

FAT CONTENT AND FAT DISTRIBUTION IN THE CARCASSES OF PIETRAIN PIGS

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Abstract. The study examined the content and distribution of fat in carcasses, joints and muscles of the Pietrain breed of porkers. The research covered 30 left half-carcasses of Pietrain gilts examined in Slaughter Quality Control Station (SKURTCh) in Chorzełów between 2004–2005. Thickness of back-fat was measured and the surface of fat above the eye of the loin was defined, following which, technological dissection and dissection of particular joints were performed. On the basis of the results of the dissection, weight and percentage of subcutaneous and intermuscular fat in half-carcasses and in the most valuable joints was defined. Percentage of intramuscular fat in loin (*m. longissimus thoracis*) and in ham (*m. semimembranosus*) was defined on the basis of extraction method. Average thickness of back-fat in the examined half-carcasses of the Pietrain breed, obtained on the basis of five measurements, was 1.53 cm, whereas the surface of fat above the eye of the loin was 12.27 cm². There was on average 6.58 kg of fat in the examined half-carcasses, which constituted 16.73% of the weight. The highest weight (4.98 kg) and content in half-carcass (13.36%) was stated for subcutaneous fat. Intermuscular fat weighed on average 0.83 kg and was located mainly in belly (0.21 kg), shoulder (0.15 kg), neck (0.11 kg) and in ham (0.17 kg). Intermuscular fat constituted 7.24%, 2.22%, 3.77% and 1.86% of the weight of these joints respectively. Total weight of the joints obtained during dissection (back-fat lobe, dewlap, groin, lard) amounted to 5.17 kg. The dewlap (2.73 kg) and the back-fat lobe (1.90) had the highest weight. It was observed that the percentage of intramuscular fat in loin amounted on average to 1.32% and was 0.37% higher as compared with the percentage of fat in ham.

Słowa kluczowe: carcasses, fat content, Pietrain breed, pigs

INTRODUCTION

The content of pork carcass, fat content in particular, depends on the quality of feed, slaughter weight, sex, age and on the genetic potential of porkers, which is to a large ex-

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ment associated with breed. The influence of breed on fat content in porkers has been confirmed by the results of the examination of slaughter quality conducted in control stations and by other research [Kondracki and Żebrowski 1991a, Kondracki and Żebrowski 1991b, Raj et al. 2002, Tereszkievicz et al. 2006, Warriss et al. 1990]. Those studies show that breeds of pigs differ with respect to back-fat thickness and intermuscular fat content. The breed effect is also reflected in intramuscular fat content. The Pietrain breed is characterized by a particularly low fat content and percentage of fat in carcass.

The history of breeding of Pietrain pigs is relatively short, as the breed was recognized as late as in 1955. The breed was first brought to Poland in 1966 and was included under slaughter quality control in 1992. As some authors claim [Kapełański et al. 1996], the Pietrain breed is characterized by exquisite muscle content in carcass, large surface of the eye of the loin, muscular ham and shoulder, small thickness of back-fat and low inter- and intramuscular fat content. The study by Raj et al. [2002] observed that fat content in carcasses of this breed amounts to 18.30%. According to Fandrejewski et al. [2001], Pietrain pigs are characterized by the most favourable proportion of fat to protein within daily growth in the group of paternal breeds. For 1 g of protein there is only 1.07 g of fat. In other breeds, for 1 g of protein, there is 1.4–1.5 g of fat. At the same time, Pietrain pigs are characterized by small food intake and smaller increase in body weight during fattening [Michalska et al. 2003]. It is also claimed that the Pietrain breed is characterized by a worse quality of meat due to a high percentage of animals with stress sensitivity gene, and despite the implementation of the lines free of the RYR^{TT} gene, the breed was eliminated from breeding programs in many EU countries [Blicharski and Hammermeister 2006]. In Poland the breed is still commonly used as a paternal component in three and four-time crossing with the aim of achieving a quick increase of meat-content and a decrease of fat content in carcasses of commercial porkers [Koćwin-Podsiadła 2002, Różycki 2003].

