Effect of growth rate on slaughter value and meat quality of pigs

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The aim of the study was to determine the relationship between rate of growth, muscling and physicochemical traits of meat. Subjects were Polish Large White, Polish Landrace and Pietrain gilts tested at a performance station. Throughout the fattening period, animals were kept in individual pens and fed *ad libitum*. Gilts were assigned based on their daily gains to either a high-gain (over 850 g) or low-gain group (below 849 g). It was shown that low-gain (slower-gaining) animals were about 20 days older at slaughter compared to gilts with high daily gains. At the same time, the longer period of fattening to 100 kg body weight caused a significantly higher feed consumption per kg weight gain. The results of post-slaughter evaluation showed a significant relationship between daily feed intake and carcass meat content. Lower fat content and greater muscling were found in animals with a lower daily feed intake. This shows that animals from this group were more efficient in conversion of dietary protein into meat protein. The rate of growth had no significant effect on meat quality characteristics.

KEY WORDS: pigs / rate of growth / fattening traits / slaughter traits / meat quality

Changes in the live pig market in Poland and abroad have forced breeders to intensify work on the improvement of pigs. Studies by Chen et al. [2], Eckert and Żak [3], Kennedy et al. [8] and Orzechowska and Eckert [15] suggest that both the rate of growth and the quality of pork carcasses have changed considerably over the years.

Station test results indicate consistent improvements in daily weight gains and feed intake per kg weight gain. As reported by Różycki and Tyra [19], over the last 10 years, feed intake per kg body weight gain decreased from 3.6 kg to 2.56 kg in the Polish Large White breed and from 3.65 kg to 2.53 kg in the Polish Landrace breed. This was paralleled by increases in daily weight gain (by 92 g and 73 g, respectively) and in meat content of primal cuts (by 3.1 kg and 3.5 kg, respectively) in the analyzed breeds of pigs.

Some authors [9, 11, 12, 21] showed that the higher rate of growth in currently used pig breeds was not always accompanied by greater protein deposition in the body and thus greater muscling.

The aim of the study was to determine the effect of rate of growth on slaughter value and meat quality in performance tested Polish Large White, Polish Landrace and Pietrain pigs.

Material and methods

The study was carried out with 300 Polish Large White, Polish Landrace and Pietrain gilts tested at the Pig Performance Testing Station in Pawłowice. Animals were housed in individual pens and fed *ad libitum* concentrates: diet I (13.5 MJ and 13.9% digestible protein) from 25 to 80 kg body weight and diet II (13.0 MJ and 12.8% digestible protein) from 80 to 100 kg body weight. Composition and nutritive value of the diets is shown in Table 1.

The pigs were slaughtered at 100 kg body weight and their right half-carcasses were dissected according to the Pig Performance Testing Station procedures [17]. Carcass meat content was calculated using the formula:

$y = 1.745x_1 + 0.836x_2 + 0.157x_3 - 1.884$

where:

y – calculated meat content (kg),

x_1 – ham without skin and backfat (kg),

x_2 – loin without backfat + tenderloin (kg),

x_3 – double width + height of loin eye (2A + B) (cm)

Quality of meat was determined based on pH of meat measured 45 min *post mortem* in *longissimus dorsi* muscle using a pH Star CPU device (Matthäus) equipped with a spearhead electrode. The next measurements of meat quality were made after 24 h on loin meat chilled at 4°C. The second measurement of meat pH (pH_{24}) was made in addition to measurement of meat lightness (L*) using a Minolta CR-310 chroma meter.

Water holding capacity was determined in ground meat using the method of Grau and Hamm [6]. After analyzing individual daily weight gains, animals were assigned to either a high-gain (over 850 g per day) or low-gain group (below 849 g per day).

The results were analyzed statistically by analysis of variance and Duncan's multiple range test using SAS statistical package.

Results and discussion

In order to characterize the population of Polish Large White, Polish Landrace and Pietrain pigs investigated in the present study, Table 2 lists the results of gilts of these breeds in the station test. In terms of fattening and slaughter traits, the data show that the breeds differ in the level of productive traits.

