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MEAT QUALITY OF PORKERS ACCORDING TO CARCASS MUSCULATURE DEGREE WITH REGARD TO RYR1 GENOTYPE*

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The experiment was carried out on 95 samples of the *longissimus dorsi* muscle (LD). They were collected from carcasses classified to meatiness classes E, U and R (24, 52 and 19 samples, respectively) of pure-bred pbz porkers, hybrids of white pigs sows (wbp x pbz) with Pietrain boars and those of Dutch pigs (Landrace x wb) x wb. After slaughter, blood samples were collected in porkers for DNA analysis to identify animals carrying a stress-susceptibility gene (RYR1). After carcass cooling, meat quality detailed evaluation (dissection) was carried out according to methods given by Walstra and Merkus [1996], on the grounds of which carcasses were classified into respective EUROP system classes. Meat quality was determined as well, pH_1, pH_k and electric conduction; meat colour, wateriness, hardness and consistency were assessed. Moreover, a measurement of the volume of free drip was made, meat wateriness was determined, as well as drip index and colour parameters were calculated. Also, meat basic chemical composition and meat water-soluble protein content were analysed. Furthermore, the frequency of meat with PSE and DFD defects was also determined. Carcasses of porkers from class E and U more frequently showed an incidence of meat defects of PSE, partial PSE and partial DFD types. Higher frequency of the incidence of normal meat was found together with an increase in carcass meatiness. All carcasses of animals with recessive homozygote genotype (nn) had the highest meatiness (classes E and U). The genetic vulnerability of the porkers to produce PSE meat was found in 25% of the studied material. In the group of porkers with the highest meatiness, class E, only 17% (out of 17 animals with genetic burdens 11 nn and 6 Nn), or 3 individuals were found after slaughter to have PSE meat.

INTRODUCTION

In recent years, the quality of meat has become increasingly important for both meat processing and for consumers, as the main objective of pig production is to obtain porkers with high meat content in carcasses, while preserving good meat quality [Nowak *et al.*, 1994].

Dissemination by the meat industry of measurements of carcass musculature and introduction of the EUROP classification when purchasing the porkers, on the one hand favours the progressive enlargement of carcass meatiness, but on the other hand it leads to the intensification of the incidence of pork meat quality defects [Borzuta, 1999; Koćwin-Podsiadła *et al.*, 1999a]. This is due to the negative correlation between carcass meatiness and meat quality traits [Sellier, 1998]. One of the reasons for the incidence of meat qualitative variations is the high frequency of the genotype of pigs susceptible to stress [Kortz *et al.*, 2000; Kapelański *et al.*, 2002].

The aim of the present study was to evaluate the effect of musculature of carcasses classified into respective EUROP system classes on the meat quality traits in pigs, with regard to the RYR1 genotype.

MATERIAL AND METHODS

The experiment was carried out on 95 samples of the *longissimus dorsi* muscle (LD), which were collected from the region of 1–4 lumbar vertebrae of the right half-carcass cooled approx. 24 h after slaughter. They were collected from carcasses classified into meatiness classes E, U and R (24, 52 and 19 samples, respectively) of pure-bred pbz porkers, hybrids of white pigs sows (wbp x pbz) with Pietrain boars and those of Dutch pigs (Landarce x wb) x wb.

The experimental material consisted of hogs, which were kept under the same environmental conditions in the AGRO-WRONIE centre at Wronie. The feeding of animals was standardized with a food ration balanced in respect to energy and protein in conformity with Pigs Feeding Standards [1993].