The aim of the following research was to assess fat content and fat distribution in porkers, joints and chosen muscles, and to evaluate the possibility of calculating content and percentage of fat in Pietrain porkers.

MATERIALS AND METHODS

The research covered 30 left half-carcasses obtained from the slaughter of Pietrain gilts examined in Slaughter Quality Control Station (SKURTCh) in Chorzelów. Porkers were slaughtered at the weight of 100 kg. After cooling, thickness of neck back-fat was measured in five points, and average thickness of back-fat from five measurements as well as average thickness of back-fat from three measurements on lower back were calculated according to SKURTCh methods [Różycki 1996]. Next, half-carcasses were weighed within an accuracy of 0.01 kg. After that, technological dissection was performed in accordance with the PN – 91/A–82001 norm. During the dissection of half-carcasses into basic joints, back-fat thickness was measured in C₁ and K points, and the fat surface above the eye of the loin was estimated on the cross section between 3rd and 4th thoracic vertebrae and behind the last rib. The obtained technological joints were weighed within an accuracy of 0.01 kg, and were

submitted for detailed dissection. On the basis of the results of the dissection, the weight and percentage of subcutaneous and intermuscular fat in the examined half-carcasses and chosen joints (shoulder, neck, loin, ham) were estimated. Using extraction method, the percentage of intramuscular fat in loin (*m. longissimus thoracis*) and in ham (*m. semimembranosus*) were measured. Results were submitted for statistical examination, during which arithmetic average (\bar{x}), standard deviation and variability factor were calculated. The simple correlation factor (r-Pearson) between chosen parameters of fat content and dissection fat weight was also calculated. Multiple regression equation was calculated to estimate the weight and fat content in Pietrain carcasses. The values of R^2 determination co-factor and of RSD were accepted as the measurement of precision of fat content evaluation.

RESULTS AND DISCUSSION

The measurements of back-fat thickness in specific anatomic points are the basic criterion in the evaluation of fat content in porkers [Wajda et al. 2004]. Considerable practical significance of back-fat thickness measurements results from the possibility of their evaluation on living animals [Czarnecki et al. 1995, Różycki 2003]. According to recent data, standard back-fat thickness measured on living animals amounts to 7.8 mm (boars) and 8.3 mm (gilts) on average [Report on pig breeding in Poland in 1989–2008 years]. In the following research, back-fat thickness was estimated after slaughter. It was observed that average back-fat thickness calculated on the basis of five measurements amounted to 1.53 cm (min = 1.16; max = 2.38), and average thickness from three measurements on lower back was 1.24 cm (min = 0.76; max = 2.13). Further examination of subcutaneous fat thickness in the examined carcasses shows that the largest average back-fat thickness ($\bar{x} = 2.78$ cm) was observed above shoulder, and the smallest on the second dorsal vertebrae (Table 1). The greatest variability of back-fat thickness for the Pietrain breed was observed in K point ($v = 40.25$). According to Różycki [2003], the first studies published in Poland concerning fat content in Pietrain pigs showed that average back-fat thickness from five measurements was 2.40 cm. According to Michalska et al. [2003], back-fat thickness is influenced by a daily weight increase. Pietrain porkers characterized by a lower speed of weight increase exhibit higher subcutaneous fat thickness. It was also observed [Różycki 2003] that Pietrain porkers with RYR_1^{TT} stress sensitivity gene are characterized by smaller back-fat thickness. The research shows that fat surface above the eye of the loin in the shoulder cut plane amounted on average to $\bar{x} = 38.94$ cm², while above the eye of the loin between 13th and 14th vertebrae it was 26.67 cm² smaller. Previous research [Tereszkiewicz 2006] showed that the surface of fat above the eye of the loin in the shoulder cut plane was on average 36.70 cm² for the Hampshire breed, and 36.14 cm² for the Duroc breed. In the section behind the last rib, it was 14.81 cm² (Hampshire breed) and 12.86 cm² (Duroc breed), respectively. Czarnecki et al. [1995] observed that the surface of fat above the eye of the loin in pigs of different breeds amounted on average to 20.87 cm², with the measurement performed on living animals. The authors showed also that boars are characterized by a larger surface of fat. The percentage of fat in carcasses of porkers bred at present amounts to 20–25% [Orzechowska and Eckert 2002].

