

## **INFLUENCE OF SELECTED FACTORS ON THE WEIGHT OF INTERNAL ORGANS OF FATTENERS**

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**Abstract.** The aim of the study was the evaluate the influence of breed, meat and fat-content on the weight of chosen internal organs. The research involved 120 fatteners of the Polish Landrace, Polish Large White, Pietrain and Duroc breeds of pigs. After slaughter and veterinary examination, internal organs were obtained: the heart, lungs, liver, spleen and kidneys. The organs were weighed to an accuracy of 0.01kg. On the basis of the weight of the organs and the weight of the fatteners before slaughter, the indicator of the proportion of the examined organs to the body-weight of fatteners was calculated. The research has shown a significant influence of breed on the weight of internal organs. Especially significant differences were observed between the Polish Large White and Duroc breeds. Statistically significant influence of fat- and meat-content on the weight of organs was also observed. Fatteners with lower fat and higher meat-content were characterized by higher weight and proportion of the heart, lungs and liver.

**Keywords:** breed, fat-content, fatternermeat-content, internal organs, pig

### **INTRODUCTION**

Among the animals used by men, pigs are characterized by numerous unique anatomical and physiological features which decide about their use and their productive potential. One of the unique properties of this species of animals is the relatively small weight and proportion of internal organs. This relation refers to the heart in particular, the weight of which represents around 0.30% of the body weight of pigs, while for other species of domestic animals this rate amounts to nearly 0.50%. According to Dammrich [1987], the process of the domestication of pigs contributed to an increase in unfavourable proportions between the body weight and the weight of internal organs, which, in the scholar's opinion, is confirmed by the differences in the weight of organs between wild boars and domestic pigs. Pigs characterized by very high meat-content are characterized by particularly unfavourable proportions between body weight and the weight of internal organs.

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According to Kołacz [2006], low weight of the heart and lungs leads to lower adaptive capabilities of those pigs due to the insufficiency of the vascular and respiratory systems.

The weight of internal organs of pigs is conditioned by numerous genetic, physiological and environmental factors [Ciplef and Mackay 1993, Migdał et al. 1999, Ruusunen et al. 2007, Tereszkievicz 2007]. The size of the internal organs of pigs and their mutual proportions and share in the body weight undergo significant changes associated with age, growth and the development of the organism. White et al. [1995], who examined the weight of internal organs of pigs slaughtered at different ages, showed that the weight of the heart of one day old female fatteners of the Yorkshire breed amounted to 13.00 g, of those 41 days old it was 73.30 g, of those 123 days old – 200.40 g, while of the 260-day-old fatteners the weight was 385.00g. Migdał et al. [1999] observed that the heart of the fatteners of the Polish Landrace breed weighing 110 kg before slaughter, weighed 303.30 g. As Pond and Haupt [1978] showed, the weight of the heart constituted around 1% of the body weight of piglets. With growth, the weight of the heart decreases and amounts to around 0.33% for somatically grown-up pigs. Similar changes have been observed for the liver and kidneys, whose proportion to the body weight of pigs amounts to 3.10% and 1.00% respectively, while for grown-up pigs 1.40% (liver) and 0.25% (kidneys).

The results of the previous research [White et al. 1995, Migdał et al. 1999, Ruusunen et al. 2007] prove that breed and the crossbreeding scheme, in particular, influence the weight of internal organs. According to Ciplef and McKay [1993], sex also influences the weight of internal organs. However, the connection between sex and the weight of internal organs was not confirmed by Ruusunen et al. [2007]. According to other studies [Davey and Bereskin 1978, Paściak et al. 2003], external factors associated with the improvement of the production traits of pigs, deciding about the effectiveness of production, exert a crucial influence on the weight of internal organs. The studies show that intensive selection directed at the lowering of fat-content in carcass leads to an increase in the weight of internal organs. The intensiveness of feeding and the content of the feed-ration also influence the weight of internal organs [Kerr et al. 2003, Ruusunen et al. 2007].

At present, the examination of physiology, structure, size and weight of internal organs of pigs is crucial, considering their use in xenotransplantation. According to Smorağ and Słomski [2005], the size and weight of internal organs, especially of the heart and kidneys, and their diversification among the breeds, makes possible the selection of organs with appropriate anatomical structure, size and weight for various recipients.

The aim of the research was to evaluate the influence of breed, meat and fat-content of fatteners on the weight of selected internal organs.