The porkers, after gaining approximately 103 kg in body weight, were slaughtered in the Meat Plant in Grudziądz, during which blood was sampled for DNA analysis with the PCR/RFLP method to identify animals carrying the stress-susceptibility gene (RYR1) [Fujii *et al.*, 1991; Kuryl & Korwin-Kossakowska, 1993]. Approx. 45 min from the slaugher, meat reaction (pH_1) and electric conduction were

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measured in the LD muscle in the region between the 4th and the 5th lumbar vertebrae of the right half-carcass. After cooling, a detailed evaluation of carcass quality (dissection) was completed according to the method of Walstra and Merkus [1996], and the carcasses were classified into respective EUROP system classes. Approx. 48 h after slaughter, muscle acidification (pH_k) was measured once again. A sensory evaluation of the fresh meat was carried out with the Clausen and Thomsen method, *i.e.* meat colour, wateriness, hardness and consistency were determined [Różyczka *et al.*, 1975]. In addition, a measurement of the volume of free drip was completed according to Honikel [1987]. In ground meat, its wateriness was determined with the Grau and Hamm method modified by Pohja and Niinivaara [1957], and the drip index (IN) was also calculated. The meat colour was determined by spectrophotometry using a simplified method [Różyczka *et al.*, 1968] and meat colour parameters, *i.e.* dominant light wavelength and meat colour lightness were calculated. Additionally, basic meat chemical composition, *i.e.* protein, fat, ash, dry matter and water-soluble protein meat contents, was analysed according to the methods commonly used for that purpose [Kortz, 1986]. Furthermore, the frequency of meat loaded with PSE and DFD defects was also determined according to Grajewska *et al.* [1984]. A statistical analysis and evaluation of differences in meat quality traits occurring between respective carcass meatiness classes E, U, R and O was performed using a one-factor analysis of variance using STATISTICA PL 6.0 computer software.

RESULTS AND DISCUSSION

The mean meatiness of the population examined in classes E, U and R, evaluated according to the method of Walstra and Merkus [1996], was 56.30%, 52.28% and 48.42%, respectively (Table 1). In analysing the results obtained in the presented study referring to warm carcass weight, one may not state explicitly that in the group of carcasses with lower meatiness there are carcasses with high weight, and that those with lower weights have been included among higher classes of EUROP system [Wajda *et al.*, 1998; Kortz *et al.*, 2002]. Warm carcass weight mean values show that the lowest weight was found in carcasses in class U and R, 80.03 kg and 79.90 kg, respectively, and the highest in class E (81.05 kg) (Table 1).

A one-factor analysis of variance showed the effect of carcass meatiness on electric conduction of LD muscle tissue, dominant light wavelenght (DDF) and wateriness evaluated with sensory analysis (Tables 1 and 3).

The values of electric conduction measured in the carcass in the LD muscle were lower for carcasses classified into class R (3.75) and showed an upward trend together with an increase in carcass meat content (U 4.28), as in the highest meatiness class (E) it amounted to 5.70 (Table 1).

The significant effect of carcass meat content on dominant light wavelength values was demonstrated (Table 1), whereas there was no significant effect on meat colour lightness, which was confirmed by prior findings of other authors [Sutton *et al.*, 1997; Beattie *et al.*, 1999].

TABLE 1. Results of physicochemical traits of meat according to EUROP meatiness classes.

Traits		Meatiness classes			Significance of differences	
		E n=24	U n=52	R n=19	group	between groups
Warm carcass weight (kg)	$\bar{x}$	81.05	80.03	79.90	ns	-
	s	4.96	3.96	4.85		
Carcass meat content (%)	$\bar{x}$	56.30	52.28	48.42	**	E>U>R
	s	1.85	1.42	1.28		
pH_1	$\bar{x}$	6.02	6.17	6.30	ns	-
	s	0.39	0.37	0.35		
pH_k	$\bar{x}$	5.50	5.52	5.50	ns	-
	s	0.16	0.11	0.10		
LF_1 (mS/cm)	$\bar{x}$	5.70	4.28	3.75	*	E>U, R
	s	3.78	1.51	1.31		
Colour lightness (%)	$\bar{x}$	27.19	26.49	24.61	ns	-
	s	5.43	3.88	3.70		
Colour saturation (%)	$\bar{x}$	21.27	20.86	21.77	ns	-
	s	3.44	2.45	2.33		
Dominant wavelenght (nm)	$\bar{x}$	583.5	583.6	584.5	*	E, U<R
	s	1.22	1.30	1.07		
Natural drip (%)	$\bar{x}$	4.35	3.50	3.71	ns	-
	s	2.75	2.09	2.59		
Free water content (%)	$\bar{x}$	21.97	21.08	20.27	ns	-
	s	3.45	3.13	3.54		
Drip index (cm^2)	$\bar{x}$	0.23	0.25	0.27	ns	-
	s	0.05	0.05	0.06		
Water-soluble protein (% in meat)	$\bar{x}$	8.18	8.30	8.71	ns	-
	s	1.32	1.01	0.87		