According to Kondracki and Żebrowski [1991a], in the total fat content in pork carcass, subcutaneous fat has the highest percentage, as it comprises around 70% of the fat, while intermuscular fat content is 20%. At the same time, though, there are considerable differences in fat content between particular breeds of pigs. Raj et al. [2002] showed that Pietrain porkers are characterized by a considerably lower fat content in carcasses in comparison with other paternal breeds bred in Poland. The following research shows that the percentage of fat in the carcasses of porkers of this breed amounts to 16.73%, and its total weight is 6.58 kg. The highest weight of 4.98 and percentage in half-carcasses (13.36%) was stated for subcutaneous fat. The evaluation of the distribution of subcutaneous fat showed that the highest fat content was in ham ($\bar{x} = 0.76$ kg) and in belly ($\bar{x} = 0.61$ kg). In the examined half-carcasses there was on average 0.83 kg of intermuscular fat, which constituted 2.12% of the weight of the examined half-carcasses. Intermuscular fat was located mainly in belly (0.21 kg), shoulder (0.15 kg), ham (0.17 kg) and in neck (0.11 kg). Intermuscular fat constituted 7.24%, 2.22%, 1.86%, 3.77% of the weight of these joints, respectively (Table 2). Orzechowska and Eckert [2002], upon examining the fat-content in basic joints of Polish Large White and Polish Landrace breeds of pigs, observed that the weight of intermuscular fat of the neck was 0.34 kg, of shoulder – 0.36 kg and of ham – 0.16 kg. As the following study shows, there was a considerably smaller amount of intermuscular fat on the neck and on shoulder. At the same time, a similar percentage of intermuscular fat in ham (0.17 kg) was observed. Total weight of the fat cuts obtained during dissection (back-fat lobe, dewlap, groin, lard) amounted to 5.17 kg (Table 3). The dewlap (2.73 kg) and the back-fat lobe (1.90) had the highest weight.

According to numerous authors [Blicharski and Hammermeister 2006, Kulisiewicz et al. 2008], intramuscular fat content is the decisive factor in determining the quality of pork and its culinary usefulness, being closely tied with tenderness and juiciness of the meat. The significance of this trait is reflected in many breeding programs realized in many countries, where obtaining an adequate level of intramuscular fat in pork is a priority in the breeding process. As Blicharski and Hammermeister [2006] show, the inclusion of IMF in the selective index in Switzerland led to a 1% increase of fat content in muscles of pigs. As the study by Tereszkievicz et al. [2006] showed, the Duroc breed is now characterized by the highest percentage of IMF. Favourable marmoration of the meat is a feature characteristic also of the Puławska breed of pigs [Kondracki and Żebrowski 1991b]. On the other hand, the Pietrain breed is characterized by a low percentage of intramuscular fat in meat [Warriss et al. 1990]. It is assumed that it is a result of intensive selection directed at low fat content and high meat content in carcasses – the traits characteristic of the Pietrain breed. Low percentage of intramuscular fat in the muscles of Pietrain pigs was stated also in the following research (Table 4). It was observed that average percentage of fat in *longissimus thoracis* muscle was 1.32%, and 0.95% in *semimembranosus* muscle. It should as well be observed that the examined breed was characterized by a high variability of this parameter, which points to the possibility of improvement of this feature [Różycki 2003]. As Blicharski and Hammermeister [2006] observe, the percentage of intramuscular fat should be included into selection criteria especially with reference to the Pietrain breed, as it represents an important component in the national breeding and production program. Referential methods of evaluation of the content of pork carcasses have started to be commonly applied in breeding, pro-

