

# Growth rate and carcass value of three types of crossbred pigs fed *ad libitum* diets with different protein and energy contents

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## ABSTRACT

Fifty-four pigs of three genotypes, 25% Polish Large White, 25% Polish Landrace (maternal genotype) and 50% Duroc or 50% Pietrain or 25% Duroc plus 25% Pietrain (paternal genotype) were fattened from 29 to 110 kg body weight. The animals were fed *ad libitum* one of three diets containing MJ ME and g crude protein in the following amounts: 12.3 and 156; 12.3 and 170; 13.4 and 173 per kilogram of diet. Increasing the concentration of protein and energy increased efficiency of feed conversion and ME per body gain, regardless of the type of crossbred. Genotype x nutrition interaction ( $P \leq 0.05$ ) on the meat content in carcass was found. Increasing the protein as well as both protein and energy contents in the diet increased the meat content in carcass of pigs with 50% Pietrain genes, while no such response was found in the other genotypes.

KEY WORDS: growing pigs, genotype x nutrition interaction, crossbreds, Pietrain, Duroc, carcass value

## INTRODUCTION

Many studies have demonstrated an interaction between pigs genotype and environmental conditions (Standal, 1984; Kanis, 1990; Englisch et al., 1990; Stern et al., 1994).

The practical consequences of this interaction for pig breeding and production as well as the best use of it are still discussed. The interaction between

genotype and environment can significantly affect fattening performance when both the genotype and the environmental conditions vary markedly.

The studies of Cöp and Buiting (1977), Peterson (1977), Rogdakis et al. (1979) and Kanis et al. (1990) indicate that the Pietrain breed differs significantly from other European or American breeds in terms of many anatomical and physiological traits, and performance. Since the Pietrain boars may replace more widely the Duroc boars, used in Poland for crossbreeding, it seems necessary to study the performance of crossbreds of these two genotypes as affected by dietary protein and energy concentration.

## MATERIAL AND METHODS

The experiment was conducted on 54 gilts and barrows, crossbreds obtained from mating 18 Large White x Polish Landrace sows with 8 boars (3 each of Duroc and Pietrain and 2 Duroc x Pietrain). The animals were kept in individual pens on bedding. The initial weight of the animals was  $29.0 \pm 2.0$  kg, final weight  $109.7 \pm 0.4$  kg. Throughout the entire experiment the pigs were fed on diets with different energy and protein contents. Group 1 received the diet containing 12.3 MJ ME and 156 g crude protein (CP), group 2 – 12.3 MJ ME and 170 g CP (+10% in comparison with group 1), group 3 – 13.4 MJ ME (+10%) and 173 g CP (+10%) per kg (Table 1). The protein content was raised by increasing the proportion of soyabean oilmeal, while energy was added in the form of animal fat. The diets were fed *ad libitum* from automatic feeders. Nutritional value of feed was determined in a balance experiment (7 days, 18 barrows weighing about 70 kg). After slaughter the primal cuts of the right half-carcass were dissected according to the methods used in Polish Pig Progeny Stations. The pH of meat was determined in the *longissimus dorsi* muscle 45 min and 24 h after slaughter.

The effect of various experimental factors was subjected to statistical analysis using the following model (all constant factors) and W. Harvey LSML 76 computer software:

$$y_{ijkl} = u + a_i + b_j + c_k + ab_{ij} + ac_{ik} + bc_{jk} + e_{ijkl}$$

where:

- y = the value of a trait in a single pig
- u = experimental mean
- a<sub>i</sub> = the effect of feed i (i = 1,2,3)
- b<sub>j</sub> = the effect of genotype j of the crossbred  
(j = 1,2,3)
- c<sub>k</sub> = the effect of sex k (k = 1,2)

$ab_{ij}$  = the effect of interaction of feed type X genetic group

$ac_{ik} bc_{jk}$  = the effects of the remaining first degree interactions

$e_{ijkl}$  = residual random error

## RESULTS

No statistically significant differences were found in the digestibility of nutrients depending on pigs genotype. Digestibility of protein, crude fibre and N-free extractives did not differ between the diets while digestibility of fat in diet 3 with added fat was greater ( $P \leq 0.01$ ) than in diets 1 and 2 (70.6 vs 34.1 and 44.1%).

