THE INFLUENCE OF THE INTENSITY OF FATTENING ON GROWTH PERFORMANCE AND MEAT QUALITY OF PIGS

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Abstract. The objective of this study was to determine the effect of daily body weight gains on the slaughter value of growing-finishing pigs and pork quality evaluated based on chemical composition, physicochemical and sensory properties. The experimental materials comprised hybrid pigs - the first generation (F_1) offspring from the crossbreeding of Polish Large White/Polish Landrace sows and Duroc boars, characterized by a calm temperament, desirable carcass traits and a high intramuscular fat content which positively affects pork flavor.

The analyzed carcasses of hybrid pigs were obtained from feeding trials. Pigs were fattened from 30 kg to 115 kg BW. The animals were fed complete diets in friable form, containing 150g/kg total protein, 8.45g/kg total lysine and 12.80 MJ ME/kg. Feed components were as follows: ground wheat, ground barley, soybean meal, rapeseed "00" meal, and feed additives: minerals, vitamins and synthetic amino acids. Daily gains and feed conversion ratio were calculated. The slaughter value of carcasses and the chemical composition, physicochemical and sensory properties of meat were determined after slaughter. A total of 177 carcasses (from three experiments), analyzed in the study, were divided into the following groups, based on the daily gains of pigs: control group 1 – daily gains below 700 g, groups 2, 3, 4 – daily gains of 701 – 800 g, 801 – 900 g, above 900 g, respectively.

Feed conversion improved with an increase in daily gains. Slaughter value, the lean meat and fat content of carcasses were correlated with the growth rate of pigs. Daily gains had no significant effect on the content of dry matter, total protein and intramuscular fat in *m. longissimus dorsi lumborum.* The pH_{45} of pork was not affected by the experimental factor. After 24 hours of carcass chilling, the color parameters and sensory properties of meat were found to improve proportionally to the increase in the daily gains of pigs.

Introduction. The results of numerous research studies indicate that genetic and environmental factors have a varied effect on the slaughter value of pigs and on the correlations between the quantity and quality of pork meat [Kauffman 1996; De Smet *et al.* 1997; Łyczyński *et al.* 2003; Migdał *et al.* 2004; Denaburski and Sobotka 2010]. According to various authors, the growth rate of pigs is determined by nutrition in 65%, genetics in 25% and rearing conditions in 10%. In view of the above, the contemporary pig fattening regime

relies on complete diets whose nutritional value is adapted to the animals' body weight gains and genetic factors conditioning the rate at which pigs deposit protein in the carcass [Białkowski and Falkowski 2000]. Protein (muscle tissue) deposition is genetically conditioned. The pigs' potential meatiness traits are determined by the selection of maternal and paternal breeds. The contemporary breeding programs aim to produce pigs with a high lean meat content of around 57%. Further efforts to maximize the meatiness of growing-finishing pigs have been abandoned, even in Denmark, the leading supplier of meat-type breeds, as this process led to a deterioration in meat quality.

An adequate nutritional regime is needed to take full advantage of the genetic predisposition of pigs to deposit protein. The energy value of feed contributes to fattening effectiveness. In growing-finishing pigs with live weight of up to 50-60 kg, carcass protein deposition grows proportionally to an increase in the intake of metabolizable energy. High-performing pigs are characterized by lower feed consumption levels than less improved breeds, therefore, efforts should be made to increase the concentration of metabolizable energy in complete diets. Fattening intensity should be lower at the second stage of the fattening period which is marked by lower protein deposition rates. Genotype effects are also noticeable at this stage of the fattening process. High-lean breeds may be fed high-energy diets for longer periods of time than average-lean pigs which should be subjected to a restricted feeding regime.

Another factor determining muscle tissue growth is the content of proteins and amino acids, mostly lysine, in diets. The diets fed to high-performance pigs should have a high total lysine content. The levels of the remaining exogenous amino acids are determined based on the "ideal protein" model. In the light of the existing body of research, carcass tissue composition and the quantity and quality of pork meat can be modified subject to feed type and the content of protein and metabolizable energy in the diets fed to pigs [Wiesemuller 1996; Wood *et al.* 2003; Grela 2004; Migdał *et al*. 2004].

The lean meat content of pork carcasses is also determined by the slaughter weight of pigs. In Poland, the optimal chemical and tissue composition of the carcass is reported in pigs with slaughter weight in the range of 90-100 kg. In practice, this threshold is significantly exceeded, and it has a detrimental effect on the meatiness of pork carcasses. According to Borzuta [2002], a model growing-finishing pig is characterized by slaughter weight of 100-120 and a lean meat content of the carcass in the range of 55-60% with no PSE or ASE defects.

