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EFFECT OF CARCASS MEATINESS LEVEL ON MEAT QUALITY OF PIGS MONOMORPHIC AT GENES *RYR1* AND *LEP*

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Key words: pigs, *RYR1* and *LEP* gene, EUROP carcass class, meat quality

The studies were carried out on 114 carcasses of hybrid porkers after Camborough 22 sows and PIC 337 boars classified in classes of the EUROP system.The carcasses of PIC pigs free from stress susceptibility gene (*CC*/*RYR1*) and monomorphic at the leptin gene (*TT* T3469C and *GG* G2728A) classified into meatiness class S, E and U differed significantly in respect of meatiness and backfat thickness but did not differ significantly in respect of weight. Meat coming from the carcasses classified into class S contained significantly less intramuscular fat than that from the carcasses classified into class U, with its content being an optimum in all meatiness classes. No significant differences were found however in the content of dry matter, total protein and ash in meat from the carcasses classified into S, E and U classes. Meat from the carcasses classified into class S was characterised by a significantly larger drip loss than that from the carcasses classified into class E but no significant differences were observed between mean values of pH_{24} and pH_{48}, water-holding capacity, thermal drip, water-soluble protein content and meat colour parameters. Despite the lack of significant differences between mean values of most meat quality traits examined, a higher frequency of PSE and partly PSE meat in carcasses with meatiness over 60% (class S) may point to an unfavourable effect of high meatiness on the quality of meat.

INTRODUCTION

Intensive works carried out on the improvement of pig slaughter traits are being considered to be associated with deterioration of meat quality. This is confirmed by studies which point to a negative relationship between lean content in carcass and its quality traits [Krzęcio *et al.,* 2005]. Worse meat quality of pigs with high meatiness is not only a consequence of the degree of muscling but also of genes determining the meat quality and of pre- and post-slaughter factors. Studies show that a commonly observed negative relationship between carcass muscling and meat quality is mainly caused by high frequency of the *RYR1* gene in populations of these animals and to a much lesser degree is being found in carcasses from pigs that are free from that allele [Kapelański *et al.,* 2002].

The leptin gene (*LEP*) and its receptor (*LEPR*) are taken into consideration as candidate genes associated with meat quality and fatness traits in livestock. Results of studies referring to association of the T3469C (*LEP*/*Hinf*I) gene polymorphism with carcass quality are not clear-cut. In the study of Kurył *et al.* [2003] on Torhyb line pigs, a higher lean content in ham was found, while in the study of Kulig *et al.* [2001] a higher lean content in carcass in Polish Landrace pigs with genotype *CT* in relation to those with genotype *TT*. Different results were obtained in PIC pigs, in which genotype *TT* proved to be more favourable for the reduction of fat and content in ham in relation to genotype *CT* [Kurył *et al.,* 2003]. In the case of the G2728A (*locus LEP*/*Hind*III) polymorphism in the study of Kaczor *et al.* [2006], no significant differences were found between genotypes *GG* and *GA* in carcass and meat quality traits, except water-holding capacity (WHC) of meat from pigs which was more favourable in pigs with genotype *GG*.

The study was aimed at determining the effect of carcass meatiness of the PIC pigs free from stress susceptibility gene (*CC*/*RYR1*) and monomorphic at the leptin gene (*TT* T3469C and *GG* G2728A), classified into class S, E and U of the EUROP system on meat quality.

MATERIALS AND METHODS

Examination was carried out on 114 PIC hybrid pigs from one of pig production farms in the Western Pomeranian Province. The study covered the offspring after PIC 337 boars and Camborough 22 sows which were housed under the same environmental conditions and fed using a balanced feed mixture *ad libitum*. All fatteners were transported to a meat processing plant in the evening, the same transport facility, and slaughtered on the next day in the morning, after 4 h of transport at a distance of 200 km.

During animal slaughtering, blood was sampled after CO_2 stunning into test-tubes containing EDTA in order

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to identify *RYR1* and *LEP* genotypes. In the whole material examined, an equal sex ratio (1:1) was maintained between barrows and gilts. Carcass slaughter value was measured with a Sydel CGM optic-needle apparatus on the left half-carcass as well as hot carcass weight of the examined fatteners was determined. Mean percent carcass meatiness amounted to 57.36 ± 3.22 and hot carcass weight to 78.98 ± 4.24 kg. Among the carcasses, three meatiness classes of the EUROP system were separated with a lean content in carcass of: >60% (S), 55-60% (E), and 50-54.9% (U). After 24-h carcass chilling, the *longissimus lumborum* (LL) muscle samples were collected from the 1st-4th lumbar vertebra region of the right half-carcass, in which pH_{24} was measured (Elmetron CP-311 pH-meter), as well as the value of drip loss from the meat determined 48 h after slaughter according to Honikel [1987].

