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RELATIONSHIP BETWEEN MEAT QUALITY TRAITS AND POLYMORPHISM OF *MYF-3* AND *MYF-4* GENES IN CROSSBRED PIGS*

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The aim of the research was to identify the relationship between meat quality traits in pigs differing in *Myf-3* and *Myf-4* gene polymorphism. Such traits as pH_1, electric conductivity, water holding capacity, drip loss and meat colour lightness, as well as the chemical composition of the *longissimus lumborum* muscle were determined. The study was carried out on 93 (47 barrows and 46 gilts) crossbred pigs (Polish Landrace × Polish Large White sows mated to Pietrain sires). All pigs were certified as *NN* and *Nn* genotypes in respect to *RYR1* gene locus. No distinct differences in meat quality traits with respect to *Myf-3* or *Myf-4* pig genotype influences were found. On average, the meat quality traits were in the range ascribed to normal meat quality classes. Nevertheless, the mean values of pH_1 in pigs of the *Myf-4 BB* genotype were significantly higher ($p<0.01$) than in meat of *AB* genotype pigs (6.48 *versus* 6.26). Similarly, meat colour was more desirable in *BB* than in *AB* genotype pigs ($p<0.05$). The intramuscular fat content was very low and did not differ between gene variants.

INTRODUCTION

It is commonly believed that meat quality depends upon many linked genetic and environmental factors. Some meat quality characteristics are determined to a great extent by *RYR1* gene polymorphism. Such traits as pH_1, electric conductivity, water holding capacity, drip loss and meat colour are significantly influenced by pig stress susceptibility frequently observed in pigs of the *TT* genotype at the *RYR1* locus [Kapelański *et al.*, 2001; Kortz *et al.*, 2000; Pommier & Houde, 1993; Sellier, 1998]. The major effects of the $RYR1^T$ gene on meat quality traits cover the influence of other genes involved in muscle metabolism, such as *MyoD* gene family.

Previous studies into the effects of *RYR1*, *myogenin* and *Myf-3* genes on meat quality characteristics found that the meat quality indices were affected by the *RYR1* gene status of pigs and by the pre-slaughter conditions to a greater degree than by some genes of the *MyoD* family [Kapelański *et al.*, 2001]. It was concluded that clearer results dealing with the *RYR1*, *Myf-3* and *Myf-4* (*myogenin*) genes' influence on meat quality traits could be obtained if the comparison is done on pigs not carrying the stress susceptibility gene.

The aim of the present study was to prove the association between meat quality traits and the polymorphism of *Myf-3* and *Myf-4* genes in only pigs of the *NN* and *Nn* genotypes.

MATERIAL AND METHODS

The experiment was carried out on 93 pigs (47 barrows and 46 gilts) from the TORHYB programme, *i.e.* offspring of crossbred sows (Polish Landrace × Polish Large White) mated to Pietrain sires. Pigs were reared under standard conditions and when reaching about 105 kg body weight they were transported by a car to a slaughterhouse 22 km away and slaughtered in accordance with current regulations.

Meat quality traits were measured in the *longissimus lumborum* muscle. The pH_1 value was recorded using pistol pH-meter (R. Matthaus, Germany) and ultimate pH (pH_u) was measured in meat-water slurry 48 h after slaughter. Meat electric conductivity at 45 min *post mortem* (EC_1) was tested by LF-STAR apparatus (R. Matthaus, Germany). Colour lightness was determined on minced meat samples on Spekol 11 with a reflectance attachment and use of the regression equation [Różyczka *et al.*, 1968]. Water holding capacity (WHC) was determined according to the filter press method [Pohja & Niinivaara, 1957] and expressed as a percentage of free water in meat. Drip loss was recorded for approx. 150 g slice of meat [Honikel, 1987].

