results and discussion

Table 1 provides the general characterization of the test material used in the study. When analyzing these data, attention should be given to the measurements of backfat thickness over individual ribs along the line separating belly and loin. The tabular data show that backfat thickness over the ribs decreased from the measurement over the first rib (no. 1) up to and including the measurement over the fifth rib (no. 5), and then increased up to the measurement over the eleventh rib (no. 11).

When analyzing the mean values in Table 1, particular attention should be given to the coefficients of variation within traits of belly and carcass fatness. They have much higher values compared to other slaughter traits and linear measurements, and considerably exceed 30% except for backfat thickness over shoulder. With this in mind, it is suspected at this stage of analysis that it will be difficult to develop the method for determining belly

Table 2 – Tabela 2

Coefficients of correlation between the analyzed measurements of carcass and belly
Współczynniki korelacji prostej między analizowanymi pomiarami wykonywanymi na tuszy oraz boczku

Lp.	1	2	3	4	5	6	7	8	9	10	11	12
1	–	−0.53**	−0.58**	−0.62**	−0.61**	−0.59**	−0.57**	−0.51**	−0.53**	−0.57**	−0.54**	−0.54**
2		–	0.93**	0.86**	0.81**	0.80**	0.77**	0.76**	0.76**	0.78**	0.74**	0.72**
3			–	0.92**	0.86**	0.85**	0.80**	0.79**	0.80**	0.82**	0.78**	0.75**
4				–	0.92**	0.89**	0.81**	0.78**	0.77**	0.78**	0.75**	0.74**
5					–	0.92**	0.85**	0.79**	0.76**	0.76**	0.72**	0.73**
6						–	0.89**	0.84**	0.81**	0.81**	0.76**	0.76**
7							–	0.93**	0.86**	0.84**	0.77**	0.77**
8								–	0.92**	0.87**	0.83**	0.82**
9									–	0.92**	0.88**	0.87**
10										–	0.93**	0.90**
11											–	0.92**
12												–
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												

**P≤0.01; *P≤0.05

1 – belly – meat (kg); 2 – backfat thickness 1 (cm); 3 – backfat thickness 2 (cm); 4 − backfat thickness 3 (cm); 5 – backfat thickness 4 (cm); 6 – backfat thickness 5 (cm); 7 – backfat thickness 6 (cm); 8 – backfat thickness 7 (cm); 9 – backfat thickness 8 (cm); 10 – backfat thickness 9 (cm); 11 – backfat thickness 10 (cm); 12 – backfat thickness 11 (cm); 13 – length of edge A (cm); 14 – length of edge B (cm); 15 – length of edge C (cm); 16 – length of edge D (cm); 17 – diagonal E (cm); 18 – diagonal F (cm); 19 – tenderloin (kg); 20 – loin (kg); 21 – ham (kg); 22 – carcass length (cm); 23 – backfat thickness – shoulder (cm); 24 – fat thickness – back (cm)

