The estimation of pork carcass primal cuts value based on backfat thickness

Szacowanie wartości handlowej wybranych elementów tuszy wieprzowej na podstawie grubości słoniny

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Abstract

The aim of the present study was to determine the effect of pork carcass backfat thickness on the dissection efficiency of four primal cuts (ham, loin, shoulder, belly), including correlation coefficients. The research material consisted of 80 pork carcasses. Backfat thickness (mm) was measured on cold half-carcasses using a vernier caliper at 6 points: at the first cervical vertebra (*atlas*), over shoulder at the thickest point, on the back, at the beginning, center, end of the *gluteus medius* muscle (CI, CII, CIII). On the basis of the average backfat thickness, measurements from 6 points were separated into two experimental groups: I (<25 mm); II (≥25 mm). Detailed dissection of the elements was performed to define mass (g): total, intermuscular fat, bones and lean meat. The significant effect of fat thickness on intermuscular fat content regardless of the cut was noted. Correlations between the average backfat thickness of 6 points and the total weight of the four main elements were calculated. In addition, the correlation coefficients were compared between the dissection elements and the average backfat thickness of 6 and 5 points. Higher backfat thickness determined the increase in the total mass of loin, shoulder and belly. A statistically proven correlation was shown between the average backfat thickness and the total mass of the analysed elements (r=0.293). When comparing the correlation coefficients of a different number of measurements a specific tendency was observed. Positive correlation coefficients were slightly higher for an average of 5 points of backfat thickness and negative correlation coefficients were slightly higher for an average of 6 points. Statistical differences between groups were recorded at the same level for the same parameters ($P \leq 0.001$ and $0.01 < P \leq 0.05$). The average backfat thickness of 6 points can be used as an indicator of the amount and quality of pork carcass primal cuts, with no adverse effects compared to standard 5 points.

Keywords: carcass fatness, correlation market value, pork elements

Abstract in native language

Celem pracy było określenie wpływu grubości słoniny tuszy wieprzowej na wydajność dysekcyjną zasadniczych elementów (szynka, schab, łopatka, boczek), z uwzględnieniem zależności korelacyjnych. Doświadczeniem objęto 80 tusz wieprzowych. Na wychłodzonych półtuszach przy pomocy suwmiarki oznaczono grubość słoniny (mm) w 6 punktach: na wysokości kręgu atlas, nad łopatką w najszerszym miejscu, na grzbiecie, nad dogłowową, pośrodkową i doogonową częścią mięśnia *gluteus medius* (KI, KII, KIII). Na podstawie średniej arytmetycznej pomiarów grubości słoniny z 6 punktów wydzielono 2 grupy doświadczalne: I (<25 mm); II (≥25 mm). Szczegółową dysekcję elementów wykonano określając masę (g): całkowitą, tłuszczu międzymięśniowego, kości oraz mięśni. Wykazano istotny statystycznie wpływ grubości słoniny na zawartość tłuszczu międzymięśniowego niezależnie od wyrębu. Obliczono korelacje pomiędzy średnia grubością słoniny z 6 punktów a łączną masą 4 głównych elementów. Porównano współczynniki korelacji pomiędzy elementami dysekcyjnymi i średnią grubością słoniny z 6 i 5 punktów. Wyższa grubość słoniny warunkowała wzrost masy całkowitej schabu, łopatki i boczku. Odnotowano potwierdzoną statystycznie korelację pomiędzy średnią grubością słoniny, a łączną masą analizowanych elementów (r=0,293). W badaniu porównano współczynniki korelacji pomiędzy średnią grubością słoniny z 6 punktów, a powszechnie stosowaną średnią grubością słoniny z 5 punktów. Zaobserwowano pewną tendencję, a mianowicie dodatnie współczynniki korelacje były nieznacznie wyższe dla grupy średniej grubości słoniny z 5 punktów, a ujemne współczynniki korelacji nieznacznie wyższe dla średniej grubości słoniny z 6 punktów. Pomiędzy grupami odnotowano różnice statystyczne na tym samym poziomie dla tych samych parametrów(P≤0,001 i 0,01<P≤0,05). Na podstawie uzyskanych wyników wnioskuje się, że średni pomiar grubości słoniny mierzony w 6 punktach może posłużyć jako poglądowy wskaźnik ilości i jakości wybranych elementów tuszy wieprzowej.

