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MEATINESS AND FATNESS TRAITS OF POLISH LARGE WHITE AND POLISH LANDRACE PIGS DIFFERING IN FATTENING TRAITS

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Abstract

Rate of growth and feed conversion during the fattening period were studied in relation to carcass meatiness and fatness traits such as fat area over loin eye, loin eye area, fat to muscle ratio, carcass meat percentage, mean backfat thickness from 5 measurements, backfat thickness over shoulder, and backfat thickness over loin eye. The present study showed a low relationship between the analysed fattening traits and carcass slaughter parameters, with low coefficients of correlation. Breeding programmes aimed at improving growth rate and increasing feed conversion (kg feed/kg gain) may lead to decreased meat content and increased carcass fatness. Compared to Polish Landrace pigs, Polish Large White pigs are characterized by greater variation of carcass meatiness and fatness traits.

Key words: pigs, fattening performance, backfat thickness, meatiness

Market analysis reveals that consumers prefer carcass components characterized by optimum muscling, low fatness and good quality of meat (Blicharski et al., 2003). Therefore, when selecting pigs for improved meatiness, attention should be given to the meatiness of most valuable cuts in addition to carcass meat percentage. This holds in particular for loin and ham, which form a considerable part of pork carcass (Virgili et al., 2003). The fat and meat content of carcass cuts and the ratios between these tissues determine whether they are technologically suitable for processing or can be sold in raw form (Blicharski et al., 2004). This translates into the economic aspect of production as it determines the price for which a fattener can be sold. Fatness of carcass and carcass cuts may also provide information on meat quality. Sonesson et al. (1998) and Orzechowska (2005) report that selecting for decreased subcutaneous fat while maintaining appropriate levels of intramuscular fat give better results than selecting for increased carcass meat percentage because good quality meat is maintained and meatiness increased. If too low, fatness of carcass cuts is related to poorer taste resulting from reduced content of intramuscular fat in the cuts (Faucitano et al., 2003). Fattening performance is the second important factor contributing to improvement of

the pig population. Fattening traits include rate of growth (expressed as daily weight gains) and feed conversion ratio (kg feed/kg gain). These traits are directly related to fattening economics, because pig feeding costs account for around 2/3 of the total costs of fattener production. Daily gains are a trait included in both live and postmortem evaluation of pigs. There are some opinions in the literature that both daily gains and feed intake are antagonistic to carcass meatiness (Cameron and Curran, 1995). These views suggest that breeding programmes aimed at improving meatiness may negatively affect fattening parameters.

Considering the fact that both carcass slaughter parameters and fattening performance are related to profitability of live pig production, this study was undertaken to determine if growth rate and feed conversion ratio during the fattening period are related to carcass meatiness and fatness traits. Slaughter parameters that can be determined without detailed carcass dissection were analysed.

Material and methods

The study was conducted at the Pig Testing Station of the National Research Institute of Animal Production using 113 Polish Large White (PLW) and 120 Polish Landrace (PL) gilts. Animals were raised and fed in accordance with regulations established by Polish pig testing stations (Różycki, 1995). Pigs were slaughtered at the end of control fattening, which according to the methodology described above takes place at 100 kg body weight. After 24-hour cooling of carcasses at 4°C, backfat thickness on the back was determined in 5 points – over shoulder, over cross-section of loin muscle, and over the loin (3 measurements). Left half-carcasses were then cut according to the EU reference dissection method (Walstra and Merkus, 1995). Loin cross-section was photographed at the cross-section between the last thoracic vertebra and the first lumbar vertebra. Loin eye area and fat over loin eye were calculated by planimetering the photographs using PlaniMeat software. The fat to muscle ratio was calculated based on the formula used in German pig testing stations (Götz, 2000):

$$\frac{\text{Fat area over loin eye}}{\text{Loin eye area}}$$

The following slaughter parameters were analysed:
– fat area over loin eye,
– loin eye area,
– fat to muscle ratio,
– carcass meat percentage ,
– mean backfat thickness from 5 measurements,
– backfat thickness over shoulder,
– backfat thickness over loin eye.

Animals were divided into groups according to the level of particular fattening parameters. As regards the rate of growth, animals were assigned to 3 groups accord-

ing to daily gains during control fattening: over 950 g (group 1), from 800 to 950 g (group 2) and below 800 g (group 3). Another 3 groups were formed according to feed conversion ratio (kg feed/kg gain): over 3.2 kg (group 1), from 2.8 to 3.2 kg (group 2) and below 2.8 kg (group 3).

The results obtained were analysed statistically using the SAS package. Differences between groups within breeds and between breeds within groups were analysed using Duncan's multiple range test.