The analysis of fattening traits showed that Polish Landrace pigs were characterized by the highest daily gain and the lowest feed intake per kg weight gain. Compared to the Polish Landrace breed, slightly lower values for the analyzed traits were obtained by Polish Landrace gilts. Pietrain gilts had the lowest weight gain and the highest feed intake per kg

Table 1 – Tabela 1

Nutritional parameters of feed
Parametry pokarmowe paszy

Components Składniki	Mixture I (30-80 kg b.w.) Mieszanka I (30-80 kg m.c.)	Mixture II (80-100 kg b.w.) Mieszanka II (80-100 kg m.c)
Metabolizable energy, min. (kcal/kg) Energia metaboliczna, min. (kcal/kg)	3223.28	3104.02
Metabolizable energy, min. (MJ/kg) Energia metaboliczna, min. (MJ/kg)	13.50	13.00
Crude protein, min. – max. (%) Białko ogólne min. – maks. (%)	17 – 19	16 – 18
Digestible protein, min. (%) Białko strawne, min. (%)	13.90	12.80
Crude fat, approx. (%) Tłuszcz surowy, orient. (%)	3 – 7	2 – 6
Linoleic acid, min. (%) Kwas linolowy, min. (%)	1.50	1.00
Lactose, min. (%) Laktoza, min. (%)	0.00	0.00
Crude fibre, min. – max. (%) Włókno surowe, min. – maks. (%)	2.5 – 4.5	3.0 – 5.0
Amino acids – Aminokwasy: lysine, approx. (%) lizyna, orient. (%)	1.04	0.85
available lysine, min. (%) lizyna przyswajalna, min. (%)	0.82	0.68
methionine, approx. (%) metionina, orient. (%)	0.32	0.26
available methionine, min. (%) metionina przyswajalna, min. (%)	0.29	0.23
methionine + cystine, approx. (%) metionina + cystyna, orient. (%)	0.64	0.52
available meth. + cyst., min. (%) meth. + cyst. przyswajalna, min. (%)	0.53	0.45
tryptophan, approx. (%) tryptofan, orient. (%)	0.21	0.17
available tryptophan, min. (%) tryptofan przyswajalny, min (%)	0.16	0.14
threonine, approx. (%) treonina, orient. (%)	0.67	0.53
available threonine, min. (%) treonina przyswajalna, min. (%)	0.55	0.48

Table 2 – Tabela 2

Fattening and slaughter traits of Polish Large White, Polish Landrace and Pietrain gilts tested at Polish Pig Testing Stations
Wyniki cech tucznych i rzeźnych loszek ras wbp, pbz i pietrain ocenianych w SKURTCh

Traits – Cechy		Breeds – Rasy		
		PLW wbp	PL pbz	PIETRAIN
No. of animals (heads) Liczba zwierząt (sztuk)	n	97	100	109
Daily gain (g)	x	891	865	830
Przyrost dzienny (g)	δ	88.1	66.10	123
Feed conversion per kg of gain (kg)	x	2.55	2.56	2.71
Zużycie paszy na 1 kg przyrostu m.c. (kg)	δ	0.22	0.27	0.37
Age at slaughter (days)	x	177	175	182
Wiek uboju (dni)	δ	16.10	18.1	29.6
Days of fattening	x	88.0	89.6	97.9
Dni tuczu	δ	9.37	7.65	13.5
Feed intake per kg of gain meat of primary cuts (kg)	x	8.39	8.18	8.06
Zużycie paszy na 1 kg przyrostu mięsa wyręb. podst. (kg)	δ	0.72	0.87	1.28
Daily feed intake (kg)	x	2.26	2.21	2.19
Dzienne zużycie paszy (kg)	δ	0.22	0.19	0.23
Ham without backfat and skin (kg)	x	8.89	9.03	9.97
Szynka zadnia bez słoniny i skóry (kg)	δ	0.39	0.35	0.69
Mean backfat thickness from 5 measurements (cm)	x	1.72	1.43	1.32
Średnia grubość słoniny z 5 pomiarów (cm)	δ	0.41	0.28	0.31
Loin eye area (cm^2)	x	55.2	56.5	67.4
Powierzchnia „oka" polędwicy (cm^2)	δ	5.63	4.73	8.23
Carcass meat percentage	x	59.2	61.4	64.9
Procentowa zawartość mięsa w tuszy	δ	2.96	2.17	3.11
Meat of primal cuts (kg)	x	23.6	24.1	26.4
Mięso wyrębów podstawowych (kg)	δ	1.05	0.88	1.55

weight gain. An inverse tendency was observed for slaughter traits. Pietrain gilts achieved best results for slaughter traits, with thinnest backfat (1.32 cm), largest loin eye area (67.4 cm^2), heaviest ham (9.97 kg) and greatest carcass meat percentage (64.9%). Compared to Pietrain gilts, Polish Landrace gilts had thicker backfat (by 0.5 cm), smaller loin eye area (by 12.2 cm^2), lighter ham (by 1.08 kg) and lower carcass meat percentage (by 5.7%).