Keywords: korelacje, otłuszczenie tuszy, podstawowe wyręby, szacowanie wartości

Introduction

The commercial quality of pork declines from year to year. The improvement of pigs in the direction of higher lean meat content has led to an increase in this trait such that a satisfactory level has now been achieved (Lisiak, et al., 2012). Unfortunately, the consequence of these actions has been to reduce the flavor by reducing the proportion of subcutaneous, intermuscular and intramuscular fat in primal cuts (Kortz, et al., 2002; Nguyen, et al., 2004).

The main source of fat in the human diet (especially saturated fatty acids) is meat and preparations derived from it (Jankowiak, et al., 2010). A specific ratio of these acids is necessary to extract the desired qualities of flavour. Growth of muscle tissue during fattening is associated with the deposition of protein and fat in the body (Schnickel, et al., 2001). Fat is deposited at first in the form of subcutaneous fat and then intermuscular and intramuscular (De Smet, et al., 2004). Therefore, increasingly often meat plants have begun to focus on higher slaughter weight associated with a longer period of fattening to receive raw material with the highest quality and commercial value (Strzelecki, et al., 1997).

Carcass value is determined primarily by meat and fat content (Lisiak, et al., 2011). The quality of slaughtered pigs is closely linked with the primal cuts and tissue composition (Karamucki, et al., 2004) and as has been proven with increasing slaughter weight and increased weight of cuts (Borzuta, et al., 2010). There is a strong relation between the value of primal cuts and the economic value of the whole carcass. Thus, other (new) techniques of cuts and dissection of elements are sought for a more accurate determination of the total carcass value (Marcoux, et al., 2007).

The overall lean meat content does not give a lot of information, so valuation based on the primal cuts may be more accurate (Pulkrabek, et al., 2006). The quantity and quality of basic cuts have become major determinants of the commercial value of the pork carcass.

From a practical point of view, it is essential to determine the commercial value as soon as possible and then sort the carcasses to the appropriate market. Thanks to this method, it could be possible, already in the cold stores, to differentiate and estimate the development of processed raw material processed according to requirements. Unfortunately, there is as yet no simple and easy-to-use method for the rapid assessment of the expected quantity and quality of pork carcass primal cuts, although one easy-to-measure indicator may be backfat thickness.

In the present study the effect was determined of pork carcass backfat thickness on the dissection efficiency of four primal cuts (ham, loin, shoulder, belly), including correlation coefficients.

Materials and Methods

Fatteners came from the Polish mass population and were slaughtered in a professional meat plant located in the Pomeranian province (53.7141°N, 17.5846°E). The carcasses were bled, separated along the centre line and deprived of tongue, bristle, hooves, genital organs, perirenal fat, kidneys, diaphragm, eyes, middle ear, brain and spinal cord. For further studies, only carcasses with weights between 60 and 120 kg were classified. The average carcass weights in experimental groups were similar. Finally, the research material consisted of 80 pork carcasses.

After 24h cooling, backfat thickness (mm) was measured at 6 points on right half-carcasses using a vernier caliper: at the first cervical vertebra (*atlas*), over the shoulder at the thickest point, on the back, at the beginning, center, end of the *gluteus medius* muscle (CI, CII, CIII). On the basis of the average backfat thickness of 6 measurements, the material was divided into two experimental groups:

a) I - group average backfat thickness <25 mm;
b) II - group average backfat thickness ≥25 mm.

The sex ratio was almost similar for each experimental group, 19 barrows and 20 gilts for group I, 20 barrows and 21 gilts for group II.