Results

Table 1 shows data for animals of the different breeds studied. They show that Polish Large White pigs were characterized by greater fatness, with highly significant differences found only for backfat thickness over shoulder. A highly significant difference was also found for the meat content of the pigs. Compared to Polish Landrace pigs, Polish Large White pigs showed greater variation for most parameters studied, as evidenced by the standard deviations.

The effect of different rates of growth on carcass slaughter parameters is presented in Table 2. Pigs characterized by the highest gains had thickest backfat and smallest loin cross-section area. The level of weight gains had no significant effect on the slaughter parameters studied in Polish Large White pigs, while for the Polish Landrace breed, animals from extreme groups differed highly significantly in mean backfat thickness. Polish Large White pigs differed highly significantly from Polish Landrace pigs in loin cross-section area and carcass meatiness (within group 2) and significantly in backfat thickness over shoulder (within groups 2 and 3).

Table 1. General characteristics of the slaughter parameters analysed in PLW and PL pigs

Trait	n	x	σ	Min.	Max.
PLW					
Fat area over loin eye (cm^2)		16.54	4.58	5.96	30.73
Loin eye area (cm^2)		49.74	4.99	36.31	61.17
Fat to muscle ratio		3.30	1.24	1.43	9.52
Carcass meatiness	113	56.61**	3.11	46.70	63.60
Mean backfat thickness from 5 measurements (cm)		1.56	0.38	0.84	2.76
Backfat thickness over shoulder (cm)		2.74**	0.53	1.10	4.60
Backfat thickness over loin eye (cm)		1.15	0.31	0.60	2.30
PL					
Fat area over loin eye (cm^2)		15.66	3.30	7.81	25.22
Loin eye area (cm^2)		51.33	6.67	34.58	69.45
Fat to muscle ratio		3.45	0.96	1.43	6.41
Carcass meatiness	120	57.90**	2.94	48.10	67.20
Mean backfat thickness from 5 measurements (cm)		1.46	0.30	0.84	2.44
Backfat thickness over shoulder (cm)		2.47**	0.42	1.30	3.40
Backfat thickness over loin eye (cm)		1.13	0.31	0.50	2.10

** – $P<0.01$.

Table 2. Mean values of slaughter parameters in PLW and PL pigs according to daily gains

Trait	Daily gain on test (25–100 kg)		
	> 950 g	800–950 g	< 800 g
PLW			
n	11	73	29
Fat area over loin eye (cm^2)	17.92±4.25	16.80±4.50	15.31±4.78
Loin eye area (cm^2)	49.21±4.86	49.89**±5.05	49.57±5.05
Fat to muscle ratio	2.92±0.88	3.20±0.99	3.71±1.78
Carcass meatiness	56.87±2.18	56.41**±3.30	57.04±2.92
Mean backfat thickness from 5 measurements (cm)	1.56±0.40	1.58±0.38	1.53±0.37
Backfat thickness over shoulder (cm)	2.86±0.54	2.72*±0.54	2.74*±0.50
Backfat thickness over loin eye (cm)	1.20±0.33	1.15±0.32	1.12±0.30
PL			
n	12	86	22
Fat area over loin eye (cm^2)	15.83±2.67	15.80±3.43	15.02±3.13
Loin eye area (cm^2)	49.29±6.67	51.74**±6.13	50.89±8.58
Fat to muscle ratio	3.23±0.86	3.46±0.99	3.54±0.94
Carcass meatiness	56.81±1.44	58.05**±2.98	57.91±3.34
Mean backfat thickness from 5 measurements (cm)	1.58a±0.31	1.47±0.28	1.35a±0.34
Backfat thickness over shoulder (cm)	2.61±0.38	2.47*±0.43	2.41*±0.39
Backfat thickness over loin eye (cm)	1.22±0.34	1.14±0.31	1.04±0.26

* – P<0.05 (between breeds), ** – P<0.01 (between breeds), a – P<0.05 (between groups within breed).

