Effect of Genotype on Slaughter Value of Pigs and Their Meat Quality

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Introduction

Meatiness of fatteners in Poland is relatively low and, on average, does not exceed 48%. Therefore, all measures, which are being undertaken by breeders and meat industry, focus on possibilities of increasing the content of meat in the carcass and maintaining good meat quality (2). According to a program developed by the government, Poland should reach the target 55% meatiness of porcine carcasses by the year 2010. The observed introduction of new technologies of pig production is accompanied by a considerable increase of interest in genetic materials characterised by high meatiness traits. At present, we observe a steady increase in the amount of boars of Duroc, Hampshire and Pietrain breeds and their crosses as well as domestic and imported hybrid lines. One of the by-product effects of these breed changes in swine stock is a considerable increase of variability in meat quality. During the last few years, the proportion of carcasses with PSE meat increased more than twice and reached approximately 17% of the population (2, 7). The frequency of the occurrence of quality variations depends, to a considerable degree, on swine breed (6, 7, 8). The variability is particularly high in these breeds producing high quantities of meat, which are however very often genetically loaded with a gene making them susceptible to stress. The aim of the performed experiments was to determine the effect of pig genotype on the slaughter value and physicochemical and sensory traits of meat of pigs reared in conditions of commercial fattening in Poland.

Material and Methods

The experimental material comprised fatteners with body weights of about 100 kg. The pigs derived from a large commercial farm, where they were fed identical complete rations in all experimental groups. The studies comprised crossbreeds of sows of Polish Large White (PLW) x Polish Landrace (PL) with boars of the same crossing (control group - C) and such breeds as Duroc (D), Hampshire (H), Hampshire x Duroc (HxD) as well as fatteners of the PIC synthetic line (PIC). The number of investigated animals in each group was 70, 87, 58, 84 and 50 respectively. Studies of physicochemical traits of meat were conducted on 30 carcasses from each group. Carcass meatiness was estimated by means of the ULTRA-FOM ultrasound apparatus containing a regression equation developed for Polish conditions (3). After chilling, left half-carcasses were cut into basic parts according to the Polish norm PN 86-A/82002. The basic parts were then grouped into three assortment groups. The most valuable parts i.e. ham, loin, shoulder, chuck composed group I. Less valuable parts i.e. belly, ribs, legs and shanks belonged to group II and fatty parts i.e. belly, lard, chap, flank, fatty meat made group III. The weight of the obtained basic parts was determined on an electronic balance with 5 g accuracy. Quality investigations were carried out on meat samples of the lumbar part of the longissimus dorsi (LD) cut out from chilled half-carcasses. The pH value was determined using a portable pH Radiometer PHM-80 with a complex electrode 45 minutes (pH_1) and 24 hours (pH_2) after slaughter. Standard methods were applied to determine the content of water, fat and protein. Drip loss was calculated from the difference in the amount of juice released from around 1 kg of meat stored in plastic bags at 4 to 6°C. The lumbar part of the longissimus dorsi muscle weighing approximately 800 g was cooked until, in its centre, it reached the temperature of 70°C (1). After cooling, from the difference in weight, losses of meat during cooking were determined. The meat colour was estimated by means of the Minolta CHROMA METERS CR-300 determining L*a*b* parameters. Electric conductivity was determined using the PQM-I/KOMI apparatus 24h after slaughter. Cooked meat was subjected to sensory evaluation by a panel made of five persons who were asked to assess in a 5 score scale colour, juiciness, tenderness and palatability (1). Texture measurements of cooked meat were performed on a universal testing machine INSTRON 1140 applying a test for compression and shear force using (4). The obtained results were processed statistically. The significance of differences between genetic groups was determined using Duncan's test (9).

