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ASSESSMENT OF SLAUGHTER EXSANGUINATION IN FATTENERS WITH A DIFFERENT BACKFAT THICKNESS

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Abstract. The aim of the study was to evaluate exsanguination of fatteners with a different backfat thickness. The study covered 126 gilts of Polish Landrace, examined in Pig Performance Testing Station in Chorzelów and slaughtered at the body weight of 100 kg. During slaughter the weight of blood from the wound and the weight of blood collected at each minute of exsanguination was measured. The tests of exsanguination were performed on the samples of the neck muscle (*musculi colli*), the diaphragm muscle (*diaphragma musculus*) and the internal oblique abdomen muscle (*musculus internus abdominis obliguus*). To assess the influence of fat content on exsanguination the animals were divided into two groups depending on the average backfat thickness from five measurements: Group I – below 1.40 cm, Group 2 – above 1.40 cm. It was shown that fatteners with a smaller backfat thickness showed a more favourable course of exsanguination and a higher weight and percentage of slaughter blood and blood output in the first minute of exsanguination. No influence of fat content on the exsanguination rate of the examined muscles was observed.

Key words: backfat thickness, exsanguination, exsanguination rate, fatteners, slaughter

INTRODUCTION

Post-slaughter exsanguination constitutes one of the decisive factors determining the processing and consumption value of pork carcass. The time and pace of blood flow, the amount of blood collected and the exsanguination rate of primary

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and secondary raw materials is the basic measure of the effectiveness of exsanguination. Many studies [Warriss and Leach 1978, Szkucik et al. 2001, Meiler 2006] showed that the quality of slaughter exsanguination of fatteners is conditioned by many genetic, physiological and environmental factors, as well as by interaction between these factors.

Exsanguination rate of the carcass and internal organs is to a large extent conditional on the intravital conditions, among which the most significant are the animals' state of health and form [Szkucik 1996]. Negative influence of diseases on post-slaughter exsanguination rate was confirmed by studies conducted during casualty slaughter. As shown by Szkucik et al. [2001] sick fatteners and those with suspected diseases slaughtered in casualty slaughter-houses are characterized by a significantly lower exsanguination rate. The studies by Tereszkiewicz et al. [2010] showed a decreased exsanguination rate of internal organs such as the liver and lungs in pigs in whose serum an increased concentration of C–reactive protein was observed.

The quality of slaughter exsanguination depends to a large extent on the factors associated with pre-slaughter handling [Bojovic et al. 1992, Tereszkiewicz 2005]. According to Warriss and Leach [1978], the stress connected with pre-slaughter handling of animals is the main factor deciding on the residual blood content. The best exsanguination rate can be observed in animals appropriately prepared for transportation, not overfed, without signs of physical tiredness. A decrease in exsanguination rate is observed mainly in porkers transported for slaughter at long distances and high temperature. According to various authors [Gregory et al. 1985, Kaczorek 1998, Anil et al. 2000, Grandin 2003, Lambooij et al. 2005], the factors directly connected with slaughter have a decisive role in the occurrence of bloody subcutaneous and intramuscular haemorrhages. The applied stunning method has a special influence on the course of exsanguination [Burson et al. 1983, Wotton 1995, Borzuta et al. 2007].

Exsanguination rate may be influenced by the time span between the moment of stunning and opening of blood vessels [Williams et al. 1983, Gerold and Stolle 1994, Omojola 2007].

Exsanguination is also influenced by the position of the animal during slaughter [Gregory 2005] and the sticking technique [Gerold and Stolle 1994, Gregory 2005]. Slaughter exsanguination of pigs is performed through an opening in the front part of the chest after incising the main vascular trunks (the brachiocephralic trunk, carotic artery trunk, carotid vein trunk) [Szkucik 1996].

Some authors [Sudakow 1990, Melier 2006,] suggest that fat content may influence fatteners' exsanguination. According to Meiler [2006], fatteners characterized by a lower fat content and higher meat content have more blood in their bodies, and yet require more time to exsanguinate. This is caused by more developed neck muscles, which, as is assumed, may cause contractures of blood vessels cut during slaughter.