In view of variations in the daily gains of growing-finishing pigs, the objective of this study was to determine the effect of gaily gains on the slaughter value of carcasses and the quality of pork meat.

Materials and method. The analyzed carcasses of hybrid pigs ((Polish Large White x Polish Landrace) x Duroc) were obtained from feeding trials conducted in 2004 – 2010. Pigs were fattened from 30 kg to 115 kg BW. The animals were fed complete diets containing 150g/kg total protein, 8.45g/kg total lysine and 12.80 MJ ME/kg, in friable form, in accordance with Pig Nutrient Requirements [1993]. Water was available *ad libitum*. Feed components were as follows: ground wheat, ground barley, soybean meal, rapeseed "00" meal, and feed additives: minerals, vitamins and synthetic amino acids.

Daily gains and feed conversion ratio were calculated for the entire fattening period (from 30 to 115 kg BW). At the completion of feeding trials the pigs were slaughtered at the "Warmia" Meat Processing Plant, immediately after transport. The slaughter quality of carcasses was determined post mortem. A total of 177 carcasses (from three experiments), analyzed in the study, were divided into the following groups, based on the daily gains of pigs:

Specification	Group			
	1-C*	2	3	4
Daily gains, g	below 700	701-800	801-900	above 900
Number of carcasses	13	29	65	70

C - control group*

Immediately after slaughter, the carcasses were graded for conformation and fatness according to the EUROP classification system, using the CGM 100 device. Back fat thickness and the depth of *m. longissimus dorsi lumborum* were measured at the level of the last thoracic vertebra, 7 cm from the carcass midline. After 24 hours of carcass chilling at 2 - 4^{o}C, samples of *m. longissimus dorsi lumborum* were collected to determine: the chemical composition of meat (content of dry matter, crude ash, total protein and intramuscular fat) and energy value – by standard methods (Official Methods 1990), the values of pH_{45} and pH_{24} – with a Radiometer pH-meter and a PHC 4406 electrode, water-holding capacity – by the Grau and Hamm method [Van Oeckel *et al.* 1995], meat color – based on the values of CIELAB coordinates *L**, *a**, *b**, with a Minolta CR-200 camera, the sensory properties ofcooked meat- ona five-point scale (PN-ISO 4121 1998).

Statistical calculations were performed using the STATISTICA data analysis software system [2010]. The significance of differences between mean values in groups was estimated by one-way ANOVA and Duncan's multiple range test.

Results and discussion. Fattening results and the slaughter value of the growing-finishing pigs are presented in Table 1. Feed conversion varied subject to the animals' growth rates. The lowest feed conversion ratio (3.67 kg feed per kg body weight gain) was determined in group 1-C where daily gains were found to be below 700 g. Feed conversion improved with an increase in daily

gains, reaching 3.31 kg/kg in the group of pigs where daily gains were in the range of 701 to 800 g (group 2). A further increase in daily gains (801-900 g in group 3) had a positive effect on the feed conversion ratio which reached 3.00 kg/kg. The highest feed conversion ratio of 2.71 kg/kg was observed in group 4 which was characterized by the highest daily gains in excess of 900 g. The differences between the means of group 1 vs. groups 2, 3 and 4 were statistically significant.

Table 1 – Production results and slaughter value of growing-finishing pigs

Specification		Group				P-values
		1-C [1]	2	3	4	
		Daily gains, g				
		below 700	701 – 800	801 – 900	above 900	
Number of carcasses	n	13	29	65	70	
Feed conversation ratio, kg/kg	$\bar{X}$	$3,67^{A}$	$3,31^{B}$	$3,00^{B}$	$2,71^{B}$	0,00
Final weight, kg	$\bar{X}$	$94,50^{A}$	$102,57^{B}$	$107,54^{B}$	$111,72_{B}$	0,00
Dressing percentage, %	$\bar{X}$	$75,70^{aA}$	$79,56^{b}$	$82,13^{B}$	$86,31^{B}$	0,00
Meat content of carcass, %	$\bar{X}$	56,40	56,88	57,17	58,15	0,12
Thickness of muscule, mm	$\bar{X}$	52,00	56,93	56,42	59,24	0,11
Back fat thickness, mm	$\bar{X}$	12,00	13,57	13,08	12,73	0,63

[1]-control group; a, b – P ≤0,05; A, B – P ≤0,01

The growing-finishing pigs with average daily gains below 700 g were characterized by the lowest average weight at slaughter which reached 91.50 kg. In the remaining experimental groups, slaughter weight was significantly higher. The slaughter weight of animals with daily gains in the range of 701 g to 800 g reached 102.57 kg. The growing-finishing pigs with daily gains between 801 g and 900 g were characterized by average slaughter weight of 107.54 kg. In group 4 pigs with daily gains in excess of 900 g, the analyzed parameter was determined at 111.72 kg.