Genomic DNA was extracted using standard molecular biology methods. Differentiation for *RYR1* genotypes was performed according to Fuji *et al.* [1991]. Polymorphism in the *myogenin* gene (*Myf-4*) was identified at its 3' end with *MspI* restriction enzyme as described by Soumillion *et al.* [1997] and that in *Myf-3* gene with *DdeI* according to Knoll *et al.* [1997]. The detailed analytical procedure was described by Cieślak *et al.* [2000].

All statistical analyses were done using the computer program STATISTICA 5.5 PL (2000).

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RESULTS AND DISCUSSION

In the studied pig population the allele frequencies of *Myf-3* gene were 0.33 for *A* and 0.67 for *C* and those of *Myf-4* gene 0.23 for *A* and 0.77 for *B*. The numbers of pigs of particular genotype are given in Table 1 together with the *RYR1* genotype. It is worthy to note that the variance analysis for particular meat quality traits in respect to *NN* and *Nn* pigs was performed, and only for drip loss was the difference hardly significant ($p<0.05$). In the experiment, only two *Myf-4* genotypes *AB* and *BB* were present in the studied pig population, and in the *Myf-3* genotype distribution the *AA'* genotype was present in only 4 animals.

No distinct differences in meat quality traits with respect to *Myf-3* or *Myf-4* pig genotype influences were found. On average, the meat quality traits were in the range ascribed to normal meat quality classes. Nevertheless, the mean values of pH_1 in pigs of the *Myf-4 BB* genotype were significantly higher ($p<0.01$) than in meat of *AB* genotype pigs (6.48 *versus* 6.26). Similarly, meat colour was more desirable in *BB* than in *AB* genotype pigs ($p<0.05$).

The problem of inferior meat quality was generally more pronounced in pigs with high carcass meatiness. Hence, it appears that genes involved in muscle development and growth may be responsible for some meat properties in slaughter animals. However, such meat quality traits as pH_1, electric conductivity, water holding capacity or proper meat colour, are under the more strong regulatory influence of *RYR1* gene than that of the *MyoD* gene family. The mode of action *RYR1* gene may be compared to MHS (Malignant Hyperthermia Syndrome) reactions, whereas the effect of *Myf-3* and *Myf-4* genes concern fiber muscle formation and differentiation during the embryonic development and the after birth growth rate or meat deposition capacity in animals.

It follows from the above that the effect of *Myf-3* and *Myf-4* gene variants may involve other meat properties than exerted by *RYR1* genotype influence. It was shown that genetic defect in the calcium release channel in the muscle reticulum, due to a single point mutation in the *RYR1* gene, primarily concerns the perimortal intensity of glycolytic processes [Cheah *et al.*, 1994; Gronek *et al.*, 1998; Lahucky *et al.*, 1997; Sellier, 1998; Sellier & Monin, 1994]. On the other hand, the *Myf-3* and *Myf-4* gene effects are more likely to be expressed as muscle fiber composition and the proportion between red and white fiber type in particular muscles, or as the establishment of fiber numbers [Christensen *et al.*, 2000; Soumilion *et al.*, 1997]. There are some findings made on the comparison of several different muscles, that their colour may be affected by mRNA expression of *Myf-4* to *Myf-3* ratio (being 0.73 to 1.07), with a higher ratio for the more red coloured muscles [Te Pas *et al.*, 2000].

In the above-mentioned study, however, the differences between gene variants have not been taken into account. As already has been shown, some differences in carcass lean content, growth rate, lean weight and backfat thickness might be linked to polymorphic forms of *Myf-3* and *Myf-4* genes [Cieślak *et al.*, 2000; 2002; Kurył, 2000; Te Pas *et al.*, 1999].

In addition, the chemical composition of meat is likely to be regulated by polymorphic forms of the *Myf-4* gene [Pietruszka *et al.*, 2002]. It was stated by these authors that slightly meatier pigs with the *Myf-4 AA* genotype compared to the *AB* genotype, had significantly lower intramuscular fat content associated with a slightly lower meat cholesterol content.