Dissections were performed according to EU reference methodology (EC Regulation no. 1249/2008; Walstra and Merkus, 1996) by specially trained personnel on the same half-carcasses. The four primal cuts were analysed for the purpose of the experiment: ham, loin, shoulder and belly. Detailed dissection of the elements was performed to define mass (g): total, intermuscular fat, bones and lean meat.

Numerical material was analyzed statistically using the STATISTICA (2013) statistical program. The values were determined by calculating the arithmetic mean ($\bar{x}$) and standard deviation (SD). The collected data were checked for normality with the Kolmogorov-Smirnov (K-S) test with Lilliefors correction. In addition, the Brown-Forsythe test (BF) determined whether the distributions of the variables had the same variance. To determine the statistical differences between the means, one-way analysis of variance (ANOVA) was used. The Pearson correlation coefficients (r) were calculated between the groups and the dissected elements. Levels of significance of differences were given as follows: 0.01<P≤0.05; 0.001<P≤0.01; P≤0.001.

Results

Dissection performance of four primal cuts (ham, loin, shoulder and belly) divided based on average backfat thickness from 6 measurements is shown in Table 1.

Table 1. Dissection performance of primal cuts divided based on average backfat thickness from 6 measurements (mean±SD)

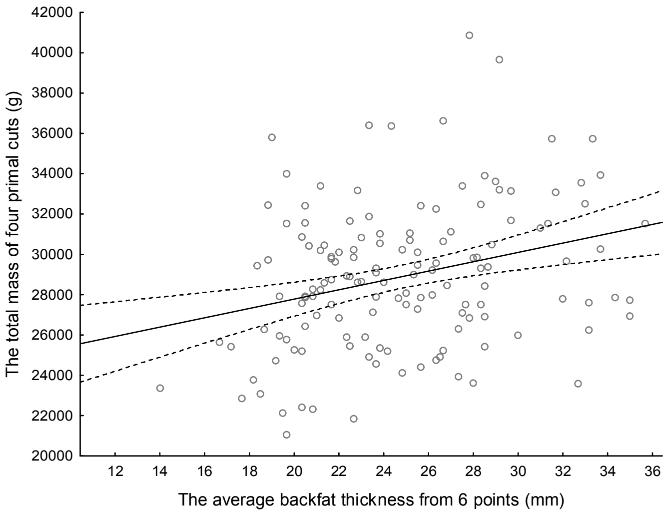
Trait	Experimental group (average backfat thickness from 6 points)		P- value
	I (<25 mm)	II (≥25 mm)	
Number of observations (n)	39	41	
Half-carcass weight (kg)	43.13±4.88	44.32±5.26	
	Ham		
Total mass (g)	10652±1349	10923±1422	0.241
Intermuscular fat mass (g)	417±96	464±100	0.005**
Bone mass (g)	886±117	845±106	0.032*
Lean meat mass (g)	7583±1092	7284±1181	0.123
	Loin		
Total mass (g)	8429±1120	9284±1236	0.001***
Intermuscular fat mass (g)	644±179	797±219	0.001***
Bone mass (g)	898±155	865±128	0.184
Lean meat mass (g)	4726±719	4562±763	0.192
	Shoulder		
Total mass (g)	5722±742	5989±805	0.041*
Intermuscular fat mass (g)	415±90	459±96	0.005**
Bone mass (g)	551±80	538±70	0.333
Lean meat mass (g)	3680±528	3609±605	0.454
	Belly		
Total mass (g)	3282±467	3506±520	0.008**
Intermuscular fat mass (g)	491±132	650±189	0.001***
Bone mass (g)	230±86	213±56	0.172
Lean meat mass (g)	1943±393	1902±319	0.493

*0.01<P≤0.05
**0.001<P≤0.01
***P≤0.001

Analyzing the ham, it should be noted that the highest statistically confirmed difference (P=0.005) between the treatment groups was observed for intermuscular fat. For group II, intermuscular fat content was higher by up to 47 g compared to Group I. A confirmed statistically significant difference (P=0.03) between the groups was observed for the mass of bones. Half-carcasses with an average backfat thickness below 25 mm were characterized by a higher mass of bones. Very large differences were shown for the total mass and mass of intermuscular fat of the loin. The average mass of this cut was about 855 g higher in group II, with a simultaneous increase in intermuscular fat mass of 153 g. Statistically higher (P=0.005) intermuscular fat mass was demonstrated in group II for the shoulder. Increased backfat thickness determined the higher total mass of cuts. Backfat thickness for the belly primarily influenced intermuscular fat content and the total mass, as was observed for the loin.