Other studies [Tereszkiewicz 2009] showed that fat content exerts a significant influence on the physiological parameters, on the course and exsanguination rate of fatteners. According to the above-mentioned study, the cause of the differences in the exsanguination of fatteners with a different fat content may lie in the differences in blood content in the body.

The aim of the following study was to evaluate the exsanguination rate of fatteners with a different backfat thickness.

MATERIAL AND METHODS

The research covered 126 gilts of Polish Landrace, examined in the Pig Slaughter Performance Testing Station in Chorzelów and slaughtered at the body weight of 100 kg. Fatteners were transported individually on a hand–operated trolley from the piggery to a pre-slaughter room. Transportation distance was around 70 m. From the pre-slaughter room, the fatteners were driven to the slaughter area, where slaughter activities were performed. Gilts were first stunned by means of the STZ–2 stunning apparatus powered by electric current of 230 V and 50 Hz frequency and amperage of 1.2–2.5 A. The current was applied for 10–15 s, using Lotterschmidt-Weinberger pliers, 250 mm wide and 950 mm long, with electrode dilation of 40–500 mm. After stunning was completed fatteners were slaughtered by exsanguination through the opening of carotid arteries and external jugular veins. Fatteners were exsanguinated in a hanging position until the outflow of blood from the wound was completed.

During slaughter the weight of blood flowing from the wound and the weight of blood collected at each minute of exsanguination were examined, as well as the time of blood flow. After slaughter the weight of the following internal organs was measured: the heart, lungs, liver, spleen and kidneys. The assessment of the exsanguination rate was conducted by means of the haemoglobin in agar diffusion test and the compressor test [Szkucik 2004]. The results of the heamoglobin in agar diffusion test were given according to a 3-point scale:

- 1 point – lack of a haemoglobin ring,
- 2 points – presence of a haemoglobin ring 2 mm thick,
- 3 points – presence of a haemoglobin ring more than 2 mm thick.

Results of the compressor test were also expressed along a 3-point scale, applying the following assessment criteria:

- 1 point – yellow stain with the surface area of 4 cm^2,

– 2 points – light red stain with the surface area above 4 cm^2 up to 5 cm^2,
– 3 points – red stain with the surface area above 5 cm^2.

The results of both tests allowed the assessment of post–slaughter exsanguination rate of the carcasses according to the following system:

– 1 point – 100% exsanguination,
– 2 points – 75% exsanguination,
– 3 points – 50% exsanguination.

The tests were performed on samples of neck muscles (*musculi colli*), the diaphragm muscle (*musculus diaphragma*) and on the internal oblique abdomen muscle (*musculus obliguus internus abdominis*).

After 24–hour cooling the measurement of backfat thickness was performed in five points on the right lying half-carcass: in the thickest point above the shoulder blade, on the back above the joint between the last pectoral vertebra and the first lumbar vertebra, in three points on the lower back: above the cephalad edge (lower back I), above the center (lower back II) and the caudal edge (lower back III) of the gluteal muscle section. Based on the measurements of backfat thickness, the average backfat thickness from five measurements was calculated as well as the average backfat thickness on the lower back, according to the methods applied in the Testing Station [Różycki 1996]. Backfat was measured with a caliper to an accuracy of 0.1 cm.

To evaluate the influence of fat content on exsanguination the carcasses were divided into two groups depending on the average backfat thickness obtained from five measurements: Group I – below 1.40 cm, Group II – above 1.40 cm.

The results were statistically analyzed with STATISTICA 8.0, including the calculation of the arithmetic average and standard deviation. The significance of the differences between the averages were evaluated with student's t-distribution and chi-squared test.

RESULTS AND DISCUSSION

Slaughter value and the exsanguination rate are presented in Table 1. It was shown that fatteners with backfat thickness below 1.40 cm were characterized by 0.46 kg higher pre-slaughter weight. At the same time, no statistically significant differences in the weight of the carcass between the analysed groups of pigs were observed. It was observed that fatteners with a lower backfat content had a higher meat content, which amounted to 59.03%, while in the group of fatteners with backfat thickness above 1.40 cm, it was 56.43%. Pigs with a lower fat content were characterized by a statistically significantly higher weight of ham and a larger surface of loin eye and a smaller weight of this product (Table 1).