About 48 h after slaughter, on the ground meat, pH measurement in water solution was made, meat colour traits, *i.e.* L* (lightness), a* (redness) and b* (yellowness), were established by means of a HunterLab Mini Scan XE Plus 45/0 with light illuminant D65 and observer 10°, and meat water-holding capacity was determined according to the method of Grau and Hamm as modified by Pohja & Niinivaara [1957], as well as thermal drip from a difference of meat sample weight before and after heating in a water bath at 85°C for 10 min, water-soluble protein content with the method of Kotik [1974]. The proximate meat chemical composition, *i.e.* total protein, fat, ash and dry matter [AOAC, 2003], were estimated. The frequency of normal and defective meat was determined based on pH_{24}, free drip and meat colour lightness (L*). For normal meat, the limit values for these meat quality traits amounted respectively to: 5.5-6.0; 2-6%; 52-58, whereas for defective meat of the PSE type they were <5.5; >6.0%; >58, for partly PSE meat <5.5; >6.0%; 52-58, and for DFD meat >6.0; <2.0%; <52.

Genomic DNA was extracted from blood using Master-Pure kit of Epicentre Technologies, according to the instruction (Madison, WI, USA). Genotypes of *RYR1* and leptin (*LEP*) gene were analysed using the PCR-RFLP method. The *RYR1*/*HinP*I genotypes were identified using a sequence of primers according to Fujii *et al.* [1991]. All of the pigs were of *CC*/*RYR1* genotype. Genotypes of leptin (*LEP*) were identified using primer sequences reported by Neuenschwander *et al.* [1996] – C3469T and Kennes *et al.* [2001] – G2728A, respectively. All of the pigs were of *GG* G2728A and *TT* T3469C genotype.

The study results were processed by means of non-orthogonal one-factor analysis of variance, while significance of differences between meatiness classes was determined with the Tukey test. The findings were processed statistically with Statistica 8.0 PL computer software.

RESULTS AND DISCUSSION

Basing on the examinations carried out on the carcasses of PIC pigs free from stress susceptibility gene (*CC*/*RYR1*) and monomorphic at the leptin gene (*TT* T3469C and *GG* G2728A), it was found that the analysed meatiness classes S, E and U significantly differed between each other in percent lean content in carcass and backfat thickness, with no significant differences in hot carcass weight (Table 1). These results

TABLE 1. Mean values and their standard deviations (SD) for carcass slaughter traits and meat chemical composition according to carcass class.

Traits	EUROP carcass class		
	S n=28	E n=61	U n=25
Hot carcass weight (kg)	79.26±3.93	78.50±5.01	79.82±3.81
Meatiness (%)	61.41^{A}±1.25	57.36^{B}±1.41	52.84^{C}±1.33
Backfat thickness (mm)	9.43^{A}±1.57	12.51^{B}±1.75	16.40^{C}±1.91
Muscle thickness (mm)	59.25^{A}±7.96	55.84^{AB}±7.97	52.28^{B}±5.56
Total protein (%)	22.38±0.58	22.25±0.55	22.44±0.80
Fat (%)	1.81^{a}±0.45	2.07^{ab}±0.54	2.16^{b}±0.59
Dry matter (%)	25.42±0.65	25.53±0.66	25.72±0.64
Ash (%)	1.17±0.04	1.16±0.04	1.16±0.04

A, B, C – values in rows marked with different letters differ significantly (p≤0.01); a, b – values in rows marked with different letters differ significantly (p≤0.05).

are not confirmed by studies on PIC pigs [Chwastowska & Śmiecińska, 2006] and other ones [Rybarczyk *et al.,* 2004; Litwińczuk *et al.,* 2005], in which a decrease in their weight was observed together with an increase in carcass meatiness according to the EUROP system. The obtained study results may show that an increase in meatiness does not have to be associated with a decrease in carcass weight. Ellis & Avery [1990] found, when carrying out examinations on synthetic lines and hybrids, that high carcass meatiness is possible even when the pigs are being slaughtered at a higher body weight. Together with an increase in meatiness class, the LD muscle thickness increased as well, with the carcasses from class E being not different significantly in respect of the LD muscle thickness from those from class S and U. Moreover, it was found that meatiness classes S and E were mostly represented by the carcasses of gilts whereas class U by those of barrows, which is confirmed by the study results pointing out to a higher meatiness and lower fatness of carcasses in gilts in relation to barrows at a similar dead weight [Bąk *et al.,* 2003]. Most similar equal participation of the carcasses of gilts and barrows was found in meatiness class E, whereas in the earlier study on fatteners after Pietrain boars in meatiness class U [Rybarczyk, 2008].