In the study, the total mass of four primal cuts was calculated, which consisted of the sum of the masses of ham, loin, shoulder and belly (Figure 1). Statistically confirmed correlations (P=0.001) were reported between the average backfat thickness from 6 points and the total mass of four primal cuts r= 0.293.

Figure 1. The mass of four primal cuts (ham, loin, shoulder, belly) depending on the average backfat thickness from 6 points



Correlation coefficients between the average backfat thickness from 6 points, and the commonly used average backfat thickness from 5 points were compared in the present study (Table 2). Between groups, statistical differences were recorded at the same level for the same parameters. However, a specific tendency was observed. Positive correlation coefficients were slightly higher for the average of 5 point backfat thickness and negative correlation coefficients slightly higher for the average of 6 point backfat thickness. The highest correlation coefficients were noted for intermuscular fat (positive) and the mass of bones for ham (negative), total mass and intermuscular fat of loin, intermuscular fat of shoulder, total mass and intermuscular fat of belly (for all P≤0.001). Lower statistical differences (P≤0.05) were observed for the lean meat mass of ham (negative) and the total mass of the shoulder (positive).

Table 2. Pearson correlation coefficients (r) between the average backfat thickness from 6 points, and the commonly used average backfat thickness from 5 points

Trait	Average backfat thickness	
	from 6 points	from 5 points
	Ham	
Total mass (g)	0.106	0.124
Intermuscular fat mass (g)	0.278***	0.292***
Bone mass (g)	-0.239***	-0.232***
Lean meat mass (g)	-0.188*	-0.172*
	Loin	
Total mass (g)	0.481***	0.502***
Intermuscular fat mass (g)	0.546***	0.577***
Bone mass (g)	-0.13	-0.122
Lean meat mass (g)	-0.125	-0.099
	Shoulder	
Total mass (g)	0.184*	0.194*
Intermuscular fat mass (g)	0.229***	0.223***
Bone mass (g)	-0.137	-0.126
Lean meat mass (g)	-0.095	-0.083
	Belly	
Total mass (g)	0.319***	0.341***
Intermuscular fat mass (g)	0.581***	0.6***
Bone mass (g)	-0.127	-0.106
Lean meat mass (g)	-0.07	-0.056

*0.01<P≤0.05
**0.001<P≤0.01
***P≤0.001

Discussion

The highest effect of backfat thickness was noted on intermuscular fat mass for all analysed cuts. Similar results have been observed in other studies, where it has even been stated that the reduction in carcass fat content was associated not only with lower backfat but also intermuscular and intramuscular fat (Kortz, et al., 2002; Wajda, et al., 2005). Intermuscular fat greatly influences the appearance of elements consisting of several muscle. Thus, it influences acceptance (or not) by consumers. Subcutaneous fat can be easily separated from these elements, while removing intermuscular fat is associated with interrupting stable connections between tissues (Kouba and Bonneau, 2009). Just as in the study conducted by Kouba and Bonneau (2009), the highest share of intermuscular fat for belly and the lowest for ham were demonstrated although average backfat thickness (experimental group) correlated in varying degrees to this parameter. The only effective way to evaluate the content of this fat is dissection. Even modern magnetic resonance imaging is not able to accurately determine the content of this parameter due to the previously mentioned stable connections (Monziols, et al., 2006). Therefore, it is possible to note the important role of the correlations obtained in this study and the differences between groups. This helps to determine assessment visually assessment without cutting. A similar number of observations and half-carcass weight enabled an objective comparison of the experimental groups.