** – significant at $p \leq 0.01$; * – significant at $p \leq 0.05$; ns – not-significant.

Wateriness evaluated with sensory analysis was the highest in the carcass classes of the highest leanness, E and U (respectively 2.3 and 2.4 point), and the lowest in the class R (2.75 points) (Table 2).

There were no significant differences between respective classes of carcass meatiness in the remaining traits of meat quality in respect of sensory, physicochemical and chemical evaluation. In the mean values for these traits, however, a tendency was observed towards worsening meat quality traits with an increase of carcass meatiness.

Out of the porker population examined in respect of loading with stress-susceptibility gene, 11 animals showed genetic susceptibility to stress (nn), 34 porkers were of the heterozygous genotype in respect of that gene (Nn), and 50 ones were genetically-resistant to stress (NN) (Table 4). A negative correlation between meatiness and meat quality is most likely influenced by the qualitative status of the material analysed with regard to genetic loading with the gene RYR1. It was found while analysing the material that animals with genotype nn did not occur only in classes E and U with the highest meatiness (6 and 5 carcasses, respectively). This is confirmed by the research of Oliver *et al.* [1993] that recessive homozygotes are of better meatiness (Table 4). Thus, referring to the above, class E and U had carcasses with PSE meat (13% and 2%, respectively), whereas class U and R had those with partially PSE meat (11% and 10%, respectively) and class E, U and R had those with partially DFD (13%, 6% and 10%, respectively) (Table 5).

Analysing the results obtained in respect of meat quality traits, it was confirmed explicitly that higher carcass meatiness is accompanied by meat quality deterioration [Sellier, 1998; Koćwin-Podsiadła *et al.*, 1999b]. The obtained results concerning the frequency of defective meat incidence confirm prior studies [Fiedler *et al.*, 1999], in which it was stated that gene RYR1 contributes to the incidence of PSE meat, as this defect has occurred only in classes E and U with the highest meatiness, in which recessive homozygotes have also been found. In each meatiness class, the

TABLE 4. Frequency of gene RYR1 incidence according to EUROP meatiness classes.

Genotype RYR1		Meatiness classes			Total
		E n=24	U n=52	R n=19	
nn	n	6	5	-	11
	%	26	9	-	1
Nn	n	11	17	6	34
	%	4	34	32	36
NN	n	7	30	13	50
	%	30	57	68	53

TABLE 5. Frequency of normal and defective meat incidence according to EUROP meatiness classes.

Meat quality classes		Meatiness classes			Total
		E n=24	U n=52	R n=19	
PSE	n	3	1	-	4
	%	13	2	-	4
Partially PSE	n		6	2	8
	%	-	11	10	8
Normal	n	18	42	15	75
	%	74	81	80	80
Partially DFD	n	3	3	2	8
	%	13	6	10	8

TABLE 2. Results of sensory traits of meat according to EUROP meatiness classes.

Traits		Meatiness classes			Significance of differences	
		E n=24	U n=52	R n=19	group	between groups
Colour (score)	$\bar{x}$	2.38	2.48	2.60	ns	-
	s	0.67	0.53	0.45		
Wateriness (score)	$\bar{x}$	2.30	2.40	2.72	*	E, U<R
	s	0.66	0.55	0.53		
Hardness (score)	$\bar{x}$	2.47	2.63	2.80	ns	-
	s	0.58	0.49	0.61		
Consistency - plasticity (cm^2)	$\bar{x}$	1.98	2.13	2.16	ns	-
	s	0.25	0.32	0.33		

ns -– not-significant.