Results and Discussion

The analysis of the degree of musculature and fatness of the examined genotypes revealed the highest meat content in carcasses of PIC pigs (57.99%) and slightly lower (by about 2%) in fatteners derived from the breed of H or H x D father (Table 1). Worse musculature was observed in the case of carcasses of crosses with Duroc (52.28%) and in the C group (50.66%). Pigs from the PIC group were also found to have the thinnest lard on their back (17.77 mm) and ham (10.59 mm) in comparison with the remaining groups. Carcasses from the C group were characterised by the highest fatness. In this group, the average thickness of back fat over shoulder was 38,57 mm, on the back - 24.0 mm and on the ham - 21.7 mm. The assessment of the examined carcasses according to EUROP classification revealed that in class E (meat content over 55%), there were 76% of PIC carcasses and about 50% of carcasses from groups H and HD. In groups D and C, there were only 22 and 11%, respectively of class E carcasses. The size of musculature had a significant influence on the yield of the most valuable carcass cuts. The fatteners with higher meat content were characterised by a better yield of valuable cuts from the group I. The proportion of such cuts in PIC carcasses amounted to 56.09% and in hybrids crossed with Hampshire and Hampshire x Duroc breeds - approximately 55%. On the other hand, the proportion of these cuts in the C group was only 47.9%, while in pigs crossed with Duroc - 51.52%. The smallest amount of fat elements from group III was recorded in PIC carcasses (16.95%), more than 18% in groups D, H and HD and the highest - 24.08% in carcasses from the C group ($P \leq 0.01$). The majority of the observed differences between groups are statistically significant ($P \leq 0.01$). The yield of individual groups of cuts was not statistically significant only in fatteners from groups H and HD.

The analysis of the examined genotypes with regard to PSE and DFD type of quality abnormalities revealed in group D 3 carcasses with symptoms of watery meat ($pH_1 \leq 5.8$) and 8 carcasses in the C group with partly DFD meat (pH_2 from 6.00 to 6.30). These findings justify significant differences in the pH values of meat from groups C and D in comparison with the remaining groups (Table 1). Higher pH_2 values in the LD muscle of the C group can be attributed to the darker colour of this meat (L*) (Table 1). The highest electrical conductivity was found in the meat of hybrids from the HD group (6.11 mS/cm), and the lowest in PIC fatteners (3.98

mS/cm) (Table 1). In the remaining groups the conductivity was approximately 3 mS/cm. Significantly lower values of the juice drip (2.30%) from the muscle tissue of PIC fatteners was observed in comparison with group H (6.25%), the C (5.84%) as well as D and HD groups (about 3.80%). Smaller losses during meat thermal treatment were observed in the C group (26.12%), whereas in the remaining groups those losses were by about 2 - 4% higher ($P \leq 0.01$). The overall value of the meat drip allows to arrange the examined swine groups in the following order: PIC (30.67%), C, D, H and HD (36.93%).

Investigations of Eikelenboom (5) showed, that the concentration of intramuscular fat decreases with the increase of meat in the carcass. This statement is corroborated by results of this study. Only 2.16% intramuscular fat was found in PIC fatteners with the best musculature, whereas in groups H, HD and C the respective quantities of intramuscular fat were: 3.25%, 3.45% and 3.36% (Table 2). At the same time, the amount of this fat in LD muscles of pigs crossed with Duroc breed reached even 4.79%. Similar results regarding the chemical composition of meat in pigs with Duroc breed upgrading were obtained by Krasnowska et al. (8). The best texture parameters of cooked meat among the examined genetic groups were recorded in the case of crosses with Hampshire breed. The maximum penetration force was 80.8 N, and the shear force – 33.79 N (Table 2). These findings were confirmed by the sensory assessment of meat tenderness (Table 2).

Conclusions

1. The crossing of sows of Polish white breeds with boars of Hampshire and Duroc breeds resulted in the increase of meatiness of commercial fatteners, however the observed increase was by a few percentage points lower than in PIC pigs.
2. The increased musculature caused by the crossing with meat breeds was accompanied by a decrease in subcutaneous and intramuscular fat.
3. A higher yield of the most valuable cuts was confirmed in carcasses characterised by higher meat content.
4. As to meat quality, the diversification among the examined genetic groups was most conspicuous with regard to meat tenderness and water holding capacity.

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Table 1.