Table 3 lists the fattening traits of gilts of the analyzed breeds depending on growth rate. In higher-gaining gilts, daily weight gain averaged 935 g in Polish Large White, 902 g in Polish Landrace and 976 g in the Pietrain breed. Lower-gaining gilts had an average daily gains of 794 g, 794 g and 763 g, respectively. These data show that lower-gaining

Table 3 – Tabela 3

Fattening traits of different pig breeds according to growth intensity
Cechy tuczne różnych ras świń w zależności od intensywności wzrostu

Traits – Cechy		Weight gain groups – Grupy o przyrostach	
		above 850 g per day powyżej 850 g na dzień	849 g and less 849 g i mniej
1	2	3	4
Polish Large White – wielka biała polska			
No. of animals (heads) Liczba zwierząt (sztuk)	n	67	30
Daily gain (g)	x	935.15^{A}	793.83^{A}
Przyrost dzienny (g)	δ	60.57	55.60
Feed conversion per kg of gain (kg)	x	2.51^{a}	2.65^{a}
Zużycie paszy na 1 kg przyrostu m.c. (kg)	δ	0.19	0.24
Age at slaughter (days)	x	171.31^{A}	190.90^{A}
Wiek uboju (dni)	δ	11.77	19.07
Days of fattening	x	83.51	98.07
Dni tuczu	δ	5.09	8.95
Feed intake per kg of gain meat of primary cuts (kg)	x	8.32	8.53
Zużycie paszy na 1 kg przyrostu mięsa wyr. podst.	δ	0.72	0.71
Daily feed intake (kg)	x	2.34^{A}	2.09^{A}
Dzienne zużycie paszy (kg)	δ	0.20	0.17
Polish Landrace – polska biała zwisłoucha			
No. of animals (heads) Liczba zwierząt (sztuk)	n	66	34
Daily gain (g)	x	902.23^{A}	793.35^{A}
Przyrost dzienny (g)	δ	42.83	42.13
Feed conversion per kg of gain (kg)	x	2.48^{A}	2.72^{A}
Zużycie paszy na 1 kg przyrostu m.c. (kg)	δ	0.23	0.26
Age at slaughter (days)	x	169.15^{A}	187.68^{A}
Wiek uboju (days)	δ	14.97	17.67
Days of fattening	x	85.45	97.50
Dni tuczu	δ	3.84	6.93
Feed intake per kg of gain meat of primary cuts (kg)	x	7.99^{A}	8.54^{A}
Zużycie paszy na 1 kg przyrostu mięsa wyr. podst.	δ	0.82	0.86
Daily feed intake (kg)	x	2.23	2.16
Dzienne zużycie paszy (kg)	δ	0.18	0.19

1	2	3	4
	Pietrain		
No. of animals (heads) Liczba zwierząt (sztuk)	n	51	58
Daily gain (days)	x	975.67^{A}	762.84^{A}
Przyrost dzienny (dni)	δ	104.49	54.46
Feed conversion per kg of gain (kg)	x	2.64^{a}	2.78^{a}
Zużycie paszy na 1 kg przyrostu m.c. (kg)	δ	0.42	0.30
Age at slaughter (days)	x	172.53^{A}	191.17^{A}
Wiek uboju (dni)	δ	32.28	24.03
Days of fattening	x	90.93	102.90
Dni tuczu	δ	16.12	8.27
Feed intake per kg of gain meat of primary cuts (kg)	x	7.85^{a}	8.24^{a}
Zużycie paszy na 1 kg przyrostu mięsa wyr. podst.	δ	1.23	1.31
Daily feed intake (kg)	x	2.27^{A}	2.11^{A}
Dzienne zużycie paszy (kg)	δ	0.21	0.23

A – values marked with the same letters differ significantly (P≤0.01) – wartości oznaczone tymi samymi literami różnią się statystycznie istotnie (P≤0,01)
a – values marked with the same letters differ significantly (P≤0.05) – wartości oznaczone tymi samymi literami różnią się statystycznie istotnie (P≤0,05)

animals were about 20 days older at slaughter compared to higher-gaining animals. The longer fattening period of animals with 25-100 kg b.w. caused a significantly higher feed intake per kg weight gain. This is not favourable in terms of fattening efficiency because feed expenditure per kg weight gain determines whether fattening is profitable or not. For these reasons, in addition to parameters of carcass slaughter quality, the selection index of the station test also accounts for daily weight gain. These activities caused an improvement in these traits, although considerable differences in these parameters still occurred within animals of the same breed. This may result not only from the genetic potential of animals, but also from other (physiological and environmental) factors.