The data in Table 1 indicate that carcass dressing percentages varied subject to the daily gains of pigs. The lowest carcass dressing percentage (75.70%) was reported in control group 1 (daily gains below 700 g). An increase in the values of this parameter was noted in the experimental groups. In growing-finishing pigs with average daily gains in the range of 701 g to 800 g, the carcass dressing percentage improved by 3.86%. A further 3.23% increase in the studied parameter was observed in the group of pigs with daily gains between 801 g and 900 g. The highest carcass dressing percentage (86.31%) was report-

ed in group 4 which was characterized by daily gains in excess of 900 g. The value of this parameter was higher by 4.18% on average in comparison with group 3, and by 10.61% in reference to the control group. Highly significant differences were determined between the means of group 1-C vs. groups 3 and 4, whereas the differences between the means of group 1 vs. group 2 were found to be significant.

As demonstrated by the data in Table 1, the meat content of the carcass varied subject to the growth rate of animals. The highest meatiness values were noted in control group animals where daily gains were below 700 g. Higher meatiness values were observed in the experimental groups which were also marked by higher daily gains. The reported meat content values are satisfactory, ranging from 56.40% to 58.15% across the analyzed groups.

The thickness of *m. longissimus dorsi lumborum* increased with an improvement in daily gains. Carcass fatness was not significantly correlated with the growth rate of pigs. The lowest carcass fatness values (12 mm) were noted in group 1-C where daily gains were below 700 g, followed by group 4 (12.73 mm) with daily gains in excess of 900 g, and group 3 (13.08 mm), while the highest values of the studied parameter were observed in group 2 (13.57 mm). It should be noted, however, that carcass fatness increased proportionally to the increase in the final body weight of pigs.

A deterioration in the quality of pork meat has been noted in recent years. Whereas selected meat defects have been successfully eliminated, other qualitative parameters, such as a low content of intramuscular fat, continue to deteriorate [Eckert 2008]. The quality of pork was determined by analyzing the chemical composition (Table 2), physicochemical parameters and sensory parameters (Table 3) of *m. longissimus dorsi lumborum*.

Table 2 – Chemical composition and energy value of longissimus dorsi lumborum muscule

Specification		Group				P- values
		1-C[1]	2	3	4	
		Daily gains, g				
		below 700	701 – 800	801 – 900	above 900	
Number of carcasses	n	13	29	65	70	
Dry matter, %	$\bar{x}$	25,27	25,55	25,35	24,93	0,10
Crude ash, %	$\bar{x}$	1,23^{aA}	1,18^{b}	1,16^{B}	1,15^{B}	0,02
Crude protein, %	$\bar{x}$	22,59	22,90	22,62	22,67	0,62
Intramuscular fat, %	$\bar{x}$	1,90	1,96	1,94	1,77	0,82

Gross energy, MJ/kg	$\bar{x}$	5,51	5,53	5,93	5,98	0,63

[1]-control group; a, b – P ≤0,05; A, B – P ≤0,01

The data in Table 2 show that the daily gains of growing-finishing pigs had no significant effect on the content of dry matter, total protein and intramuscular fat in *m. longissimus dorsi lumborum.* Differences were noted only in the crude ash content, subject to the analyzed experimental factor. Crude ash levels increased with an improvement in the daily gains of pigs. Energy values were determined at a similar level in all experimental groups, reaching 5.51 to 5.98 MJ/kg. The results of this experiment correspond to the referenced values for pork meat [Łyczyński *et al.* 2003] .

Acidity (pH) is a basic indicator of meat quality, and it affects other physicochemical properties of meat such as water-holding capacity, color and sensory attributes [Kortz 2003]. In the meat of experimental group pigs, pH_{45} values were similar in groups 1-C, 2 and 3 within the range of 6.24 to 6.30. In group 4, the value of this parameter was determined at 6.24, suggesting that meat acidity decreases with an increase in daily gains (in excess of 900 g).

In chilled meat, the value of pH_{24} increased proportionally to the improvement in the daily gains of pigs. This parameter reached the lowest value (5.44) in the meat of growing-finishing pigs with daily gains below 700 g (group 1-C), while the highest value (5.52) was noted in meat from animals whose daily gains exceeded 900 g. The above values are typical of normal-quality pork. According to Meller *et al.* [1997], the desirable value of pH_{45} falls in the range of 5.6 – 6.8, while the optimal value of pH_{24} is 5.2 to 6.4.