Slaughter value and quality characteristics of pigs and meat from evaluated breeding groups

Analysed traits	Breeding groups				
	C	D	HD	H	PIC
Slaughter value of pigs					
Live Weight, kg	$100,09^{ab}$	$98,87^{bc}$	$103,01^{a}$	$95,75^{c}$	$99,14^{bc}$
Hot carcass Weight, kg	$75,85^{ab}$	$74,94^{bc}$	$78,03^{a}$	$72,53^{c}$	$75,10^{bc}$
Meat content in carcass, %	$50,66^{c}$	$52,28^{c}$	$55,32^{b}$	$55,61^{b}$	$57,99^{a}$
Backfat thickness, mm					
- shoulder	$38,57^{a}$	$35,63^{ab}$	$33,77^{bc}$	$31,43^{c}$	$32,63^{bc}$
- back	$24,03^{a}$	$21,47^{ab}$	$22,97^{a}$	$19,43^{bc}$	$17,77^{c}$
- ham	$21,70^{a}$	$18,27^{b}$	$17,00^{cb}$	$14,40^{c}$	$10,57^{d}$
Quality characteristic of meat					
pH_1 value	$6,56^{ab}$	$6,38^{b}$	$6,65^{a}$	$6,62^{a}$	$6,63^{a}$
pH_2 value	$5,94^{a}$	$5,64^{c}$	$5,67^{cb}$	$5,72^{b}$	$5,66^{c}$
Colour - L*	$46,85^{b}$	$48,81^{a}$	$49,20^{a}$	$48,55^{ab}$	$46,70^{b}$
- a*	$6,11^{a}$	$6,59^{a}$	$6,02^{a}$	$6,60^{a}$	$5,12^{b}$
- b*	$3,10^{a}$	$3,11^{a}$	$2,26^{b}$	$2,65^{ab}$	$2,84^{ab}$
Electric conduc-tivity, mS/cm	$4,79^{bc}$	$4,83^{bc}$	$6,11^{a}$	$5,34^{ab}$	$3,98^{c}$
Drip loss, %	$5,84^{a}$	$3,86^{b}$	$3,80^{b}$	$6,25^{a}$	$2,30^{c}$
Cooking loss, %	$26,12^{c}$	$29,6^{ab}$	$30,90^{a}$	$30,68^{a}$	$28,37^{b}$

Table 2

Basic composition of meat from various breeding groups and its sensory and texture profile

Analysed traits	Breeding groups				
	C	D	HD	H	PIC
Basic composition of m. longissimus dorsi (%)					
- water	$72,66^{c}$	$71,06^{d}$	$73,34^{b}$	$73,68^{ab}$	$74,03^{a}$
- fat	$3,36^{b}$	$4,79^{a}$	$3,25^{b}$	$3,45^{b}$	$2,16^{c}$
- protein	$22,98^{a}$	$22,91^{a}$	$22,40^{b}$	$21,97^{c}$	$22,73^{ab}$
Sensory properties of cooked loin (scores)					
- flavour	$4,50^{bc}$	$4,24^{d}$	$4,40^{c}$	$4,52^{b}$	$4,74^{a}$
- juiciness	$3,99^{a}$	$3,62^{b}$	$4,00^{a}$	$4,04^{a}$	$3,84^{ab}$
- tenderness	$4,15^{b}$	$3,96^{b}$	$4,07^{b}$	$4,43^{a}$	$3,73^{c}$
- palatability	$4,42^{a}$	$4,15^{b}$	$4,17^{b}$	$4,36^{a}$	$4,05^{b}$
Texture profile analysis of cooked loin					
- hardness, N	$92,03^{a}$	$83,71^{ab}$	$86,39^{ab}$	$80,80^{b}$	$98,47^{c}$
- cohesiveness	$0,250^{b}$	$0,200^{c}$	$0,189^{c}$	$0,245^{b}$	$0,285^{a}$
- elasticity	$5,720^{b}$	$4,830^{c}$	$4,993^{c}$	$5,404^{b}$	$6,240^{a}$
- shear force, N/cm^2	$44,33^{b}$	$27,91^{c}$	$30,18^{c}$	$33,79^{c}$	$53,45^{a}$

Explanations to the table 1 & 2

a, b, c...* - means followed by various letters are different at $P \leq 0,01$