## MATERIAL AND METHODS

The research was conducted in Pig Slaughter Performance Testing Station in Chorzów. The study involved 120 fatteners of the Polish Large White, Polish Landrace, Pietrain and Duroc breeds from control fattening. Before slaughter, fatteners were weighed

individually to an accuracy of 0.10 kg. After evisceration and veterinary examination, internal organs: hearts, lungs, livers, spleens and kidneys, were extracted for examination. The organs were weighed to an accuracy of 0.01 kg. On the basis of the weight of internal organs and the weight of fatteners before slaughter, the indicator of the proportion of the examined internal organs to body weight of fatteners was calculated. Successively, the thickness of back-fat in five points was measured and the average back-fat thickness from the five measurements was estimated. Back-fat was measured to an accuracy of 0.10 cm. Then, a division and detailed dissection of the carcasses was performed. The percentage of meat-content in carcass was estimated on the basis of the data obtained from the division into parts and from the dissection.

Numerical material obtained in the research was statistically evaluated. The following factors were taken into account: the influence of breed (Polish Landrace, Polish Large White, Pietrain, Duroc), meat-content (S, E and U classes of the SEUROP system) and subcutaneous fat content (backfat of thickness below 1.40 cm and above 1.40 cm) of carcasses. T-Student or Tukey's tests were used to evaluate the significance of the difference between the factors. The results of the research were calculated with Statistica®9.0 PL. [StatSoft, Inc. 2010].

## RESULTS AND DISCUSSION

The previous research [Ciplef and McKay 1993, White et al. 1995, Ruusunen et al. 2007] showed that the weight of internal organs of pigs depends on breed. According to Migdał et al. [1999], mixed-breed pigs also differ in the weight of internal organs. Ruusunen et al. [2007] prove that the weight of the heart, liver and kidneys of the Landrace breed of fatteners weighing 104 kg during slaughter amounts to 342 g, 1625 g, 355 g, respectively, while for the Yorkshire fatteners with a similar body weight, the weight of these organs is 351 g, 1515 g, and 343 g. The study conducted by Migdał et al. [1999] shows that commercial cross-breeds with the Pietrain breed have heavier hearts, livers and kidneys in comparison to the fatteners of the Polish Landrace breed and the mixed-breed fatteners obtained without the share of the Pietrain breed.

The description of internal organs of the examined breeds of fatteners is presented in Table 1. It was proved that the breed factor exerted a statistically significant influence on both the weight of the organs and their percentage in the body weight. Particularly visible differences were observed between the Polish Large White and other breeds. The fatteners of the Polish Large White breed had a considerably lower weight of the heart, lungs, spleen and kidneys in comparison to the average weight of organs of the fatteners of the Polish Landrace, Pietrain and Duroc breeds, which were characterized by the highest weight of the organs in the group of the examined breeds. The differences in the weight of organs between the Duroc and Polish Large White breeds were significant and amounted on average to 0.03 kg for the heart, 0.54 kg for lungs, 0.26 kg for the liver and 0.02 for kidneys. It should be noted that the fatteners of the Polish Landrace and Pietrain breeds were characterized by a similar weight of internal organs (with the exception of kidneys) (Table 1).

According to the previous research, the heart constitutes from 0,34% [Clyplef and McKay 1993] to 0.41% [Yang and Lin 1997] of the slaughter weight of fatteners. The following study shows that the proportion of the heart to the body weight of Polish Landrace, Pietrain and Duroc fatteners was within the ranges presented in the previous research on the subject. Fatteners of the Duroc breed were characterized by the highest proportion of the weight of the heart to pre-slaughter weight, which amounted to 0.41% on average (Table 1). Polish Large White fatteners were characterized by a slightly lower proportion of the weight of the heart, amounting to 0.32% on average, in comparison to what was stated in the previous research. Previous research [Tereszkiewicz 2007] proved that the liver comprises 1.75% of the body weight of fatteners of the Polish Landrace breed, while the proportion of lungs is 1.18%. In this study, a slightly lower proportion of these organs to the body weight of the Polish Landrace fatteners was observed (Table 1).

The research proved that the weight and proportion of internal organs, except for the spleen and kidneys, was visibly dependent on back-fat thickness of the examined fatteners (Table 2). It was observed that fatteners with lower fat-content were characterized by a statistically significantly higher weight and percentage of the heart, lungs and liver. The greatest difference between the groups, which amounted to 0.18 kg on average, was stated for the weight of lungs. The previous research [Tereszkiewicz 2007] proved that fatteners with back-fat thickness below 1.20 cm were characterized by the weight of lungs 0.07 kg higher in comparison to the fatteners with back-fat thickness above 1.60 cm. The interdependence between subcutaneous fat-content and the weight of internal organs was also observed by Davey and Bereskin [1978], who proved that pigs selected for smaller fat-content were characterized by a higher weight of the liver, heart, kidneys and stomach. Yang and Lin [1997] showed a negative correlation between the fat-content of fatteners and the weight of the heart. Also according to Ruusunen et al. [2007 a], the correlation between the weight of fat in carcass and the weight of the heart is negative and amounts to  $-0.020$ .