Daily feed and nutrients intake are the main factors affecting fattening performance of pigs fed *ad libitum*. Crossbreds with 50% Pietrain genes ate less feed than the other groups during both periods and especially in the first period of the experiment, while the greatest feed intake in this period was found in crossbreds from Duroc x Pietrain sires (Table 2). The type of crossbred had no significant effect on feed intake in the second period of fattening (65-110 kg). Over the entire period of experiment, crossbreds with 50% Pietrain genes ate 7%

Composition (%) and nutritive value of diets

TABLE 1

Indices	Diet		
	1	2	3
<b>Components</b>			
protein concentrate <sup>1</sup>	17.0	17.0	17.0
barley	73.0	67.0	60.5
wheat bran	10.0	10.0	-
soyabean oilmeal	-	6.0	7.5
fat concentrate <sup>2</sup>	-	-	15.0
<b>Chemical composition</b>			
crude protein	15.56	16.98	17.32
ether extract	2.36	2.45	7.50
crude fibre	4.48	4.74	4.31
N-free extractives	60.18	58.14	54.18
<b>In 1 kg:</b>			
metabolizable energy, MJ	12.32	12.35	13.37
digestible protein, g	119	132	138
lysine, g	8.2	9.3	9.6

<sup>1</sup> composition of protein concentrate, %: soyabean oilmeal 40.5, rapeseed oilmeal "00" 30.0, meat-and-bone meal 20.0, premix PT-2 3.0, dicalcium phosphate 3.0, NaCl 1.8

<sup>2</sup> composition of fat concentrate, %: wheat bran 66, feed grade fat 34

TABLE 2

Daily mean intake: feed, metabolizable energy (ME) and digestible protein (DP)

Indices	Breed of boars			D i e t			SE
	Duroc	Pietrain	Duroc x Pietrain	1	2	3	
Feed intake, kg/d							
29- 65 kg	2.23	2.13 <sup>a</sup>	2.30 <sup>b</sup>	2.27	2.24	2.14	0.04
65-110 kg	3.14	2.92	3.10	3.13	3.16	2.88	0.10
29-110 kg	2.76	2.56	2.72	2.74	2.74	2.56	0.06
ME intake, MJ							
29-110 kg	35.0	32.4	34.4	33.7	33.8	34.2	0.8
DP intake, g							
29-110 kg	357	331	352	326 <sup>A</sup>	360 <sup>B</sup>	354 <sup>B</sup>	8

a, b -  $P \leq 0.05$ ; A, B -  $P \leq 0.01$ 

TABLE 3

Daily liveweight gain and feed intake and metabolizable energy (ME) and digestible protein (DP) utilization per kg gain

Indices	Breed of boars			D i e t			SE
	Duroc	Pietrain	Duroc x Pietrain	1	2	3	
Daily liveweight gain, g							
29- 65 kg	870 <sup>A</sup>	779 <sup>B</sup>	879 <sup>A</sup>	770 <sup>A</sup>	871 <sup>B</sup>	886 <sup>B</sup>	26
65-110 kg	837	831	880	855	828	866	38
29-110 kg	854	803	877	818	845	871	28
Feed efficiency, kg/kg							
29-110 kg	3.26	3.20	3.14	3.38 <sup>A</sup>	3.27 <sup>A</sup>	2.96 <sup>B</sup>	0.09
ME, MJ/kg gain							
29-110 kg	41.2	40.5	39.8	41.6	40.3	39.6	1.2
DP, g/kg gain							
29-110 kg	421	414	406	402	430	410	12

A, B -  $P \leq 0.01$

less feed than the other crossbreeds, but this difference was statistically not significant.

The greater protein content in the diet 2 did not affect significantly feed intake while increasing the energy concentration by adding fat to diet 3 resulted in a 7% decrease of feed intake.

Raising the protein content in the diets 2 and 3 increased the daily intake of this nutrient in all pigs ( $P \leq 0.01$ ).