TABLE 3. Chemical composition of meat according to EUROP meatiness classes.

Traits		Meatiness classes			Significance of differences	
		E n=24	U n=52	R n=19	group	between groups
Protein (%)	$\bar{x}$	22.49	22.28	22.35	ns	-
	s	0.67	0.96	0.73		
Fat (%)	$\bar{x}$	1.99	2.06	2.20	ns	-
	s	0.78	0.71	0.65		
Ash (%)	$\bar{x}$	1.10	1.11	1.09	ns	-
	s	0.09	0.22	0.08		
Dry matter (%)	$\bar{x}$	25.71	25.52	25.73	ns	-
	s	0.68	0.83	0.74		

** – significant at $p \leq 0.01$; * – significant at $p \leq 0.05$; ns – not-significant.

occurrence of normal meat was found in the case of 18 carcasses (class E), 42 carcasses (class U), and 15 carcasses (class R) (Table 5).

CONCLUSIONS

1. Carcasses of porkers from class E showed a more frequent incidence of meat defects of PSE, partial PSE and partial DFD types.

2. The genetic vulnerability of the porkers to produce PSE meat was found in 25% of the studied material. In the group with porkers of the highest meatiness, in class E, only 17% (out of 17 animals with genetic burdens 11 nn and 6 Nn), or 3 individuals were found after slaughter to have PSE meat.

3. A higher frequency of the incidence of normal meat was found together with a decrease in carcass meatiness.

4. All carcasses of animals with recessive homozygote genotype (nn) had the highest meatiness (class E and U).

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JAKOŚĆ MIĘSA TUCZNIKÓW W ZALEŻNOŚCI OD STOPNIA UMIĘŚNIENIA TUSZY Z UWZGLĘDNIENIEM GENOTYPU RYR1

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Badania przeprowadzono na 95 próbach mięśnia najdłuższego grzbietu (LD). Pobierano je z tusz zakwalifikowanych do klas mięsności E, U, R (odp. 24, 52 i 19 prób) czystorasowych tuczników rasy pbz, mieszańcach loch ras białych (wbp x pbz) z pietrain oraz mieszańcach ras holenderskich (Landrace x wb) x wb. U tuczników po uboju pobierano krew do analizy DNA w celu identyfikacji osobników obciążonych genem wrażliwości na stres (RYR1). Po wychłodzeniu tusz przeprowadzono szczegółową ocenę jakości tuszy (dysekcję) zgodnie z metodyką podaną przez Walstra i Merkusa [1996], na podstawie której tusze kwalifikowano do odpowiednich klas systemu EUROP. Wykonano oznaczenia jakościowe mięsa, tj.: pH_1, pH_k, przewodnictwa elektrycznego. Oceniano barwę, wodnistość, twardość i konsystencję. Ponadto wykonano pomiar wielkości wycieku swobodnego i oznaczano wodochłonność a także obliczono indeks nacieku oraz wyliczono parametry barwy. Analizowano również podstawowy skład chemiczny mięsa i zawartość w mięsie białka rozpuszczalnego w wodzie. Ponadto oszacowano częstość występowania mięsa obarczonego wadami PSE i DFD. Tusze tuczników z klasy E wykazywały częstsze występowanie wad mięsa typu PSE, częściowo PSE jak i częściowo DFD (tab. 5). Wraz z obniżaniem się mięsności tusz stwierdzono wyższą częstość występowania mięsa normalnego (tab. 5). Wszystkie tusze osobników o genotypie homozygot recesywnych (nn) cechowały się najwyższą mięsnością (klasy E i U) (tab. 4). Stwierdzane w badanym materiale predyspozycje genetyczne tuczników do wytwarzania mięsa PSE ujawniły się w 25% (tab. 5).