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INFLUENCE OF MHS GENETIC STATUS OF BOARS ON FERTILITY OF SOWS AND PRODUCTION TRAITS OF PIGLETS

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SUMMARY

The research aim was to determine influence of MHS gene polymorphism on the most important slaughter and production traits of pigs. For the purpose of carrying out the research, semen of 6 Pietrain boars of different MHS genetic status was used for insemination of 120 Large White and German Landrace sows crossbreds. Fertility and production traits were monitored during rearing and fattening period of offspring. Upon completion of fattening and slaughtering, the slaughter traits of pig carcasses and meat were determined. The results proved that sows inseminated by boars carrying MHS gene had weaker fertility, and their piglets grew slower during sucking period and rearing. As for the production traits during fattening, there were no significant differences determined between the investigated pig groups. Values of slaughter traits obtained on pig carcasses and meat pointed out the necessity of excluding carriers of MHS gene from production because of their unfavourable influence on carcass and meat quality.

Key-words: pigs, MHS gene, stress, productive traits, slaughtering traits

INTRODUCTION

Stress sensitivity pig syndrome (Porcine Stress Syndrome – PSS) occurs in pigs as a consequence of intensive pig selection to meatiness. This syndrome is manifested in stress conditions through symptoms of malignant hyperthermia (MHS) characterized by fast breathing, strong pulse, muscle tremor, elevated body temperature, partial to total muscular rigidity, metabolic disorders, and in more serious cases the MHS can be lethal. Stress sensitivity of pigs is caused by mutation in RYR1 gene known as halothane or MHS gene. The RYR1 gene participated in Ca^{++} transport and mutation causing pig stress sensitivity, occurred in the 1843rd nucleotide ryanodine receptor-1 gene on the chromosome 6. Negative consequences of this mutation in RYR1 gene are weaker fertility and resistance, as well as poorer quality of muscle tissue usually manifested through occurrence of pale, soft and exudative meat (PSE meat). Many authors determined that MHS-carriers (Nn) and stress susceptable animals (nn) had greater portion of muscle tissue in carcass (Aalhus et al., 1991, Pommier et al., 1992), and that those traits were clearly related to pig stress sensitivity, thus causing poorer meat quality (Denborough, 1998; Houde et al., 2001). Some researchers proved that stress susceptable animals (nn) grew faster than MHS heterozygotes (Luescher et al., 1979). On the contrary, some authors did not determine differences in the growth rate between stated genotypes (Simpson and Webb, 1989; Sather et al., 1991; Pommier et al., 1992). Some authors determined higher daily gain in stress free (NN) pigs (Jensen and Barton-Gade, 1985). Matoušek et al. (2003) determined weaker fertility of sows carrying mutated RYR1 allele. On the other hand, Češhova et al. (2007) pointed out greater number of live-born and weaned piglets of sows carrying that allele. Hamilton et al. (2000) concluded that removal of recessive allele of halothane gene from pig population would influence improvement of pig meat quality. The research aim was to determine influences that RYR1 gene had on production and slaughter traits of fattened pigs, and to determine influence of the gene polymorphism on the most important slaughter and production traits.

MATERIAL AND METHODS

The research was carried out on 120 sows crossbreds of Large White and German Landrace (LW x GL) inseminated by Pietrain (PI) boars of different MHS genetic status (NN, Nn and nn). Each boar inseminated 20 sows. The sows were kept and fed in equal conditions. After initial rearing, piglets were kept in groups of