No significant differences were found in the percent content of dry matter, total protein and ash in meat samples coming from the carcasses classified into class S, E and U. Significant differences were only found in the case of the percent content of intramuscular fat in meat, with meat coming from the carcasses classified into class S containing significantly less intramuscular fat than that from the carcasses classified into class U. These findings are confirmed by the results of study on the quality of meat from the carcasses of PIC pigs classified into class E and U, carried out by Chwastowska & Śmiecińska [2006]. They are also consistent with the study results of Wajda *et al*. [2005] and Florowski *et al*. [2007] who found a drop in intramuscular fat content in meat together with an increase in carcass meatiness. However, they are not confirmed by the study results of Grajewska *et al.* [2006] and Rybarczyk [2008].

Fat content in meat affects its juiciness, palatability and tenderness as well as the intensity and desirability of its odour. According to Fortin *et al.* [2005], its optimum intramuscular content in pork which ensures a desirable sensory quality is from 1.5 to 3%. In the present study, these criteria were met by meat from carcasses from all three meatiness classes analysed.

No statistically significant differences were found between mean values of pH measured 24 h and 48 h after slaughter in meat coming from the carcasses of fatteners classified into respective meatiness classes (Table 2). No significant differences were observed in the case of water-holding capacity (expressed as% of free water), thermal drip, and water-soluble protein content in meat as well as of meat colour parameters (L*, a*, b*), either. Significant differences referred only to the value of drip loss, with meat from the carcasses classified into class S being characterised by a significantly larger drip loss than that from the carcasses classified into class E. On the other hand, Chwastowska & Śmiecińska [2006] did not find any significant differences in the quality of meat coming from the carcasses of PIC pigs classified into meatiness class E and U. Also Rybarczyk *et al.* [2004] and Wajda *et al.* [2005] did not find significant differences in meat quality between carcasses with different meatiness classified into the EUROP system classes in, respectively, PEN AR LAN fatteners and those from mass purchase.

In meatiness class S, a higher frequency of PSE (7.1%) and partly PSE (17.9%) meat was found when compared to class E and U (properly: 1.6 and 4.0% as well as 6.6 and 8.0%), although no significant differences were observed in meat quality traits, except drip loss (Table 3). Also Florowski *et al.* [2007] in the study on fatteners free from the *RYR1*^{T} gene and Rybarczyk [2008] observed a higher frequency of PSE meat in the carcasses of pigs classified into class S but did not find any significant differences in the quality of meat coming from the carcasses classified into respective meatiness classes. On the other hand, Grajewska *et al.* [2006] found – basing on the evaluation of the meat quality of pig carcasses classified into E, U and R classes – that in the case of pigs that are free of stress susceptibility gene the increase of meatiness is associated with deterioration of meat quality.

TABLE 2. Mean values and their standard deviations (SD) for meat quality traits according to carcass class.

Traits	EUROP carcass class		
	S (♀=18; ♂=10)	E (♀=32; ♂=29)	U (♀=6; ♂=19)
pH_{24}	5.79±0.15	5.81±0.11	5.80±0.08
pH_{48}	5.68±0.11	5.70±0.13	5.71±0.09
L*	55.57±2.09	55.69±2.23	56.03±1.51
a*	7.00±0.98	6.88±1.05	6.69±1.04
b*	15.58±0.59	15.66±0.90	15.70±0.61
WHC (% of free water)	18.69±4.06	17.76±3.63	17.49±2.46
Thermal drip (%)	25.65±1.95	25.21±2.15	25.28±1.75
Drip loss (%)	6.09^{A}±1.93	4.72^{B}±1.82	5.06^{AB}±1.79
Water-soluble protein (%)	10.32±0.96	9.85±1.36	10.13±1.25

A, B – values in rows marked with different letters differ significantly (p≤0.01)

TABLE 3. Frequency of normal and defective meat.

Meat quality classes	EUROP carcass class					
	S		E		U	
	n	%	n	%	n	%
Normal	20	71.4	54	88.5	22	88.0
Partly PSE	5	17.9	4	6.6	2	8.0
PSE	2	7.1	1	1.6	1	4.0
DFD	1	3.6	2	3.3	-	-

CONCLUSIONS

1. The carcasses of PIC pigs free from stress susceptibility gene (*CC*/*RYR1*) and monomorphic at the leptin gene (*TT* T3469C and *GG* G2728A) classified into meatiness class S, E and U differed significantly in respect of meatiness and backfat thickness but did not differ significantly in respect of weight.

2. Meat coming from the carcasses classified into class S contained significantly less intramuscular fat than that from the carcasses classified into class U, with its content being an optimum in all meatiness classes. No significant differences were found however in the content of dry matter, total protein and ash in meat coming from the carcasses classified into S, E and U.

3. Meat from the carcasses classified into class S was characterised by a significantly larger drip loss than that from the carcasses classified into class E but no significant differences were observed between mean values of pH_{24} and pH_{48}, water-holding capacity, thermal drip, water-soluble protein content and meat colour parameters.

4. Despite the lack of significant differences between mean values of most meat quality traits examined, a higher frequency of PSE and partly PSE meat in carcasses with meatiness over 60% (class S) may point to an unfavourable effect of high meatiness on the quality of meat.

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