The fact that station methodology was changed by adopting *ad libitum* feeding instead of standard feeding and by increasing the final weight of gilts from 86 kg to 100 kg [17] increased the fattening period to 180 days, i.e. to the point when many gilts reach sexual maturity and the associated estrus. Orzechowska and Mucha [14] showed that about 40% of gilts tested at the Pig Performance Testing Station had at least one oestrus at slaughter. According to Ellison-Seling and Andersson [4] and Fandrejewski [5], the occurrence of oestrus is paralleled by loss of appetite, which is associated with reduced feed intake and leads to a decrease in body weight gains. Differences in daily weight gains that occur in some gilts within a breed may result from the fact that they achieved sexual maturity.

Station test results, published every year in "Stan hodowli i wyniki oceny świń" [19], indicate a consistent improvement of daily gains. This value increased over 10 years from 830 g to

Table 4 – Tabela 4

Some slaughter traits of different breeds of pigs according to growth intensity
Niektóre cechy użytkowości rzeźnej tuczników różnych ras świń w zależności od intensywności wzrostu

Traits – Cechy		Weight gain groups – Grupy o przyrostach	
		above 850 g per day powyżej 850 g na dzień	849 g and less 849 g i mniej
Polish Large White – wielka biała polska			
Ham without backfat and skin (kg)	x	8.81[a]	9.06[a]
Szynka zadnia bez słoniny i skóry (kg)	δ	0.39	0.31
Mean backfat thickness from 5 measurements (cm)	x	1.80[A]	1.52[A]
Średnia grubość słoniny z 5 pomiarów (cm)	δ	0.42	0.33
Loin eye area (cm^2)	x	54.71	56.20
Powierzchnia „oka" polędwicy (cm^2)	δ	5.71	5.40
Carcass meat percentage	x	58.47[A]	60.69[A]
Procentowa zawartość mięsa w tuszy	δ	2.95	2.36
Meat of primary cuts (kg)	x	23.46[a]	24.01[a]
Mięso wyrębów podstawowych (kg)	δ	1.05	0.98
Polish Landrace – polska biała zwisłoucha			
Ham without backfat and skin (kg)	x	8.92[A]	9.23[A]
Szynka zadnia bez słoniny i skóry (kg)	δ	0.31	0.36
Mean backfat thickness from 5 measurements (cm)	x	1.49[a]	1.32[a]
Średnia grubość słoniny z 5 pomiarów (cm)	δ	0.26	0.27
Loin eye area (cm^2)	x	56.04	57.45
Powierzchnia „oka" polędwicy (cm^2)	δ	4.83	4.45
Carcass meat percentage	x	60.88[A]	62.53[A]
Procentowa zawartość mięsa w tuszy	δ	2.01	2.07
Meat of primary cuts (kg)	x	23.90[A]	24.61[A]
Mięso wyrębów podstawowych (kg)	δ	0.83	0.79
Pietrain			
Ham without backfat and skin (kg)	x	9.83[a]	10.06[a]
Szynka zadnia bez słoniny i skóry (kg)	δ	0.49	0.79
Mean backfat thickness from 5 measurements (cm)	x	1.35	1.29
Średnia grubość słoniny z 5 pomiarów (cm)	δ	0.32	0.31
Loin eye area (cm^2)	x	68.58	66.46
Powierzchnia „oka" polędwicy (cm^2)	δ	7.99	8.37
Carcass meat percentage	x	64.08[A]	65.52[A]
Procentowa zawartość mięsa w tuszy	δ	2.25	3.59
Meat of primary cuts (kg)	x	26.18	26.51
Mięso wyrębów podstawowych (kg)	δ	1.12	1.84

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Table 5 – Tabela 5

Physicochemical parameters of *m. longissimus dorsi* of pigs according to rate of their growth
Parametry fizykochemiczne mięśnia najdłuższego grzbietu tuczników w zależności od ich tempa wzrostu

Traits – Cechy		Weight gain groups – Grupy o przyrostach	
		above 850 g per day powyżej 850 g na dzień	849 g and less 849 g i mniej
Polish Large White – wielka biała polska			
pH	x	6.27	6.18
	δ	0.35	0.38
pH_{24}	x	5.61	5.64
	δ	0.14	0.19
Barwa	x	54.85	53.73
Colour	δ	2.86	3.13
Wodochłonność	x	33.57	31.54
Water holding capacity	δ	7.57	5.64
Polish Landrace – polska biała zwisłoucha			
pH	x	6.28	6.16
	δ	0.46	0.31
pH_{24}	x	5.64	5.62
	δ	0.24	0.18
Barwa	x	55.04	54.50
Colour	δ	3.51	2.73
Wodochłonność	x	31.91	30.71
Water holding capacity	δ	6.50	5.88
Pietrain			
pH	x	6.04[a]	5.82[a]
	δ	0.54	0.51
pH_{24}	x	5.53	5.48
	δ	0.14	0.14
Barwa	x	57.60	56.28
Colour	δ	4.58	4.16
Wodochłonność	x	30.95	29.93
Water holding capacity	δ	6.06	6.25

a – values marked with the same letters differ significantly (P≤0.05) – wartości oznaczone tymi samymi literami różnią się statystycznie istotnie (P≤0,05)