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20, on full-floored pens. Feeding regime involved standard mixtures for fattening pigs. After fattening period, pigs were slaughtered in a slaughtering house. Warm pig halves were used for taking measures of halves length, points *a* and *b*, ham, back fat and muscle thickness for the purpose of assessing portion of muscle tissue in carcass by the two-points method (Regulations 2003). After 45 minutes post mortem, pH (pH_{45}) and electrical conductivity (EC_{45}) were measured. Final pH (pH_{24}) and final electrical conductivity (EP_{24}) were also determined. MLD Samples were taken on the spot between 13th and 14th rib and analyzed to determine color, water holding capacity and drip loss. Meat color values were determined by Minolta CR300. Drip loss (Kauffman, 1992) was presented in %, and obtained on the basis of weight loss after the 3 cm thick and 4 cm long MLD sample had been kept in plastic bag for 48 hours at 4°C. Water holding capacity was determined by the compression method of Grau and Hamm (1953). Genomic DNA was isolated from boars' blood by using standard extraction protocol by phenol-chloroform-isoamyl (25:24:21) alcohol (Ausubel et al., 2000). Reaction was run in thermal cycler PTC-100 (MJ Research, USA). Amplification started with 5 min denaturation step on 95°C, followed by 35 cycles of: denaturation: 95 °C, 45 s, annealing: 53-57°C (depending on the locus), 35 s, elongation: 72°C, 20 s. The reaction ended with final elongation step at 72°C for 6 minutes. Restriction fragment length polymorphisms (RFLP) of amplified part from of RYR1 gene where the mentioned mutation occurs was performed using HhaI restriction enzyme in total volume of 10.3 μl, whose 3 μl was 10x restriction puffer, 1.3 μl was enzyme and 8.7 μl was PCR of the sample. There were three genotypes determined by restriction: stress resistant boars (NN), heterozygote carriers of MHS gene (Nn) and stress sensitive recessive homozygote (nn). Statistical data analysis was performed by using SASSTAT, v 8. software (SAS Institute INC, 2002).

RESULTS AND DISCUSSION

Table 1 shows the results of productive traits obtained during the research. Sows' fertility was around 75% for all sows. Sows inseminated by stress resistant boars had statistically significantly more ($P<0.05$) live-born and weaned piglets than sows inseminated by stress sensitive boars. Consequently, number of pigs fattened and delivered for slaughter was greater at the same level of statistical significance. No statistically significant differences were determined while conducting comparison with sows fertilized by boars heterozygote to MHS gene. However, when compared with them, sows inseminated by stress resistant boars still had better production results.

When comparing weight gains (piglets birth weight included) between the investigated pig groups, it was determined that offspring of stress resistant fathers had statistically significantly higher ($P<0.05$) individual birth weight than offspring of stress sensitive fathers. Total weight of pig litter of heterozygote fathers was significantly higher ($P<0.05$) than recessive homozygotes of litter. Piglets of dominant homozygotes had higher average gain ($P<0.05$) during sucking period than piglets of stress sensitive fathers, which corresponded to the generally accepted fact that weight gain during sucking period was most influenced by lactation of mother and by other paragenetic factors while genetic influence was exhibited in considerably smaller share. Statistically significant differences between the investigated groups were not determined either for average daily gains during raring and fattening periods, or for finishing weights.

Table 1. Production traits

Tablica 1. Proizvodna svojstva

Trait	Genotype		
	NN	Nn	nn
Total born piglets	363 ^{A}	334	301 ^{B}
Number of live born piglets	334 ^{A}	308	274 ^{B}
Weaned piglets	301 ^{A}	274	256 ^{B}
Delivered for slaughter	231 ^{A}	215	196 ^{B}
Individual birth weight (g)	1516	1605 ^{A}	1490 ^{B}
Average weight of litter (kg)	16.65	17.05 ^{A}	14.11 ^{B}
Daily gain in suckling period (kg)	252.56 ^{A}	228.90	220.04 ^{B}
Weight of litter after weaning (kg)	66.52 ^{A}	61.20	52.58 ^{B}
Daily gain in rearing period (g)	372.42	375.11	358.37
Daily gain during fattening (g)	620.34	638.54	612.38
Weight at slaughter delivering (kg)	98.17	99.79	95.79

^{A,B} $P<0.05$

Table 2 shows pig halves traits at slaughter. Weight of warm carcasses was significantly higher ($P<0.05$) in offspring of heterozygotes than in offspring of stress sensitive fathers. The same level of statistical significance was set for back fat thickness as fattened pigs of stress resistant fathers had significantly thicker back fat in comparison with offspring of stress sensitive fathers. Muscle thickness of offspring of heterozygote parents was significantly higher than of stress sensitive boars offspring, but no statistical differences were determined in relation to stress resistant pigs. Values of pH in MLD of stress sensitive pigs were very low and statistically significantly ($P<0.05$) differed from values of other two groups. Forest (1998) and Van Laack (1999) determined pH_{24} to be less than 5.5, i.e. 5.7 as an indicator of PSE meat, which proved that obtained results clearly indicated occurrence of PSE meat in the tested pigs. Drip loss values and water holding capacity also supported this conclusion as these values were significantly higher ($P<0.05$) in meat of pigs of stress sensitive boars than in meat of pigs of stress resistant and heterozygote parents.