In spite of lower feed intake, protein intake in the 50% Pietrain crossbreeds fed on diets 2 and 3 was similar as in other crossbreeds fed on diet 1 with lower protein content.

The weight gains of the animals were high and equalled 845 g daily for the entire period of fattening (Table 3).

Increasing the protein content in diet 2 increased ( $P \leq 0.01$ ) the rate of gain of all crossbreeds only in the first period of experiment (Table 3). The response to the higher protein level in the second period of fattening was much less pronounced.

Only simultaneous increasing the protein and energy concentrations in the diet improved ( $P \leq 0.01$ ) efficiency of feed utilization (Table 3), while increasing only the protein content resulted in lower efficiency of protein utilization per kilogram gain.

The weight of *longissimus dorsi*, the content of meat in ham and in the carcass (per cent) were greater ( $P \leq 0.01$ ) while that of fat was lower in 50% Pietrain crossbred than in other crossbreeds. The crossbreeds of Duroc x Pietrain sires had meat traits intermediate between those of crossbreeds sired by Pietrain or Duroc

TABLE 4

Carcass value of pigs slaughtered at  $109.7 \pm 0.4$  kg

Indices	Breed of boars			Diet			SE
	Duroc	Pietrain	Duroc x Pietrain	1	2	3	
Meat of loin, kg	2.09 <sup>A</sup>	2.76 <sup>B</sup>	2.30 <sup>A</sup>	2.33	2.34	2.48	0.07
Meat of ham, kg	6.08 <sup>A</sup>	7.39 <sup>B</sup>	6.26 <sup>A</sup>	6.42	6.47	6.85	0.14
Meat in primal cuts, % *	55.1 <sup>A</sup>	66.2 <sup>B</sup>	59.4 <sup>C</sup>	59.5	60.0	61.2	0.8
Fat in primal cuts, %	29.8 <sup>A</sup>	20.1 <sup>B</sup>	25.6 <sup>C</sup>	26.0	25.4	24.3	0.9
pH <sub>1</sub>	6.30 <sup>A</sup>	5.95 <sup>Bh</sup>	6.19 <sup>A</sup>	6.11	6.17	6.17	0.07
pH <sub>24</sub>	5.60	5.51	5.50	5.50	5.56	5.55	0.03

a,b -  $P \leq 0.05$ ; A,B,C -  $P \leq 0.01$

\* - crossbred x diet interaction ( $P \leq 0.05$ ). Explanation see Table 5

TABLE 5

Crossbred x diet interaction for meat content in the carcass, %

Breed of boars	Diet		
	1	2	3
Duroc	55.6	53.9	55.9
Pietrain	63.0	66.0	69.6
Duroc x Pietrain	60.0	60.2	58.1

boars, although the leanness of the most valuable cuts of carcass resembled more Duroc than Pietrain.

The very high meat content of the 50% Pietrain crossbreeds was accompanied by an unfavourable reduction in meat pH measured 45 min after slaughter. Increasing the concentration of protein and energy in the diet resulted in deterioration of this parameter in crossbreeds with 50% Pietrain genes, most likely indirectly by increasing the meat content.

Increasing the concentration of nutrients in the diet did not affect the leanness of the crossbreeds with 50% Duroc genes or those with 25% Duroc and 25% Pietrain genes while increasing both protein and protein and energy concentration caused an increase in the meat content of carcass in crossbreeds with 50% Pietrain genes. This difference explains the observed significant ( $P \leq 0.05$ ) interaction between type of diet x type of crossbred for the trait of meat percentage in the carcass (Table 5).

## DISCUSSION

Planning the experimental design, we expected that the crossbreeds having 50% Pietrain genes would eat less feed than other genotypes (Peterson, 1977), especially than the Duroc breed, which is characterized by a great appetite (Cöp and Buiting, 1977).