Lp.	13	14	15	16	17	18	19	20	21	22	23	24
1	−0.10	0.01	0.04	0.03	−0.09	0.00	0.22*	−0.39**	−0.03	−0.17	−0.32**	−0.43**
2	0.08	−0.10	−0.03	−0.06	0.04	0.00	−0.19*	0.50**	−0.12	0.21*	0.52**	0.53**
3	0.05	−0.13	−0.06	−0.07	0.02	−0.03	−0.19	0.56**	−0.08	0.22	0.54**	0.58**
4	0.08	−0.08	−0.04	−0.08	0.04	−0.03	−0.14	0.60**	−0.07	0.25**	0.55**	0.54**
5	0.15	0.02	0.03	0.00	0.11	0.06	−0.16	0.56**	−0.12	0.20	0.58**	0.56**
6	0.13	−0.01	0.02	−0.02	0.09	0.05	−0.16	0.58**	−0.12	0.18	0.62*	0.56*
7	0.08	0.02	0.02	−0.02	0.06	0.03	−0.20*	0.51**	−0.19*	0.06	0.60**	0.57**
8	0.07	0.05	0.01	0.03	0.06	0.04	−0.18	0.45**	−0.21*	0.09	0.56**	0.57**
9	0.12	0.06	0.04	0.07	0.10	0.10	−0.19*	0.44**	−0.08	0.05	0.60**	0.60**
10	0.11	0.02	0.02	0.04	0.10	0.08	−0.19*	0.48**	−0.04	0.09	0.55**	0.58**
11	0.12	0.02	0.04	0.01	0.09	0.08	−0.15	0.50**	−0.07	0.11	0.56**	0.58**
12	0.12	0.06	0.03	0.08	0.11	0.08	−0.13	0.47**	−0.10	0.10	0.57**	0.55**
13	–	0.70**	0.93**	0.70**	0.96**	0.95**	−0.03	0.18	0.06	0.00	0.09	0.03
14		–	0.71**	0.83**	0.79**	0.78**	0.09	−0.10	−0.09	−0.19*	−0.11	−0.08
15			–	0.65**	0.93**	0.95**	−0.08	0.05	0.00	−0.06	−0.09	−0.04
16				–	0.79**	0.78**	0.05	−0.08	−0.01	−0.11	−0.25*	−0.09
17					–	0.96**	−0.05	0.10	0.03	−0.03	−0.13	−0.01
18						–	−0.07	0.05	0.02	−0.03	−0.10	0.01
19							–	0.15	0.24*	0.04	−0.13	−0.27**
20								–	0.22*	0.24*	0.30**	0.34**
21									–	0.07	−0.12	−0.08
22										–	0.00	−0.02
23											–	0.63**
24												–

1 – boczek – mięso (kg); 2 – grubość słoniny 1 (cm); 3 – grubość słoniny 2 (cm); 4 – grubość słoniny 3 (cm); 5 – grubość słoniny 4 (cm); 6 – grubość słoniny 5 (cm); 7 – grubość słoniny 6 (cm); 8 – grubość słoniny 7 (cm); 9 – grubość słoniny 8 (cm); 10 – grubość słoniny 9 (cm); 11 – grubość słoniny 10 (cm); 12 – grubość słoniny 11 (cm); 13 – długość krawędzi A (cm); 14 – długość krawędzi B (cm); 15 – długość krawędzi C (cm); 16 – długość krawędzi D (cm); 17 – przekątna E (cm); 18 – przekątna F (cm); 19 – polędwiczka (kg); 20 – polędwica (kg); 21 – szynka właściwa (kg); 22 – długość tuszy (cm); 23 – grubość słoniny – łopatka (cm); 24 – grubość słoniny – grzbiet (cm)

meat content based on measurements of backfat thickness. Similar findings were reported by Żak and Tyra [23].

The primary goal of analyzing the results obtained was to examine the relationship between belly meat percentage and carcass slaughter parameters, with particular consideration of the linear measurements of the belly. The coefficients of simple correlation are shown in Table 2. The linear measurements of the belly can be divided into 2 groups in terms of how they correlate with belly meat content. The first group includes backfat thickness measurements taken over individual ribs, along the line separating belly and loin. For this group of traits, correlations with belly meat percentage were found to range from r=−0.51 to r=−0.62. It should be noted that in all cases, these correlations were highly significant (P≤0.01). The correlations between backfat thickness and belly meatiness were also determined by Blicharski et al. [2], who showed that simple correlation coefficients between backfat thickness measured over loin eye and behind the last rib and belly meat content were r=−0.64 and r=−0.61, respectively. Many authors reported high correlations between backfat thickness measured at different carcass locations and meatiness not only of individual cuts but also of the whole carcass. Żak et al. [24] reported that the coefficients of simple correlation between backfat thickness over rump and carcass meatiness ranged from r=−0.40 to r=−0.43. Meanwhile, Nguyen and McPhee [12] found the coefficient of simple correlation between carcass meatiness in Large White pigs and backfat thickness at a location corresponding to P2 in the Polish system to be r=−0.58.