That relation has not been found in this study because the mean values of meat intramuscular fat content were, on average, at a very low level and did not exceed 1 % of muscle wet weight.

In conclusion for meat quality traits in pigs not burdened with stress susceptibility, the effects of *Myf-3* and *Myf-4* gene variants are of minor significance. However, meat pH_1 and meat colour values were slightly more desirable in the *Myf-4 BB* than the *AB* genotype pigs.

Further studies are required.

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TABLE 1. Results of meat quality traits as related to *Myf-3* and *Myf-4* genotypes.

Trait	*Myf-3* genotypes			*Myf-4* genotypes	
	AA	AC	CC	AB	BB
Number, n (%)	4 (4.3)	43 (46.2)	46 (49.5)	44 (47.3)	49 (52.7)
Number, n NN	-	17	21	16	20
Number, n Nn	4	26	25	28	29
pH_1	6.62 ± 0.30	6.38 ± 0.38	6.35 ± 0,37	6.26^{A} ± 0.36	6.48^{B} ± 0.36
pH_k	5.48 ± 0.08	5.50 ± 0.09	5.58 ± 0.53	5.48 ± 0.07	5.52 ± 0.12
EC_1 (mS/cm)	4.20 ± 0.43	3.96 ± 0.69	3.90 ± 0.86	4.02 ± 0.77	3.87 ± 0.76
Colour lightness (%)	22.52 ± 3.10	23.16 ± 3.32	22.16 ± 3.14	23.36^{a} ± 3.38	21.99^{b} ± 2.97
WHC, loose water (%)	21.23 ± 3.16	19.99 ± 2.33	19.19 ± 2.23	20.10 ± 2.39	19.23 ± 2.56
Drip loss (%)	5.22 ± 3.43	3.64 ± 2.40	3.49 ± 2.33	4.00 ± 2.57	3.30 ± 2.22
Water content in meat (%)	74.74 ± 0.32	74.22 ± 0.84	74.31 ± 0.82	74.15 ± 0.98	74.42 ± 0.63
Crude protein (%)	23.19 ± 1.09	23.42 ± 0.65	23.52 ± 0.59	23.50 ± 0.65	23.42 ± 0.63
Intramuscular fat (%)	1.00 ± 0.30	1.06 ± 0.50	1.05 ± 0.45	1.12 ± 0.53	0.99 ± 0.39

a, b – significant differences at $p \leq 0.05$, A, B – significant differences at $p \leq 0.01$

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ZALEŻNOŚĆ MIĘDZY CECHAMI JAKOŚCI MIĘSA I POLIMORFIZMEM GENÓW *MYF-3* I *MYF-4* U ŚWIŃ MIESZAŃCÓW

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Celem badań było wykazanie różnic między cechami jakości mięsa w zależności od polimorfizmu genu *Myf-3* i *Myf-4* świń. W mięśniu *longissimus lumborum* oznaczano pH_1, przewodność elektryczną, wodochłonność, swobodny wyciek soku jak również skład chemiczny mięsa. Badania przeprowadzono na 93 (47 wieprzkach i 46 loszkach) mieszańcach otrzymanych z kojarzenia loch pbz × wbp i knurów pietrain. Badane zwierzęta były sprawdzone względem *RYR1* locus i wykazywały genotyp *NN* i *Nn*. Nie wykazano widocznych różnic w cechach jakości mięsa w odniesieniu do genotypu *Myf-3* i *Myf-4*. Średnio, zakres badanych cech odpowiadał klasie dobrego mięsa. Jednakże wartości średnie pH_1 mięsa świń genotypu *BB* względem *Myf-4* były istotnie wyższe ($p<0.01$) niż mięso świń genotypu *AB* (6,48 wobec 6,26). Podobnie barwa mięsa świń *BB* była bardziej pożądana niż świń genotypu AB ($p< 0.05$). Zawartość tłuszczu śródmięśniowego była bardzo niska i niezróżnicowana względem genotypów *Myf-3* i *Myf-4* (tab. 1).