Detailed evaluation of subcutaneous fat content shows that the compared groups differed significantly in the average backfat thickness above the shoulder blade and on the back. The greatest difference (0.79 cm) in backfat thickness between the examined groups was observed in the measurement above the shoulder blade. Statistically significant differences between the average backfat thickness from five measurements and the average backfat thickness on the lower back were also observed between the groups (Table 1). These differences were 0.56 cm and 0.55 cm, respectively.

Table 1. Characteristics of fatteners' slaughter traits depending on their fat content

Tabela 1. Charakterystyka cech rzeźnych tuczników w zależności od stopnia ich otłuszczenia

Traits Cechy	Thickness of backfat, cm Grubość słoniny, cm				*t*–Student test test *t*–Studenta
	below 1.40 poniżej 1,40 n = 62		above 1.40 powyżej 1,40 n = 64		
	$\bar{x}$	SD	$\bar{x}$	SD	
Weight of blood, kg Masa krwi, kg	3.87	0.28	3.70	0.39	**
Body weight, kg Masa przedubojowa, kg	100.68	1.29	100.22	0.90	*
Weight of carcass, kg Masa tuszy, kg	79.70	2.58	79.32	2.85	ns
Meatiness, % Mięsność, %	59.03	2.03	56.43	1.24	**
Thickness of backfat over the shoulder, cm Grubość słoniny nad łopatką, cm	1.81	0.31	2.59	0.41	**
Thickness of backfat on the back, cm Grubość słoniny na grzbiecie, cm	0.93	0.17	1.29	0.19	**
Mean backfat thickness from 5 measurements, cm Średnia grubość słoniny z 5 pomiarów, cm	1.12	0.16	1.68	0.23	**
Mean backfat thickness on loin, cm Średnia grubość słoniny na krzyżu, cm	0.94	0.18	1.49	0.26	*
Weight of ham, kg Masa szynki, kg	10.91	0.65	9.45	2.12	**
Weight of loin, kg Masa polędwicy, kg	6.81	0.36	7.11	0.45	**
Loin "eye" area, kg Powierzchnia „oka" polędwicy, cm^2	56.41	6.73	49.81	6.96	**

**Means differ significantly at $P \leq 0.01$; *means differ significantly at $P \leq 0.05$.
**Średnie różnią się przy $P \leq 0,01$; *średnie różnią się przy $P \leq 0,05$.

The most recent reports on the results of slaughter value assessment show that the average backfat thickness in pigs examined in SKURTCH is 9,1mm, with breed being the main factor determining the fat content of the tested pigs. Paternal breeds are characterized by a lower fat content. It should be noted that fatteners slaughtered in Polish meat processing stations have a higher fat content and the average backfat thickness in these pigs is on average between 1.10 and 2.30 cm [Szymańska et al. 2012]. Sometimes there occur specimens characterized by average backfat thickness above 3 cm. It is believed that such differences in the fat content of the mass headage of fatteners are caused by environmental factors. The variability of fat content influences the commercial value of the produced carcasses and the fact that some of them are classified in the O or P classes of the EUROP system.

The present research shows that the examined carcasses with different subcutaneous fat content exsanguinated in a similar period of time, on average amounting to 182s (Table 2). However, differences in the course of exsanguination connected with the blood output in each minute should be noted. It was observed that fatteners with a lower fat content were characterized by a statistically significantly higher blood output in the first minute. At the same time no influence of fat content on blood output in the second minute of exsanguination was observed (Table 2). Previous research shows that the time of slaughter exsanguination of pigs varies between 2 and 6 minutes, according to different sources. Gardner et al. [2006] showed that exsanguination may last even 10 minutes. However, most authors state that the time of exsanguination does not exceed 180 s. Warriss and Leach [1978] think that a quick discontinuation of blood outflow may signal incomplete slaughter exsanguination and a higher amount of blood remaining in the meat, and especially in internal organs.