889 g in Polish Large White, from 861 g to 913 g in Polish Landrace, and from 736 to 825 g in the Pietrain breed. Research has shown considerable variation of this trait within breeds, which suggests that it can be further improved through selection. One has to consider, however, whether excessively high gains observed in some animals will bring negative consequences in the form of greater carcass fatness, as reported by Quinion et al. [16] and Thomke et al. [20].

The results of post-slaughter evaluation of the pigs indicate a possible relationship between daily feed intake and carcass quality (Tab. 4). Animals that showed both higher feed intake and more rapid growth rate were characterized by greater fatness and smaller muscling compared to pigs that had lower daily feed intake. Animals with lower feed intake were more efficient in feed protein conversion into body protein and thus showed better capacity for carcass meat production. Similar tendencies were found by Koczanowski et al. [9], Michalska et al. [10] and Nowachowicz [12]. Bikker et al. [1] report that with *ad libitum* feeding, the appetite of animals may influence the amount of protein deposition and the extent of weight gains. Pietrain pigs, which had lower feed intake capacity compared to other breeds [7] are one example. The results obtained suggest that Pietrain breeds currently used in Poland are characterized by similar fattening properties to Polish Large White and Polish Landrace pigs.

In terms of meat quality traits, no significant differences were found between pigs differing in growth rate. Only in the Pietrain breed, there was the meat of higher-gaining pigs characterized by significantly lower pH measured 45 min *post mortem* (Tab. 5).

Literature data suggest that a decrease in meat quality is strictly related to increased carcass muscling. This relationship is confirmed by the Pietrain pigs, which had the highest carcass meat content. Both 10 years ago and today, the meat of Pietrain pigs has been characterized by poorer quality indicators compared to other breeds raised in Poland [13].

Determining the relationship between growth rate and physicochemical characteristics of meat while accounting for carcass meatiness will make it possible to determine the extent to which selection for improved daily gains should be carried out so as not to decrease meat quality, which is negatively correlated with fattening and slaughter traits [18].

The following conclusions can be drawn from this study:

– lower growth rate is appropriate to obtain best meatiness results,

– higher growth rate is more favourable in terms of pork production economy.

Selection carried out using the present station and performance test index will further improve carcass muscling without improving meat quality. When selecting animals, both carcass quality and meat quality should be regularly monitored in the animals obtained.

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Wpływ tempa wzrostu na wartość rzeźną i jakość mięsa tuczników

S t r e s z c z e n i e

Badania miały na celu ustalenie związku pomiędzy tempem wzrostu, umięśnieniem a cechami fizykochemicznymi mięsa. Materiał do badań stanowiły loszki ras wbp, pbz i pietrain, oceniane w stacji kontroli. Przez cały okres tuczu zwierzęta utrzymywane były w kojcach indywidualnych i żywione *ad libitum*. Na podstawie wielkości przyrostów dobowych loszki podzielono na 2 grupy: o wysokich przyrostach (powyżej 850 g) i o niskich przyrostach (poniżej 849 g). Wykazano, że zwierzęta o niskich przyrostach, tj. o wolniejszym tempie wzrostu, osiągnęły masę ubojową o ok. 20 dni później niż zwierzęta o wysokich dobowych przyrostach masy ciała. Dłuższy okres tuczu do 100 kg masy ciała spowodował istotnie wyższe zużycie paszy na 1 kg przyrostu. Wyniki oceny poubojowej zwierząt wykazały istotny związek pomiędzy wielkością dziennego pobrania paszy a zawartością mięsa w tuszy. Stwierdzono mniejsze otłuszczenie i większe umięśnienie u loszek pobierających dziennie mniejszą ilość paszy. Wynika stąd, że zwierzęta o niższym tempie wzrostu lepiej wykorzystywały białko z paszy na odłożenie białka w mięsie. Nie stwierdzono istotnego wpływu tempa wzrostu na cechy jakościowe mięsa.

SŁOWA KLUCZOWE: świnie / tempo wzrostu / cechy tuczne / cechy rzeźne / jakość mięsa