Table 3. Mean values of slaughter parameters in PLW and PL pigs according to feed conversion

Trait	Feed conversion (kg feed/kg gain)		
	>3.2 kg	2.8–3.2 kg	<2.8 kg
PLW			
n	35	62	16
Fat area over loin eye (cm^2)	16.07±4.30	16.28±3.95	18.80±6.91
Loin eye area (cm^2)	47.95±5.50	50.37*±5.08	51.46*±4.45
Fat to muscle ratio	3.26±1.21	3.31±1.03	3.32±2.03
Carcass meatiness	56.03a±3.24	57.15a±2.59	55.81*±4.28
Mean backfat thickness from 5 measurements (cm)	1.60±0.38	1.52±0.33	1.65±0.53
Backfat thickness over shoulder (cm)	2.82**a±0.49	2.67a±0.50	2.86±0.66
Backfat thickness over loin eye (cm)	1.15±0.30	1.14±0.30	1.18±0.39
PL			
n	48	56	16
Fat area over loin eye (cm^2)	15.95±3.81	15.63±2.96	14.86±2.68
Loin eye area (cm^2)	49.58A±6.25	51.80*±6.94	55.13*A 6.10
Fat to muscle ratio	3.31±0.95	3.47±0.98	3.85±0.88
Carcass meatiness	57.33a±3.32	58.12±2.67	58.88*a±2.34
Mean backfat thickness from 5 measurements (cm)	1.46±0.36	1.45±0.26	1.51±0.22
Backfat thickness over shoulder (cm)	2.43**±0.43	2.47±0.40	2.59±0.44
Backfat thickness over loin eye (cm)	1.11±0.36	1.14±0.29	1.12±0.15

* – P<0.05 (between breeds), ** – P<0.01 (between breeds), a – P<0.05 (within breed), A – P<0.01 (within breed).

The second fattening trait studied – feed conversion (kg feed/kg gain) – had a slightly greater effect on carcass slaughter parameters compared to rate of growth (Table 3). In PLW pigs, feed conversion ratio had a significant effect on carcass meatiness and backfat thickness over shoulder, with differences between groups 1 and 2. PL pigs from groups 1 and 3 differed highly significantly in loin cross-section area and significantly in carcass meatiness. Analysis of the differences between the breeds within individual groups showed higher carcass fatness parameters in PLW pigs and lower muscling parameters compared to PL pigs. In many cases, the statistical analysis confirmed the significant differences.

Coefficients of phenotypic correlation were estimated between daily weight gains and feed conversion ratio vs. slaughter parameters (Table 4). The correlations between the analysed fattening and slaughter traits were low. They were statistically significant only in 4 cases.

Table 4. Coefficients of correlation between fattening traits and slaughter parameters of carcasses

Parameter	Fat area over loin eye	Loin eye area	Fat to muscle ratio	Carcass meat percentage	Mean backfat thickness from 5 measurements	Backfat thickness over shoulder	Backfat thickness over loin eye
PLW breed							
Daily gain	0.15	–0.07	–0.15	–0.07	0.08	0.00	0.11
Feed conversion	–0.11	–0.19*	–0.04	–0.06	–0.05	–0.02	–0.06
PL breed							
Daily gain	0.11	–0.06	–0.14	–0.16	0.19*	0.07	0.17
Feed conversion	0.02	–0.33**	–0.08	–0.14	–0.12	–0.18*	–0.17

* – $P<0.05$, ** – $P<0.01$.

Discussion

The results of our study showed that the level of daily weight gains has a greater effect on carcass fatness compared to carcass slaughter parameters. The decrease in growth rate was paralleled by the decrease in fat area over loin eye, the increase in fat to muscle ratio, and the decrease in backfat thickness over loin eye. This direction of change was observed in pigs of both breeds studied. In addition, in Polish Landrace animals the increase in daily weight gains was paralleled by the increase in overall carcass fatness expressed as mean backfat thickness measured in 5 carcass areas. Analysis of the effect of growth rate on carcass meatiness parameters did not show any clear trends towards improvement or deterioration. Differences between the groups of animals differing in daily weight gains were non-significant for individual slaughter parameters except mean backfat thickness from 5 measurements in Polish Landrace pigs, in which a significant difference was found between the extreme groups.

Today, pig producers and breeders who carry out selection and breeding programmes in herds give attention to meatiness, which is one of the most important factors that determine the final price of the pig. It should be remembered, however,

that carcass meatiness is negatively correlated to the fat content of carcass cuts. Many authors have indicated that the content of subcutaneous and intermuscular fat is positively correlated to the content of intramuscular fat. The level of intramuscular fat in turn has a fundamental effect on sensory parameters of meat and meat products, and thus on their palatability (Enser, 2004; Orzechowska, 2004; Suzuki et al., 2005). Our results showed that animals with high weight gains tended to have greater carcass fatness. It can therefore be concluded that their meat was characterized by a higher content of intramuscular fat compared to slower growing animals and thus had better taste. This thesis is supported by the findings of Łyczyński et al. (2001), who observed statistically significant differences in intramuscular fat content between the groups of slow- and fast-growing animals, in favour of the animals with higher gains. Another method to improve meat sensory parameters related to higher content of intramuscular fat is to increase the final weight of slaughtered pigs. This relationship was reported by Candek-Potokar et al. (1998). This fattening method makes it longer, which directly impinges on the second factor that determines fattening economics, namely feed conversion ratio.