Table 2. Characteristics of the time of slaughter of fatteners with a different backfat thickness

Tabela 2. Charakterystyka czasu uboju tuczników o zróżnicowanej grubości słoniny

Traits Cechy	Thickness of backfat, cm Grubość słoniny, cm				*t*–Student test test *t*–Studenta
	below 1.40 poniżej 1,40 n = 62		above 1.40 powyżej 1,40 n = 64		
	$\bar{x}$	SD	$\bar{x}$	SD	
Time interval from stunning to sticking, s Czas od zakończenia oszałamiania do kłucia, s	26.13	9.14	23.91	8.95	ns
Duration of blood flow, s Czas wykrwawiania, s	182.19	7.67	182.09	5.92	ns

The amount of blood collected during slaughter is a crucial indicator of the quality of slaughter exsanguination. Pigs belong to animals which are characterized by a relatively small blood content in the body. It is assumed [Gardner et al. 2006] that blood constitutes around 4.5–5.0% of the animal's body weight and may vary between 1.5 to 6.0%. During slaughter only a part of the blood is collected. According to various sources [Warriss and Leach 1978, Sudakov 1990, Szkucik et al. 2001, Meiler 2006], the collected blood constitutes between 30 and 80% of the total blood content. During exsanguination blood flows predominantly from large blood vessels and internal organs, which store the blood. Residual blood is mainly located in muscles and blood vessels with a diameter below 0.3 mm.

The study showed a statistically significant influence of fat content on the slaughter blood weight. It was observed that 0.17 kg more blood was collected during the slaughter of fatteners with a lower backfat thickness. Such blood constituted 3.86% of the weight of these fatteners, and the output was 0.17% higher in comparison with pigs with backfat thickness above 1.40 cm. A significant influence of fat content on the amount of blood collected during slaughter was shown by Sudakov [1990].

It can be assumed that significant differences in the weight of blood collected during the slaughter of fatteners with a different backfat thickness result from the differences in the amount of blood in fatteners' bodies in both compared groups. According to Prost [1985], a smaller blood content in the bodies of pigs with a higher fat content is connected with a higher amount of fatty tissue, which is characterized by a relatively low blood supply. This interdependence may be confirmed by previous results of the research in which a significant influence of meat content on the weight of blood collected during slaughter was observed [Tereszkiewicz 2009]. The studies showed that more blood can be collected from fatteners with a higher meat content.

The quality of exsanguination depends on the pace of blood flow and blood output in the first minute in particular. Fatteners with a lower fat content were characterized by a more favourable value of this parameter (Table 3). From fatteners of this group on average 3.22 kg of blood was collected in the first minute, which constituted 83.22% of the total blood content collected during slaughter. In the group of pigs with 1.40 cm fat content, 0.14 kg less blood was collected in the first minute, while the output expressed in the relative values was the same as in group I (Table 3). The research did not show any influence of fat content on the amount of blood collected in the second minute of exsanguination, while its output in group II was 1.22% lower (significant with $P \geq 0.01$). Most probably it was connected with a lower total blood content which was collected from fatteners with a lower fat content.

The research also examined the weight of internal organs. It is believed that their weight may indicate post–slaughter exsanguination [Szkucik 1996]. According to this author, after slaughter large amounts of blood remain especially in the lungs and the liver and influence the weight of these organs. Depending on the exsanguination rate blood constitutes between 15.1 and 21.3% of the weight

Table 3. Slaughter exsanguination indicators of fatteners with a different backfat thickness

Tabela 3. Wskaźniki wykrwawienia ubojowego tuczników o zróżnicowanej grubości słoniny

Traits Cechy	Thickness of backfat, cm Grubość słoniny, cm				t–Student test test t–Studenta
	below 1.40 poniżej 1,40 n = 62		above 1.40 powyżej 1,40 n = 64		
	$\bar{x}$	SD	$\bar{x}$	SD	
Weight of blood, kg Masa krwi, kg	3.87	0.28	3.70	0.39	**
Blood – percentage of body weight, % Udział masy krwi do masy przedubojowej, %	3.86	0.29	3.69	0.38	**
Blood – percentage of hot carcass weight Udział krwi do masy tuszy, %	4.87	0.38	4.67	0.48	**
Blood output in the 1st minute of exsanguination, kg Uzysk krwi w 1 minucie wykrwawiania, kg	3.22	0.26	3.08	0.39	**
Blood output in the 1st minute of exsanguination, % Uzysk krwi w 1 minucie wykrwawiania, %	83.22	2.78	83.23	3.37	ns
Blood output in the 2nd minute of exsanguination, kg Uzysk krwi w 2 minucie wykrwawiania, kg	0.52	0.09	0.54	0.09	ns
Blood output in the 2nd minute of exsanguination, % Uzysk krwi w 2 minucie wykrwawiania, %	13.50	2.04	14.72	2.84	**
pH of blood pH krwi	7.32	0.10	7.33	0.11	ns