The highest percentages of lean meat content depending on the experimental group were noted respectively for ham (72 and 66%), shoulder (64 and 60%), belly (60 and 54%) and loin (56 and 49%). The values were higher than those presented by Winiarski, et al. (2004). One reason for the discrepancy was probably the higher half-carcass weight and the mass of ham, shoulder, and lower mass of belly in comparison with the cited work. This is related to the changing structure of the fattener mass population in the following years (Lisiak, et al., 2012). It has also been shown that the higher the lean meat content, the higher the proportion of carcass primal cuts with a higher lean meat content (Nowachowicz, 2009). Between the groups very high declines were reported in the share of lean meat. It could be explained on the basis of the disclosed negative correlations for the lean meat mass of the individual cuts.

The level of meat content of pig carcasses has a very large impact on the balance between the primal cuts. Our research indicates that fatness determines the mass and composition of the tissue. Skałecki, (2006) showed a significant negative correlation between the backfat thickness in different places (from r=-0.6 to r=-0.84) and meatiness. Similar results were obtained in another study (Winiarski, et al., 2004). Lisiak, et al. (2011) and Borzuta, et al. (2010) observed that with the increase of lean meat in the carcass there was an increased proportion of ham, loin and shoulder and a decreased proportion in the belly, although the trend is not clear. On the other hand, Zybert, et al. (2005) reported the impact of hot carcass weight on the mass of meat and fat. Marcoux, et al. (2007) found that, because of the differences in construction, carcasses with similar weight may have different dimensions of primal cuts. In our study, despite the unified carcass weight individual differences were also observed. The results indicate that higher fatness acts on the total mass of the loin, shoulders and belly. The average percentage content of the four cuts (ham, loin, shoulder, belly) analyzed in the study was approximately 65% and 67%, respectively, for group I and II. Similar values were demonstrated in other research (Lisiak, et al., 2011).

The correlations obtained in our study between the average backfat thickness and the mass of the four main cuts were positive. That would explain the observation of significantly higher intermuscular fat content, which contributed to the total mass of the elements. The belly is a cut that contains a lot of subcutaneous and intermuscular fat, and is most responsive to an increase in average backfat thickness (Pulkrábek, et al., 2006); and this is partly confirmed in our results.

To date, studies have focused mainly on reducing body fat, without tracking carcass quality consequences. Muscles and fat are the main features of the quality of pig carcasses and individual primal cuts. A very good indicator of pig body fat is the backfat thickness (Jankowiak, et al., 2010). Research (Pulkrábek, et al., 2006) has shown that with an increase in meatiness the average backfat thickness decreases. The study by the same authors demonstrated that backfat thickness at the point of CI differed by as much as 50% between groups S and R.

An innovative solution proposed in this study was to take into account the average backfat thickness of 6 measurements. An additional measurement at the first cervical vertebra (*atlas*) gives a cross-sectional image of the whole half-carcass. Overall characteristics of the elements expressed by correlation was, however, almost identical between 5 and 6 measurements. However, it should be noted that there were stronger negative correlations with the average of 6 measurements.

Additionally, the correlation coefficients obtained in our study, regardless of the number of measurements, were similar to those presented in the research conducted by Skałecki, (2006). The exception was the loin and positive correlations for total mass (both proved in our research), which was the reason for the high increase in intermuscular fat mass.

Optimization of backfat thickness is almost impossible because the deposition of fat in the body depends on many factors, in particular genetic and nutritional ones (Skiba, et al., 2012). Crossing the border of balanced muscle tissue and fat growth causes rapid growth of the fat. Confirmation may be demonstrated by positive correlations for weight before slaughter and backfat thickness from r=0.23 to r=0.57 (Skałecki, 2006).

Demonstration of the relationship between simple measurements and the real value of the carcass contributes to the estimation of a raw material management regime. The present study proved that backfat thickness affects especially the mass of intermuscular fat and the total mass of primal cuts and it is an important source of information. The average backfat thickness of 6 points can be used as an indicator of the amount and quality of pork carcass primal cuts, with no adverse effects compared to standard 5 points.

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