duction and food-processing practices. The basic expectations associated with these methods include: high accuracy, repetitiveness of results and ease of measurements [Koćwin-Podsiadła et al. 2002]. In the following research, the correlation factors which reflect the degree of relation between chosen properties were determined on the basis of linear measurements of fat content properties and on the basis of the results of dissection of half-carcasses [Wajda et al. 2004]. Within the group of linear measurements, the highest values of the correlation factor were observed between the weight of fat and the average thickness of back-fat from five measurements ($r = 0.77$) and the thickness of back-fat on the third dorsal vertebrae ($r = 0.61$) (Table 5). With the inclusion of fat content parameters during dissection, the highest values of correlation were observed between the weight of dissection fat, the weight of subcutaneous fat ($r = 0.97$) and the back-fat lobe ($r = 0.92$). In previous research [Tereszkiewicz et al. 2006], identical value of the correlation factor between the weight of dissection fat and the weight of subcutaneous fat was observed, while the correlation between intramuscular fat and the weight of the back-fat lobe was smaller and amounted to $r = 0.87$.

Table 1. Thickness of back fat and the surface of subcutaneous fat of the Pietrain pigs
Tabela 1. Grubość słoniny i powierzchnia tłuszczu podskórnego świń rasy pietrain

Specification Wyszczególnienie	Measurement unit Jednostka	\bar{x}	Min.	Max.	SD	v
Backfat of thickness: – Grubość słoniny:						
– over the shoulder – nad łopatką	cm	2.78	1.80	3.80	0.57	20.50
– on the back – na grzbiecie	cm	1.43	0.50	2.30	0.44	30.77
– on loin I – I krzyżu	cm	1.22	0.80	2.50	0.43	35.25
– on loin II – II krzyżu	cm	0.78	0.40	1.20	0.20	25.64
– on loin III – III krzyżu	cm	1.46	0.80	2.80	0.54	36.99
Mean backfat thickness from 5 measurements Średnia z 5 pomiarów	cm	1.53	1.16	2.38	0.30	19.61
Mean backfat thickness on the loin Średnia na krzyżu	cm	1.24	0.76	2.13	0.42	33.87
Backfat thickness above loin's „eye” in C ₁ point Punkt C ₁	cm	0.84	0.30	1.70	0.33	39.29
Backfat thickness above loin's „eye” in K point Punkt K	cm	1.59	0.60	2.60	0.64	40.25
Backfat area between 4th and 5th the rib Pow. tł. nad okiem połędwicy między 4/5 żebrem	cm ²	38.94	32.20	44.60	3.26	8.37
Backfat area between 13/14 the rib Pow. tł. nad okiem połędwicy między 13/14 żebrem	cm ²	12.27	8.80	18.20	2.77	22.58

Table 2. Weight and content of fat in half-carasses and cuts of the Pietrain pigs
Tabela 2. Masa i udział tłuszczu w półtuszach i wyrobach mięsnych świní rasy pietrain

Specification Wyszczególnienie	Measurement unit Jednostka	\bar{x}	Min.	Max.	SD	v
Cold half-carass weight Masa półtuszy lewej zimnej	kg	39.34	37.40	41.40	1.02	2.59
Meatiness half-carass Mięsność półtuszy	%	62.36	56.39	63.84	1.80	2.89
Fat in half-carass Tłuszcz dysekcyjny półtuszy	kg	6.58	5.30	8.46	0.78	11.85
	%	16.73	13.12	20.84	1.89	11.30
Subcutaneous fat Tłuszcz podskórny	kg	4.98	3.92	6.46	0.68	13.65
	%	13.36	10.61	17.02	1.74	13.02
Intermuscular fat Tłuszcz międzymięśniowy	kg	0.83	0.64	1.04	0.09	10.84
	%	2.12	1.63	2.68	0.24	11.32
Subcutaneous fat – Tłuszcz podskórny						
– shoulder – łopatki	kg	0.54	0.36	0.73	0.11	20.37
	%	7.81	5.45	11.71	1.74	22.28
– ham – szynki	kg	0.76	0.30	1.42	0.26	34.21
	%	8.10	3.14	15.47	2.90	35.80
– belly – boczek	kg	0.61	0.28	0.77	0.18	29.50
	%	21.03	9.65	26.55	5.39	25.63
Intermuscular fat – Tłuszcz międzymięśniowy						
– shoulder – łopatki	kg	0.15	0.05	0.23	0.05	33.33
	%	2.22	0.70	3.12	0.70	31.53
– neck – karkówki	kg	0.11	0.06	0.22	0.04	36.36
	%	3.77	2.11	7.24	1.18	31.30
– loin – schabu	kg	0.15	0.07	0.36	0.07	46.67
	%	2.77	1.23	7.20	1.33	48.01
– ham – szynki	kg	0.17	0.10	0.25	0.04	23.50
	%	1.86	1.09	2.74	0.48	25.80
– belly – boczek	kg	0.21	0.12	0.28	0.02	9.52
	%	7.24	4.13	9.65	0.70	9.66