**Means differ significantly at $P \leq 0.01$.
**Średnie różnią się przy $P \leq 0,01$.

of lungs, and between 12.9 and 16.4% of the weight of the liver. The conducted research proved that the compared groups of fatteners differed in the weight of the heart, lungs and spleen (Table 4). A higher weight of these organs was observed in fatteners in group I, whereas the highest difference amounting on average to 0.18 kg was stated for the weight of lungs. It is assumed that the differences in the weight of lungs could have been influenced by a lower exsanguination rate of this organ. Increasing disproportions between the body weight and the weight of internal organs, which result from improving pigs to enhance their slaughter value and increasing meat content in the carcasses, could also be significant. Such correlation was also stated by Dammrich [1987].

Table 4. Weight of selected internal organs of fatteners depending on their fat content

Tabela 4. Masa wybranych narządów wewnętrznych tuczników w zależności od stopnia ich otłuszczenia

Traits Cechy	Thickness of backfat, cm Grubość słoniny, cm				*t*–Student test test *t*–Studenta
	below 1.40 poniżej 1,40 n = 62		above 1.40 powyżej 1,40 n = 64		
	Ńx	SD	Ńx	SD	
Weight of heart, kg Masa serca, kg	0.40	0.04	0.36	0.06	**
Heart – percentage of body weight Serce – procent masy ciała	0.40	0.04	0.36	0.06	**
Weight of lungs, kg Masa płuc, kg	1.20	0.28	1.02	0.25	**
Lungs – percentage of body weight Płuca – procent masy ciała	1.19	0.28	1.02	0.24	**
Weight of liver, kg Masa wątroby, kg	1.76	0.18	1.76	0.20	ns
Liver – percentage of body weight Wątroba – procent masy ciała	1.75	0.18	1.76	0.20	ns
Weight of spleen, kg Masa śledziony, kg	0.18	0.02	0.17	0.03	**
Spleen – percentage of body weight Śledziona – procent masy ciała	0.18	0.02	0.17	0.03	**
Weight of kidneys, kg Masa nerek, kg	0.35	0.04	0.34	0.04	ns
Kidneys – percentage of body weight Nerki – procent masy ciała	0.35	0.04	0.34	0.04	ns

**Means differ significantly at $P \leq 0.01$.
**Średnie różnią się przy $P \leq 0,01$.

Tables 5 and 6 present results of the assessment of post–slaughter exsanguination rate of selected muscles of the examined carcasses. The examination covered muscles which, according to Warriss and Leach [1978] and Szkucik [1996], are the best material allowing an objective assessment of the exsanguination rate of the whole pork carcass. The results show that subcutaneous fat content did not influence the exsanguination rate of the examined muscles. It should be noted that in both compared groups there were muscles characterized by 75% bleeding. Most symptoms of incomplete bleeding were observed in the neck and diaphragm muscles. This was confirmed in the results of both tests (Table 5 and Table 6).