As the present study shows, fatteners with lower subcutaneous fat-content were characterized by a significantly higher weight of the liver (0.11 kg difference). According to Paściak et al. [2003], the selection conducted with the aim of decreasing back-fat thickness leads to changes in the ways of storing additional energy, which the animals accumulate in the liver in the form of glycogen, which in turn leads to the growth of the weight of this organ.

According to Kołacz [2006], the current direction of the development of pigs leads to an increase in unfavourable disproportions between body-weight and the weight of internal organs. However, a view dominates among scholars that breeding directed at the improvement of slaughter traits, at increasing meat-content and decreasing fat-content in particular, leads to an increase in body-weight and the weight of internal organs of fatteners. These interdependences were also confirmed by Davey and Bereskin [1978] and Clyplef and McKay [1993]. Migdał et al. [1999] also proved that fatteners with higher muscle-content are characterized by a higher weight of internal organs, mainly of the heart, liver and kidneys. These observations were also confirmed in the present research (Table 3). It was observed that fatteners with higher meat-content were characterized by a higher weight and proportion of the heart, liver and kidneys. Especially high dynamism of the growth of the weight and proportion of these internal organs was observed among fatteners whose carcass was classified into the U and E classes of the SEUROP system.

Table 1. Description of internal organs of fatteners of the examined breeds  
 Tabela 1. Charakterystyka narządów wewnętrznych tuczników badanych ras

Traits Cechy	Breeds – Rasy										Tukey's test Test Tukeya
	Polish Landrace – pbz (1)		Polish Large White – wbp (2)		Pietrain (3)		Duroc (4)				
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	
Body weight Masa przedubojowa	kg 100.56	1.27	99.57	0.50	100.33	0.71	101.20	1.19			1-2,4
Heart	kg 0.39	0.04	0.32	0.03	0.40	0.03	0.42	0.06			1-2,4;2-3,4;
Serce	% 0.38	0.04	0.32	0.03	0.40	0.03	0.41	0.06			1-2,4;2-3,4;
Lungs Pluca	kg 1.06	0.19	0.86	0.12	1.09	0.15	1.45	0.22			1-4;2-3,4;3-4;
	% 1.05	0.19	0.86	0.12	1.09	0.15	1.44	0.23			1-4;2-3,4;3-4;
Liver	kg 1.72	0.18	1.70	0.17	1.67	0.09	1.96	0.17			1-4;2-4;3-4
Wątroba	% 1.71	0.18	1.70	0.18	1.67	0.09	1.94	0.18			1-4;2-4;3-4
Spleen Śledziona	kg 0.19	0.03	0.15	0.01	0.19	0.02	0.17	0.01			1-2,4;2-3,4;3-4;
	% 0.19	0.03	0.15	0.01	0.19	0.02	0.17	0.01			1-2,4;2-3,4;3-4;
Kidneys Nerki	kg 0.36	0.04	0.31	0.04	0.33	0.03	0.38	0.03			1-2,3;2-4;3-4;
	% 0.35	0.04	0.32	0.04	0.33	0.03	0.37	0.03			1-2,3;2-4;3-4;

1-2 – means differ significantly at  $P \leq 0.05$ .

1-2 – istotne statystycznie dla  $P \leq 0.05$ .

Table 2. Description of internal organs of fatteners with differing backfat thickness  
 Tabela 2. Charakterystyka narządów wewnętrznych tuczniaków o różniącowanej grubości słoniny

Traits Cechy	Backfat of thickness, cm – Grubość słoniny, cm				t-Student test Test t-Studenta	
	below 1.40 poniżej 1.40		above 1.40 powyżej 1.40			
	$\bar{x}$	SD	$\bar{x}$	SD		
Body weight Masa przedubojowa	kg	100.56	1.28	100.35	0.98	**
Mean backfat thickness from 5 measurements Średnia grubość słoniny z 5 pomiarów	cm	1.10	0.15	1.66	0.23	**
Heart Serce	kg	0.40	0.04	0.36	0.06	**
	%	0.40	0.04	0.36	0.06	**
Lungs Płuca	kg	1.20	0.28	1.02	0.25	**
	%	1.19	0.28	1.02	0.24	**
Liver Wątroba	kg	1.79	0.18	1.68	0.20	**
	%	1.78	0.18	1.68	0.20	**
Spleen Śledziona	kg	0.18	0.02	0.17	0.03	ns
	%	0.18	0.02	0.17	0.03	ns
Kidneys Nerki	kg	0.35	0.04	0.34	0.04	ns
	%	0.35	0.04	0.34	0.04	ns

\*\* means differ significantly at  $P \leq 0.01$ .