Table 3. Weight and content of fat cuts in half-carasses of the Pietrain pigs
Tabela 3. Masa i udział wyrobów tłuszczowych w półtuszach świní rasy pietrain

Specification Wyszczególnienie	Measurement unit Jednostka	\bar{x}	Min.	Max.	SD	v
Fat cuts Wyroby tłuszczowe	kg	5.17	4.31	5.98	0.42	8.12
	%	13.14	11.06	14.91	1.06	8.07
Backfat Płat słoninowy	kg	1.90	1.43	2.56	0.32	16.84
	%	4.83	3.54	6.46	0.82	16.98
Dewlap Podgardle	kg	1.07	0.83	1.30	0.11	10.28
	%	2.73	2.15	3.34	0.30	10.99
Lard Sadło	kg	0.49	0.27	0.67	0.13	26.53
	%	1.25	0.67	1.73	0.31	24.80
Gron Pachwina	kg	1.70	1.70	1.70	0.00	0.00
	%	4.32	4.11	4.55	0.11	2.55

Table 4. Content of intramuscular fat in the muscles of the Pietrain pigs

Tabela 4. Zawartość tłuszczu śródmięśniowego w mięśniach świń rasy pietrain

Specification Wyszczególnienie	Measurement unit Jednostka	\bar{x}	Min.	Max.	SD	v
– muscle longissimus dorsi (LD) – mięsień najdłuższy grzbietu	%	1.32	0.89	1.98	0.33	25.00
– muscle semimembranosus (SM) – mięsień półbłoniasty	%	0.95	0.62	1.56	0.25	26.31

Table 5. R-Pearson correlation coefficients between chosen parameters of defatting and the weight of dissectional fat in half-carcasses of the Pietrain pigs

Tabela 5. Współczynniki korelacji (r-Pearsona) między wybranymi parametrami odfuszczenia a masą tłuszczu dysekcyjnego w półtuszach świń rasy pietrain

Specification Wyszczególnienie	Measurement unit Jednostka	r
Weight of subcutaneous fat Masa tłuszczu podskórnego	kg	0.97
Weight of intermuscular fat Masa tłuszczu międzymięśniowego	kg	-0.10
Backfat of thickness over the shoulder Grubość słoniny nad łopatką	cm	0.48
Backfat of thickness on the back Grubość słoniny w grzbiecie	cm	0.48
Backfat of thickness on loin I Grubość słoniny I krzyżu	cm	0.59
Backfat of thickness on loin II Grubość słoniny II krzyżu	cm	0.44
Backfat of thickness on loin III Grubość słoniny III krzyżu	cm	0.61
Mean backfat thickness from 5 measurements Średnia grubość słoniny z 5 pomiarów	cm	0.77
Mean backfat thickness on the loin Średnia grubość słoniny na krzyżu	cm	0.38
Backfat area behind the last rib Powierzchnia tł. nad „okiem” połędwicy za ostatnim żebrem	cm ²	0.02
Backfat thickness above loin's „eye” w in C ₁ point Grubość słoniny w punkcie C ₁	cm	0.78
Backfat thickness above loin's „eye” in K point Grubość słoniny w punkcie K	cm	0.73
Weight of lard Masa sadła	kg	0.70
Weight of dewlap Masa podgardla	kg	-0.59
Weight of backfat Masa płata słoninowego	kg	0.92

At present, multiple regression equations are most commonly applied among the methods of indirect assessment of the content of pork carcasses [Koćwin-Podsiadła et al. 2002]. In the following research, mathematic models for the evaluation of the weight and percentage of fat in the carcasses of Pietrain pigs were calculated. It was observed that the weight of dissection fat can be best calculated with the following equation:

$$y = 1.043 \times \text{weight of subcutaneous fat} + 1.405 \times \text{weight of intermuscular fat} + 1.063 \times \text{weight of lard} - 0.307.$$

The value of R^2 determination factor for this equation is 0.993 with RSD 0.068.