Meat color parameters are presented as values L* (related to paleness), a* (related to redness, i.e. red-green spectrum) and b* (related to yellowness, i.e. yellow-blue spectrum). Stated parameters are known

as CIE values (Commision Internationale de l' Eclairage, 1976) (Van Oeckel et al., 1999). No statistically significant differences (P>0.05) were determined between the investigated pig groups with respect to the traits that determine sensory quality of muscle tissue. However, CIE L^+ values were above level set for "normal" meat according to Hofmann (1994). This author stated that CIE L^+ value for PSE meat was higher than 53, being in consent with the author's doubt that the meat in present research was PSE.

Table 2. Slaughtering traits

Tablica 2. Klaonička svojstva

Trait	Statistical parameters	Genotype		
		NN	Nn	nn
Mass of warmed carcasses (kg)	$\bar{x}$	77.89	78.16 ^{A}	73.31 ^{B}
	sd	6.29	6.92	6.33
	vk	6.01	5.44	5.78
	$s_{\bar{x}}$	1.64	1.33	1.67
Fat thickness – S (mm)	$\bar{x}$	12.36^{A}	11.23	10.97 ^{B}
	sd	3.24	3.56	3.24
	vk	18.33	19.36	17.11
	$s_{\bar{x}}$	0.89	0.86	0.86
Muscle thickness – M (mm)	$\bar{x}$	67.92	69.43^{A}	64.11 ^{B}
	sd	7.69	9.36	8.35
	vk	8.17	10.58	9.91
	$s_{\bar{x}}$	1.93	2.76	2.13
Carcass meatiness – DT (%)	$\bar{x}$	57.79	58.66	58.91
	sd	2.96	3.31	3.06
	vk	5.42	5.95	5.64
	$s_{\bar{x}}$	0.84	0.75	0.77
pH_{45} MLD	$\bar{x}$	6.28 ^{A}	6.01 ^{A}	5.34 ^{B}
	sd	0.23	0.35	0.21
	vk	3.55	5.47	3.18
	$s_{\bar{x}}$	0.07	0.07	0.06
pH_{24} MLD	$\bar{x}$	5.61 ^{A}	5.51	5.21 ^{B}
	sd	0.07	0.07	0.06
	vk	1.26	1.26	1.24
	$s_{\bar{x}}$	0.02	0.01	0.01
Water holding capacity (cm^2)	$\bar{x}$	6.76 ^{B}	6.87 ^{B}	8.31 ^{A}
	sd	1.38	1.17	1.24
	vk	17.76	13.63	14.56
	$s_{\bar{x}}$	0.40	0.43	0.43
Drip Loss (%)	$\bar{x}$	4.10^{B}	4.78^{B}	5.63 ^{A}
	sd	1.41	1.41	1.42
	vk	33.95	31.33	33.11
	$s_{\bar{x}}$	0.41	0.28	0.30
CIE L^*	$\bar{x}$	50.11	52.86	57.12
	sd	1.90	3.34	3.12
	vk	3.51	6.12	4.19
	$s_{\bar{x}}$	0.55	0.67	0.61
CIE a*	$\bar{x}$	9.01	9.84	10.32
	sd	1.88	1.70	1.77
	vk	20.70	19.43	19.56
	$s_{\bar{x}}$	0.54	0.34	0.51
CIE b*	$\bar{x}$	7.01	7.13	7.86
	sd	1.59	1.46	1.44
	vk	22.69	22.29	21.19
	$s_{\bar{x}}$	0.46	0.29	0.22

^{A,B} = P<0.05

CONCLUSION

Based on the obtained results, it was concluded that there were no economically justified reasons to use stress sensitive (nn) boars in production because they exhibited significantly poorer production and slaughter results than stress resistant pigs. Since there were no significant differences determined between stress resistant (NN) and heterozygote (Nn) boars referring to productivity, the issue of appropriateness of MHS gene carriers for large-scale production can be raised. However, further researches performed on greater number of pigs will be needed prior to making final conclusions.