Kanis (1990) demonstrated the marked effect of the voluntary feed intake on the performance of pigs fed *ad libitum*. Thus it should have been expected that the crossbreeds with a large proportion of Pietrain genes will respond favourably to the increased concentration of energy and protein in the diet. Due to the differences in carbohydrate and fat metabolism between Pietrain (Rogdakis et al., 1979; Berschauer et al., 1982) and other breeds the increased fat deposition should not be expected. This was confirmed in our experiment. The pigs with 50% Pietrain genes ate 7% less feed than the others. These crossbreeds on diet 3, with the increased protein and energy contents, ate a similar amount of nutrients as pigs of the other genotypes on diet with lower concentration of protein and

energy (diet 1). Increasing the concentration of nutrients, i.e. protein (diet 2) or protein and energy (diet 3) influenced favourably daily gains and feed efficiency ratio. The response of different genotypes was similar, and the genetic group x type of feed interaction for these traits was not significant.

These results are in agreement with those obtained in fattening the same type of crossbreds on similar diets fed according to standards (Sokoł et al., 1994). Also other authors (Holmes et al., 1983; Kowach et al., 1984) have not found significant interactions between different genotypes of pigs and the feeding level or dietary energy concentration (Savidge et al., 1984) for body gain and feed utilization.

There was, however, a significant ( $P \leq 0.05$ ) effect of genotype x nutrition interaction on the percentage of meat in the carcass. The higher energy and protein concentrations increased the leanness of the 50% Pietrain crossbreds, while in other genotypes the ratio of meat to fat was unchanged or was slightly lower.

Peterson (1977) found that Pietrain pigs should be given the diets with higher protein level than the German Landrace to take advantage of their capacity to meat production. The results of our study indicate that it is advisable to increase the concentration of both protein and energy in the diets for fattened crossbreds of Polish maternal breeds and Pietrain, fed *ad libitum*. Campbell et al. (1985) and Chabiera et al. (1994) also found that in young pigs with a high ability to protein deposition in the body, a diet with a higher energy protein or lysine content can be used without deterioration of its utilization or increasing fat deposition. Our results are in agreement with results obtained by these authors.

## SUMMARY

Increased protein concentration, especially protein and energy, in the feed increased the growth rate of pigs regardless of their genotype, while the effect of the interaction of genotype x nutrition on this trait was nonsignificant.

A significant effect of interaction of genotype x nutrition on the meat content in the carcass was found. Increasing the digestible protein content from about 12 to 14% and the energy concentration from 12.3 to 13.3 MJ ME in 1 kg of the diet given *ad libitum* increased the meatiness of the crossbreds with 50% Pietrain genes, but had no effect on the meatiness of the crossbreds with Duroc genes.

Crossbreds with 50% Pietrain genes, as compared with those with Duroc genes, were characterized by a greater meat content in carcass, slower growth rate, especially in the first period of fattening (29-65 kg), lower pH<sub>45</sub> and lower appetite during both periods of fattening.

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## STRESZCZENIE

**Wyniki tuczu trzech typów mieszańców świń żywionych do woli dawkami o zróżnicowanym poziomie białka i energii**

Pięćdziesiąt cztery tuczniaki trzech różnych genotypów: 25% wielka biała polska, 25% polska biała zwisłoucha (genotyp matek) i 50% Duroc lub 50% Pietrain albo 25% Duroc i 25% Pietrain (genotyp ojców) tuczono od 29 do 110 kg masy ciała. Zwierzęta żywiono do woli trzema rodzajami dawek zawierających (MJ ME, g białka ogólnego): 12.3, 156; 12.3, 170 i 13.4, 173 w 1 kg paszy, odpowiednio.

Zwiększenie poziomu białka w dawce spowodowało wzrost przyrostów dziennych z 818 do 845 g, a jednocześnie zwiększenie koncentracji energii i białka dalszy wzrost przyrostów do 871 g i zmniejszenie zużycia paszy z 3.38 do 3.27 i 2.96 kg na 1 kg przyrostu, przy braku istotnej interakcji genotyp x żywienie.

Stwierdzono wpływ ( $P \leq 0.05$ ) interakcji genotyp x żywienie na zawartość mięsa w wyrębach podstawowych. Wzrost koncentracji białka, a także białka i energii w dawkach spowodował wzrost zawartości mięsa u tuczniaków z 50% udziałem genów rasy Pietrain, przy braku takiej reakcji u pozostałych genotypów.