One of the key indicators of the processing suitability of meat is its water-holding capacity [Van Oeckel *et al.*1999, Micklander *et al.* 2005] which determines meat weight loss during storage and the meat's ability to retain water during heat treatment [Aaslyng *et al.* 2003]. In this experiment, no statistically significant differences were observed in the water-holding capacity of meat subject to the daily gains of growing-finishing pigs. The lowest water-holding capacity (6.88 cm2) was reported in animals with daily gains in the range of 701 g to 800 g. The value of the investigated parameter improved with an increase in fattening intensity. In group 3 pigs characterized by daily gains of 801 g to 900 g, the water-holding capacity of meat reached 7.03 cm^2. The value of the analyzed parameter increased to 7.22 cm^2 in meat from growing-finishing pigs with the highest daily gains. The highest water-holding capacity values were observed in meat from control group pigs whose daily gains were below 700 g. The noted results indicate that the water-holding capacity of meat is not correlated with the daily gains of growing-finishing pigs. The water-holding capacity of meat is largely determined by acidity. The results of this experiment

showed an improvement in the water-holding capacity of meat with an increase in pH_{24} values (group 2 vs. groups 3 and 4).

Table 3 – Physico-chemical and sensory properties of longissimus dorsi lumborum muscule

Specification		Group				P - value
		1-C[1]	2	3	4	
		Daily gains, g				
		below 700	701 – 800	801 – 900	above 900	
Number of carcasses	n	13	29	65	70	
pH_{45}	$\bar{x}$	6,29	6,30	6,29	6,24	0,62
pH_{24}	$\bar{x}$	5,47	5,50	5,53	5,54	0,23
Water-holding capacity, cm^2	$\bar{x}$	7,61	6,88	7,03	7,22	0,61
Meat colour:						
L*	$\bar{x}$	56,73	58,96	57,97	57,68	0,37
a*	$\bar{x}$	5,19	6,10	6,03	6,04	0,75
b*	$\bar{x}$	13,02[A]	14,71[B]	14,35[B]	14,10[B]	0,01
Sensory properties *(points)*						
Aroma – intensity	$\bar{x}$	3,60	3,85	4,44	4,32	0,16
Aroma – desirability	$\bar{x}$	5,00	5,00	4,93	5,00	0,19
Juiciness	$\bar{x}$	4,25	4,00	4,10	4,39	0,11
Tendereness	$\bar{x}$	3,50	4,18	3,86	4,26	0,11
Taste – intensity	$\bar{x}$	4.14	4.34	4.26	4.46	0.13
Taste - desirability	$\bar{x}$	4.26	4.45	4.32	4.64	0.10

[1]-control group; a, b – P ≤0,05; A, B – P ≤0,01

Color is one of the key properties of meat that affect the purchase decisions of consumers [Brewer *et al.* 2002, Kennedy *et al.* 2004). Based on a visual evaluation of this trait, consumers form opinions on the freshness and eating quality of meat [Mancini, Hunt 2005]. As demonstrated by the data in Table 3, meat from group 2 pigs, where average daily gains were determined in the range of 701 g to 800 g, was characterized by the highest values of color parameters L*, a* and b*. An increase in daily gains (group 3 – 801-900 g, group 4 – in excess of 900 g) lowered the above parameters, but the noted decrease

was statistically non-significant. The lowest color parameter values (L*, a* and b*) were observed in the control group (1-C) where average daily gains remained below 700 g. A CIELAB analysis of color parameters of the studied meat yielded the following average results: L* =56.73 – 58.96; a*=5.19 – 6.10; b*= 13.02 – 14.71, indicating that the analyzed samples were characterized by a typical color, with a low contribution of yellowness and redness.

Consumer perceptions rely mostly on the sensory attributes of meat. The meat of the analyzed pigs was evaluated for its aroma, juiciness, tenderness and palatability. Based on an evaluation on a five-point scale, the sensory properties of meat from growing-finishing pigs improved with an increase in the daily gains of animals. The most desirable sensory attributes were noted in animals with daily gains in excess of 900 g, and the least desirable properties – in pigs characterized by daily gains below 700 g.

Conclusions. Feed conversion improved with an increase in daily gains. Slaughter value, the lean meat and fat content of carcasses were correlated with the growth rate of pigs. Daily gains had no significant effect on the content of dry matter, total protein and intramuscular fat in *m. longissimus dorsi lumborum.* The pH_{45} of pork was not affected by the experimental factor. After 24 hours of carcass chilling, the color parameters and sensory properties of meat were found to improve proportionally to the increase in the daily gains of pigs.

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