The percentage of dissection fat in carcass can be calculated with the following equation:

$$y = 2.407 \times \text{weight of subcutaneous fat} - 0.444 \times \text{weight of dewlap} + 3.035 \times \text{weight of intermuscular fat} + 11.238 \quad (R^2 = 0.971, \text{RSD} = 0.349).$$

CONCLUSIONS

Average thickness of back-fat in the examined half-carcasses of the Pietrain breed, obtained on the basis of five measurements, was 1.53 cm, whereas the surface of fat above the eye of the loin was 12.27 cm². There was on average 6.58 kg of fat in the examined half-carcasses, which constituted 16.73% of the weight. The highest weight (4.98 kg) and content in half-carcass (13.36%) was stated for subcutaneous fat. Intermuscular fat weighed on average 0.83 kg and was located mainly in belly (0.21 kg), shoulder (0.15 kg), neck (0.11 kg) and in ham (0.17 kg). It was observed that the percentage of intramuscular fat in loin amounted on average to 1.32% and was 0.37% higher as compared with the percentage of fat in ham.

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ZAWARTOŚĆ I ROZMIESZCZENIE TŁUSZCZU W TUSZACH ŚWIŃ RASY PIETRAIN

Streszczenie. Przeprowadzono ocenę zawartości i rozmieszczenia tłuszczu w tuszach, wyrebach technologicznych i mięśniach tuczników rasy pietrain. Do badań wykorzystano 30 lewych półtuszek loszek rasy pietrain ocenianych w SKURTCh w Chorzelowie, w latach 2004–2005. Na półtuszach zmierzono grubość słoniny oraz określono powierzchnię tłuszczu nad okiem połędwicy, następnie przeprowadzono rozbiór technologiczny oraz dysekcję wyodrębnionych wyrebów. Na podstawie wyników dysekcji ustalono masę i udział tłuszczu podskórnego i międzymięśniowego w półtuszach oraz najcenniejszych wyrebach. Metodą ekstrakcji określono zawartość tłuszczu śródmięśniowego w schabie (*m. longissimus thoracis*) i szynce (*m. semimembranosus*). Średnia grubość słoniny ocenianych półtuszek rasy pietrain, obliczona z pięciu pomiarów, wynosiła 1,53 cm, a powierzchnia tłuszczu nad okiem połędwicy 12,27 cm². W badanych półtuszach było średnio 6,58 kg tłuszczu, który stanowił 16,73% masy. Największą masę (4,98 kg) i udział w półtuszy (13,36%) miał tłuszcz podskórny. Tłuszcz międzymięśniowy ważył średnio 0,83 kg i był zlokalizowany głównie w boczku (0,21 kg), w łopatce (0,15 kg), w karkówce (0,11 kg) i w szynce (0,17 kg). Tłuszcz międzymięśniowy stanowił odpowiednio 7,24%, 2,22%, 3,77% i 1,86% masy tych wyrebów. Łączna masa wyrebów tłuszczowych uzyskiwanych podczas rozbioru technologicznego (płat słoninowy, podgardle, pachwina, sadło) wynosiła 5,17 kg. Największą masę miało podgardle (2,73 kg) oraz płat słoninowy (1,90 kg). Stwierdzono, że zawartość tłuszczu śródmięśniowego w schabie wynosiła średnio 1,32% i była wyższa o 0,37% w porównaniu z zawartością tłuszczu w szynce.

Słowa kluczowe: otłuszczenie, pietrain, świnię, tusze

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