The second group of the linear measurements of belly, established because of the magnitude of the correlation coefficient with belly meatiness, comprised 6 measurements of belly dimensions. The correlations between traits in this group had very low values ranging from r=−0.10 to r=0.04, with no correlation found in one case (r=0.00). For this group of traits, the coefficients of correlation were not significant (P>0.05). Analysis of the relationships between belly meat percentage and some carcass slaughter traits (measured outside the belly) showed that the highest correlations with belly meat content occurred with: fat thickness on the back (r=−0.43), weight of loin (r=−0.39) and backfat thickness over shoulder (r=−0.32). These correlations were highly significant (P≤0.01). A significant correlation (P≤0.05) with belly meat content was found for weight of tenderloin, but the coefficient of simple correlation (r=0.22) was not as high as those reported previously. No statistically significant correlations (P>0.05) were found between weight of ham, carcass length and belly meat content (r=−0.03 and r =−0.17, respectively).

It is concluded from the correlations obtained that measurements of backfat thickness over the 3rd and 4th ribs would be most useful for developing methods for estimation of belly meat content using regression equations because they achieved the highest coefficients of simple correlation (r=−0.62 and r=−0.61, respectively). Our study suggests, however, that this will be very difficult because of enormous differences in belly muscling and fatness within the analyzed breeds, as indicated by the results presented in Table 1, i.e. the high standard deviations and the resulting high coefficients of variation. One possible reason for such large differences in belly fat and meat content is that 30-year selection of boars and 15-year selection of gilts was based on performance tests that used backfat thickness measured along or near the midline [9].

A similar situation occurred for post-slaughter evaluation in which the selection index, which is used as a tool in selection and breeding work, comprises mean backfat thickness from 5 measurements taken along the mid-back [18]. It can be suggested that over a long period of time this procedure may cause fat to "move" from the dorsal to the ventral part of the carcass. In general, this phenomenon is not routinely observed, which means that it is out of control. The movement of fat differs considerably, which is probably not without an influence on belly fatness. It is hard to conclude that the considerable decrease in backfat thickness that has been observed over the years in pigs at measurement locations results exclusively from a certain reduction in overall fat content of carcass, caused by appropriate selection, modern nutrition or import of pedigree animals [5]. Especially in the case of gilts, which were investigated in the present study, fat plays a significant role in reproductive performance, which, according to published results, constantly improves [13, 16]. Appropriate adipose tissue reserves in carcass are necessary for normal reproduction. It is therefore believed that appropriate stores of this tissue are found in the body, but their location could undergo certain modifications. Given that there is little adipose tissue in the dorsal part, it may be assumed that it is situated in the other parts of the carcass.

In summary, it is concluded that the measurements of backfat thickness within belly are highly correlated with belly meat content. In addition, they are characterized by high standard deviation values and high coefficients of variation. In the present study, no relationship was ascertained between belly dimensions and belly meat content.

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Analiza zależności między cechami rzeźnymi tusz świń ras wbp i pbz a mięsnością boczku

Streszczenie

Badania przeprowadzono na 120 loszkach ras wbp i pbz w SKURTCh w Rossosze. Zwierzęta utrzymywano w czasie testu i ubito zgodnie z metodyką stosowaną w stacjach kontroli. Wykonano pomiary: grubości słoniny nad poszczególnymi żebrami na całej linii odcięcia boczku od polędwicy, masy polędwiczki i polędwicy, szynki właściwej, długości tuszy, grubości słoniny nad łopatką i na grzbiecie, długości boków i przekątnych boczku. Obliczono korelacje pomiędzy poszczególnymi cechami rzeźnymi a zawartością mięsa w boczku. Stwierdzono korelacje (r) między grubością słoniny nad żebrami a procentową zawartością mięsa w boczku wynoszące od −0,51 do −0,62. Korelacje między wymiarami wyrębu były niskie (r=−0,10 do 0,04). Wśród pozostałych cech, najwyżej skorelowane z mięsnością boczku były: grubość słoniny na grzbiecie (r=−0,43), masa polędwicy (r=−0,39) i grubość słoniny nad łopatką (r=−0,32).

SŁOWA KLUCZOWE: świnie / boczek / mięsność / wydajność rzeźna