As already mentioned, feeding costs account for over 65% of total costs incurred on the production of a pig and thus have an essential effect on the economic result of live pig production. It therefore seems obvious that breeding programmes are aimed at improving the rate of growth and feed conversion ratio. The investigation of this trait in our study was inspired by Hoque et al. (2007), who analysed feed conversion ratio and found that the heritability of this trait is $h^2 = 0.27$, which means that this trait is subject to considerable influence by environmental factors and there is limited scope for the genetic improvement of this trait. The same authors also reported that long-term selection aimed at improving daily gains, carcass meat content or loin eye area has a positive effect on feed conversion ratio. According to the same authors, selection for feed conversion ratio is expected to improve the fattening and slaughter traits mentioned above. Considering the findings of Hoque et al. (2007), it was justified to include feed conversion ratio and analyse the effect of this factor on carcass slaughter parameters. Analysis of this factor in our study showed more differences between breeds than within groups of animals differing in feed conversion ratio. The results obtained tended to be more consistent with the literature for Polish Landrace compared to Polish Large White pigs. This could be due to the greater variation of the analysed slaughter parameters in Polish Large White pigs. However, it can be stated that in the case of animals of both breeds, the effect of feed conversion ratio was more noticeable for meatiness parameters, i.e. carcass meat percentage and loin eye area. The increasing was paralleled by increased loin eye area and fat to muscle ratio in both breeds analysed, and by increased carcass meat percentage in the Polish Landrace breed. The relationships obtained between feed conversion ratio and slaughter parameters may indicate that there is limited scope for improving carcass slaughter parameters through breeding programmes aimed at improving feed conversion ratio. This is due to low phenotypic correlations between this trait and the slaughter parameters observed in our study. Low and negative coefficients of correlation between fattening traits and carcass meatiness were reported by Cameron and Curran (1995). This is also supported by the findings of Johnson et al. (1999), who obtained low

phenotypic correlations between feed:gain ratio and backfat thickness ($r_p = 0.14$) and between feed:gain ratio and loin eye area ($r_p = 0.16$). According to the same authors, daily feed intake (feed intake capacity) would be a better indicator for use in breeding programmes. This trait is characterized by higher heritability compared to feed conversion ratio. In addition, feed intake capacity is easier to observe in practice compared to feed conversion ratio. It should be noted, however, that efforts to reduce feed intake by the pigs via genetics may have negative consequences in the form of poorer parameters of meat quality, such as reduced pH of meat and less intense meat colour, as indicated by the study of Gilbert et al. (2007). Therefore, improvement of this trait should especially account for the parameters of meat quality, and meat colour in particular, because this trait is of special importance to the consumer, especially when raw meat is sold.

In conclusion, the present results show that the level of fattening traits studied bears little relationship to carcass slaughter parameters. Because of the low coefficients of correlation between the fattening traits studied and parameters of carcass muscling and fatness, there is limited scope for achieving breeding progress in slaughter traits when selecting for fattening traits. Breeding programmes aimed at improving the rate of growth and decreasing feed conversion could result in decreased meat content and increased carcass fatness.

The slaughter parameters studied differ among breeds. Polish Large White pigs are characterized by greater variation of carcass muscling and fatness traits compared to Polish Landrace pigs.

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Wskaźniki charakteryzujące umięśnienie i otłuszczenie świń ras wbp i pbz różniących się pod względem cech tucznych

STRESZCZENIE

Badano zależność między poziomem tempa wzrostu i zużycia paszy w okresie tuczu a wskaźnikami charakteryzującymi umięśnienie i otłuszczenie tuszy – powierzchnią tłuszczu nad „okiem" polędwicy, powierzchnią „oka" polędwicy, stosunkiem tłuszczowo-mięśniowym, procentową zawartością mięsa w tuszy, średnią grubością słoniny z 5 pomiarów, grubością słoniny nad łopatką i grubością słoniny nad „okiem" polędwicy. Wyniki badań wskazują na niewielkie powiązanie poziomu badanych cech tucznych z parametrami rzeźnymi tuszy – niskie współczynniki korelacji. Prowadzenie prac hodowlanych ukierunkowanych na poprawę tempa wzrostu i obniżenie zużycia paszy na 1 kg przyrostu masy ciała może dać efekt w postaci obniżenia zawartości mięsa i zwiększenia otłuszczenia tuszy. Świnie rasy wbp charakteryzują się większą zmiennością wskaźników charakteryzujących umięśnienie i otłuszczenie tuszy w porównaniu do świń rasy pbz.