\*\* istotne statystycznie dla  $P \leq 0,01$ .

ns – insignificant differences.

ns – nieistotne statystycznie.

Table 3. Description of internal organs of fatteners with differing carcass meatiness  
 Tabela 3. Charakterystyka narządów wewnętrznych tuczników o różnicowanej miąższości tuszy

Traits Cechy	Meatiness of carcass, % – Miąższość tuszy, %								Tukey's test test Tukeya
	Class U – Klasa U (1)		Class E – Klasa E (2)		Class S – Klasa S (3)				
	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD			
Body weight Masa przedubojowa	kg	99.88	0.83	100.82	1.24	100.21	0.79		1-2,3
Meatiness Miąższość	%	53.43	0.66	57.51	0.85	62.75	1.64		1-2,3; 2-3
Heart	kg	0.35	0.06	0.39	0.06	0.40	0.03		1-2,3;
Serice	%	0.35	0.06	0.38	0.06	0.40	0.03		1-2,3;
Lungs	kg	0.90	0.15	1.24	0.24	1.16	0.29		1-2,3;
Płuca	%	0.91	0.15	1.23	0.23	1.16	0.30		1-2,3;
Liver	kg	1.67	0.17	1.76	0.20	1.78	0.20		1-2,3;
Wątroba	%	1.66	0.18	1.75	0.20	1.76	0.19		1-2,3;
Spleen	kg	0.17	0.03	0.17	0.02	0.18	0.02		ns;
Sledziona	%	0.17	0.03	0.17	0.02	0.18	0.02		ns;
Kidneys	kg	0.32	0.04	0.36	0.03	0.35	0.04		1-2,3;
Nerki	%	0.32	0.04	0.36	0.03	0.35	0.04		1-2,3;

\*\* means differ significantly at  $P \leq 0.01$ .

\*\* istotnie statystycznie dla  $P \leq 0.01$ .

ns – insignificant differences.

ns – nieistotne statystycznie.

It should also be observed that in the group of fatteners whose carcass was characterized by very high meat-content (S class) a stoppage of the growth of the weight and proportion of the heart and liver was observed, while in the case of lungs and kidneys, even a slight decrease in the weight and proportion was observed, in comparison to the fatteners whose carcass was classified into the E class (Table 3). According to Kołacz [2006], extreme meat-content results in poorer adaptive capabilities and high susceptibility to stress of fatteners due to cardiac and respiratory insufficiency associated with a low weight of the heart and lungs.

## CONCLUSION

The conducted research proves that the weight of organs and their proportion to body weight of fatteners was significantly influenced by the breed factor. Particularly visible differences in the weight of internal organs were observed between the Polish Large White and Duroc breeds. A statistically significant influence of fat-content of fatteners on the weight of organs was also observed. Fatteners with lower fat-content were characterized by a higher weight and proportion of the heart, lungs and liver. It was also proved that fatteners with a higher meat-content were characterized by a higher weight and proportion of the heart, liver and kidneys. Particularly high dynamism of the growth of the weight and proportion of these internal organs was observed between those fatteners whose carcass was classified into the U and E classes of the SEUROP system.

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## WPLYW WYBRANYCH CZYNNIKÓW NA MASĘ NARZĄDÓW WEWNĘTRZNYCH TUCZNIKÓW

**Streszczenie.** Celem badań było określenie wpływu rasy, mięsności i otłuszczenia tuczników na masę wybranych narządów wewnętrznych. Materiał badawczy stanowiło 120 tuczników rasy polskiej białej zwisłouchej, wielkiej białej polskiej, pietrain i duroc. Po uboju tuczników i badaniu weterynaryjnym pobierano do oceny narządy wewnętrzne: serca, płuca, wątrobę, śledzionę, nerki. Pobrane narządy ważono z dokładnością do 0,01 kg. Na podstawie masy narządów i masy tuczników przed ubojem obliczono wskaźnik udziału ocenianych narządów wewnętrznych do masy ciała tuczników. Z przeprowadzonych badań wynika, że na masę narządów oraz ich udział w masie ciała tuczników istotnie wpływał czynnik rasowy. Szczególnie wyraźne różnice ciężaru organów wewnętrznych odnotowano między rasą wbp i duroc. Wykazano również statystycznie istotny wpływ otłuszczenia i mięsności tuczników na masę narządów. Większą masą i udziałem serca, płuc i wątroby charakteryzowały się tuczniaki o mniejszym otłuszczeniu i wyższej mięsności.

**Słowa kluczowe:** mięsność, narządy wewnętrzne, otłuszczenie, rasa, świnia, tucznik

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