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REFERENCES

1. Ausubel, F.M., Brent, R., Kingston, R.E., Moore, D.D, Seidman, J.G., Smith, J.A., Struhl, K. (2000): Current Protocols in Molecular Biology. Vol. I, section 2 and 3, John Wiley and Sons, Inc., New York, USA.
2. Aalhus, J.L., Jones, W.M., Robertson, W.M., Tong, A.K.W., Sather, A.P. (1991): Growth characteristics and carcass composition of pigs with known genotypes for stress susceptibility over a weight range of 70 to 120 kg. Anim. Prod. 52: 347.
3. Čechová, M., Wolf, J., Trčka, P. (2007): Impact of RYR1 genotype of Piétrain boars on litter traits of Czech Large White × Czech Landrace crossbred sows. Journal of Animal Breeding and Genetics, 124(2): 86–93.
4. Denbrough, M. (1988): Malignant Hyperthermia. Lancet 352: 1131-1136.
5. Forrest, J.C. (1998): Line speed implementation of various pork quality measures. Www.nsif./Conferences/1998/forrest.htm
6. Houde, A., Godbout, D., Gariepy, C. (2001): Major Genes and Meat Quality. Advances in Pork Science, 12: 139-142.
7. Jensen P., Barton-Gade, P. (1985): Performance and carcass characteristics of pigs with known genotypes for halothane susceptibility and meat quality in pigs. EAAP Publication 33: 80-87.
8. Luscher, U., Schneider, A., Jucker, H. (1979): Genetic of halothane sensitivity and change of performance, carcass and meat quality traits induced by selection against halothane sensitivity. In "Proc. 30th Anual Meeting of the EAAP", Harrogate, England.
9. Matoušek, V., Kernerova, N., Kolarikova, O., Križova, H., Urban, T., Vrtkova, I. (2003): Effect of RYR1 and ESR genotypes on the fertility of sows of Large White breed in elite herds. Czech J. Anim. Sci., 48: 129–133.
10. Pommier, S.A., Houde, A., Rousseau, F., Savoie, Y. (1992): The effect of the malignant hyperthermia genotype as determinated by restriction endonuclease assay on carcass characteristic of commercial crossbred pigs. Can.J. Anim. Sci. 72: 973-976.
11. Sather, A., Murray, A.C., Zawadski, S.M., Johnson, P. (1991): The effect of the halothane gene on pork production and meat quality of pigs reared under commercial conditions. Can.J. Anim. Sci. 71: 959.
12. Simpson, S., Webb, A.J. (1989): Growth and carcass performances of British Landrace pig heterozygous at the halotane locus. Anim. Prod. 49: 503.
13. Van Laack, R.L.J.M., Kauffman, R.G. (1999): Glycolytic potential of red soft, exudative pork longissimus muscle. J.Anim. Sci. 77: 2971-2973.
14. Van Oeckel, M.J., Warnants, N., Boucque, C.V. (1999): Measurement and prediction of pork colour. Meat Science 52(4): 347-354(8).

UTJECAJ MHS GENETSKOGA STATUSA NERASTOVA NA PLODNOST KRMAČA I PROIZVODNA SVOJSTVA PRASADI

SAŽETAK

Cilj je istraživanja bio utvrditi utjecaj polimorfizma MHS gena na najznačajnija klaonička i proizvodna svojstva svinja. Za potrebe istraživanja korišteno je sjeme od 6 pietren nerastova različitoga MHS genetskoga statusa, kojim je osjemenjeno 120 krmača križanki velikoga jorkšira i njemačkog landrasa. Plodnost krmača i proizvodna svojstva prasadi mjerena su tijekom uzgoja i tova, a nakon klanja tovljenika utvrđena su klaonička svojstva svinjskih polovica i mesa. Rezultati istraživanja ukazuju da su krmače koje su osjemenjene nerastovima nositeljima MHS gena imale slabiju plodnost, a njihova prasad rasla je sporije tijekom dojnoga razdoblja i u uzgoju. Tijekom razdoblja tova nisu utvrđene statistički značajne razlike između istraživanih skupina svinja u pogledu proizvodnih pokazatelja. Vrijednosti klaoničkih svojstava utvrđenih na svinjskim polovicama i u mesu ukazuju na potrebu isključivanja nerastova nositelja MHS gena iz proizvodnje, zbog njegovoga nepovoljnoga učinka na svojstva kakvoće trupova i mišićnoga tkiva.

Ključne riječi: svinje MHS gen, stres, proizvodna svojstva, klaonička svojstva

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