Table 5. Assessment of the post–slaughter exsanguination rate of muscles of fatteners with a different backfat thickness using a haemoglobin diffusion test

Tabela 5. Ocena stopnia wykrwawienia poubojowego mięśni tuczników o zróżnicowanej grubości słoniny przy użyciu testu dyfuzji hemoglobiny

Muscle Mięsień	Exsanguination rate Stopień wykrwawienia	Thickness of backfat, cm Grubość słoniny, cm				Chi-square test test Chi-kwadrat
		below 1.40 poniżej 1,40 n = 62		above 1.40 powyżej 1,40 n = 64		
		n	%	n	%	
Colli muscles Mięśnie szyi	Exsanguination 100% Wykrwawienie 100%	51	82.25	53	82.81	0.93
	Exsanguination 75% Wykrwawienie 75%	11	17.74	11	17.19	
Obliguus internus abdominis muscle Miesień skośny wewnętrzny brzucha	Exsanguination 100% Wykrwawienie 100%	56	90.32	53	82.81	0.21
	Exsanguination 75% Wykrwawienie 75%	6	9.68	11	17.19	
Diaphragm muscle Miesień przepony	Exsanguination 100% Wykrwawienie 100%	52	83.87	50	78.12	0.41
	Exsanguination 75% Wykrwawienie 75%	10	16.13	14	21.80	

Table 6. The evaluation of post-slaguther exsanguination of the muscles of fatteners with a different backfat thickness using a compressor test

Tabela 6. Ocena stopnia wykrwawienia poubojowego mięśni tuczników o zróżnicowanej grubości słoniny przy użyciu testu kompresorowego

Muscle Mięsień	Exsanguination rate Stopień wykrwawienia	Thickness of backfat, cm Grubość słoniny, cm				Chi-square test test Chi-kwadrat
		below 1.40 poniżej 1,40 n = 62		above 1.40 powyżej 1,40 n = 64		
		n	%	n	%	
Colli muscles Mięśnie szyi	Exsanguination 100% Wykrwawienie 100%	55	88.70	53	82.81	0.33
	Exsanguination 75% Wykrwawienie 75%	7	11.30	11	17.19	
Obliguus internus abdominis muscle Miesień skośny wewnętrzny brzucha	Exsanguination 100% Wykrwawienie 100%	56	90.32	55	85.93	0.44
	Exsanguination 75% Wykrwawienie 75%	6	9.68	9	14.07	
Diaphragm muscle Miesień przepony	Exsanguination 100% Wykrwawienie 100%	53	85.48	52	81.25	0.52
	Exsanguination 75% Wykrwawienie 75%	9	14.51	12	18.75	

CONCLUSIONS

It was shown that fatteners with a smaller backfat thickness were characterized by a more favourable course of exsanguination expressed in a higher weight and percentage of slaughter blood and the output of blood in the first minute of exsanguination. Fatteners with a lower subcutaneous fat content were characterized by a higher weight of the heart, lungs and spleen. No influence of backfat content on the exsanguination rate of the examined muscles was observed.

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OCENA WYKRWAWIENIA POUBOJOWEGO TUCZNIKÓW O ZRÓŻNICOWANEJ GRUBOŚCI SŁONINY

Streszczenie. Przedmiotem pracy była ocena wykrwawienia ubojowego tuczników o zróżnicowanej grubości słoniny. Badaniami objęto 126 loszek rasy polskiej białej zwisłouchej, ocenianych w Stacji Kontroli Użytkowości Rzeźnej Trzody Chlewnej w Chorzelowie i ubijanych przy masie ciała 100 kg. W czasie uboju określono masę krwi wypływającej z rany ubojowej oraz masę krwi uzyskanej w poszczególnych minutach wykrwawienia. Testy stopnia wykrwawienia wykonano na próbach mięśni szyi (*musculi colli*), przepony (*musculus diaphragma*) oraz mięśnia skośnego wewnętrznego brzucha (*musculus obliguus internus abdominis*). Dla oceny wpływu otłuszczenia tuczników na wykrwawienie tusze podzielono na dwie grupy w zależności od średniej grubości słoniny z pięciu pomiarów: Grupa I – poniżej 1,40 cm, Grupa II – powyżej 1,40 cm. Wykazano, że korzystniejszym przebiegiem wykrwawienia wyrażonym większą masą i udziałem krwi ubojowej oraz uzyskiem krwi w pierwszej minucie wykrwawienia charakteryzowały się tuczniki o mniejszej grubości słoniny. Nie stwierdzono wpływu otłuszczenia tuczników na stopień wykrwawienia ocenianych mięśni.

Słowa kluczowe: grubość słoniny, stopień wykrwawienia, tuczniki, ubój, wykrwawienie

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