EXPRESSION AND EFFECT OF HAL^n ALLELE IN HETEROZYGOUS FATTENERS FOR CARCASS AND MEAT QUALITY TRAITS

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Background

The explorations of molecular genetic and accessibility to use the precise method of identification (on the DNA level) the mutate stress susceptibility gene caused that the effect and expression of HAL^n gene for economically important features became the object of many investigations (Ellis & Mc Keith 1996, Sellier 1998).

At the present, among breeders and investigators the problem of production of heterozygous fatteners - HAL^n allele carriers is widely discussed. The subject of this discussion is the force of influence HAL^n allele on useful features (mainly the meat quality traits) and the strategy of practical procedures in national breeding programs. This strategy is connected with keeping or entire elimination of this gene from different breeds of pigs. The strategy is closely connected with improvement or stabilisation meat quality traits.

Objective

The aim of this study is performance of expression and phenotypic effect of HAL^n allele in heterozygous scheme in two-breed simply crossing (on the background of pure maternal breed) for selected carcass traits, quality and technological yield of meat. Traits' values of heterozygous fatteners were referred to analogous values of stress resistant animals.

Methods

In this study two genetic groups of fatteners: polish landrace and crossbreed fatteners originated from crossing Polish landrace sows with boars of synthetic line (free of RN$^-$gene, formed from Hampshire, Duroc, Pietrain and Large White breeds) were used. In each group were 40 animals (20 NN and 20 Nn genotype) with equal gilts and castrates number. The analysed fatteners originated from crossbreeding of stress resistant sows with heterozygous boars. The HAL genotypes were identified by PCR/RFLP method (Fujii et al. 1991, Kurył & Korwin-Kossakowska 1993). From animals by 60-80 kg live weights from the *Longissimus Lumborum muscle* (m. LL.) the biopsy samples were taken. In samples the glycolytic potential and lactate content were determined (Monin & Sellier 1985). Animals in similar breeding and living conditions were held and slaughtered at about 100 kg live weight (in May and June) in slaughterhouse 55km distanced from pig farm, after 2-4 hours resting. Carcass quality was estimated in accordance with method using in polish Pig Testing Stations. Quality of fresh meat was estimated in m.LL. using parameters such as pH_{45} and pH_{24} (in muscle water homogenates), R_1 as a IMP/ATP ratio (Honikel and Fischer 1977), Water Holding Capacity (Grau and Hamm 1952, Pohja and Ninivaara 1957) and muscle lightness using Momcolor D-3098 with white standard. Napole yield (RTN) was evaluated according to Naveau et al. (1985) on the *Semimembranosus* muscle. Moreover, the yield of hams and loin in curing and smoking process, according to technology utilised in polish meat industry was evaluated.

The significance of differences between means values of heterozygous and stress resistant animals for analysed traits was calculated using one-way variance analysis method. The mean values were compared by t-Student test. The expression of HAL^n allele as a difference between mean of phenotypic value of Nn and NN animals for analysed traits was showed. The effect of this allele as a estimated Nn-NN difference to standard deviation (SD) for all genetic group ratio was showed. The Nn-NN difference: SD ratio express the force of analysed allele on the trait.

Results and discussion

Analysis of variance showed influence of HAL^n allele both on lactate level in m. *Longissimus Lumborum* and on the most of analysed meat and carcass traits. Differences between mean values of Nn and NN groups in accordance to standard deviation of mean were also expressed (Tab. 1). One generally considers that gene can be termed "major gene" when the difference between the mean value homozygous animals (in HAL gene NN and nn) is equal or superior to 1 phenotypic standard deviation of the trait (Sellier 1998).

In this investigations the effect of Hal^n gene only in heterozygous scheme was analysed, but strongest and profitable influence was noted for weight of ham without backfat and skin (0,89 SD for pure-breed fatteners and 0,82 SD for crossbreeds), weight of meat in primal cuts (0,70 SD and 0,74 SD) and meatiness (0,87 SD and 0,68 SD). Interesting is that in this investigations strong and negative effect of HAL^n allele for meat quality traits was noted. Obtained differences among heterozygous and stress resistant animals were near 1 SD for traits - basis to classification of meat quality and determinants of meat with PSE syndrome e.g. pH_{45} and R_1 (respectively for pure-breed and crossbreeds: -0,95 and -0,87 SD for pH_1, 0,87 and 0,76 SD for R_1). Similar strong effect was also noted for extent of pH fall: -0,94SD for Polish landrace and -0,79SD for crossbreeds. More intensive metabolism (energetic changes) in HAL^n carriers muscles is also indicated by statistically significant higher lactate level (measured in biopsy samples) and exceptional high Nn-NN difference: SD share for lactate level (2,37 SD for Polish landrace and 1,56 SD for crossbreed fatteners).

The HAL^n allele effect for WHC was stronger for pure Polish landrace animals group (three times than for crossbreed animals: 1,01 SD and 0,38 SD respectively). The similar tendencies for direction and force of HAL^n allele influence were noted by Sellier (1998), who compared the results of 13 different experiments.

In this investigations very low HAL^n effect for pH_{24} was noted. It confirms opinion of many researches that this allele doesn't influence on ultimate pH. For yield of meat in technological process treatment (as in the laboratory - RTN so in meat industry TY-of loin and ham) the HAL^n allele effect was also low and non-significant.

On the basis of obtained results it seems, that the HAL^n allele expression is stronger in pure maternal breed than in group originated from crossing of maternal breed sows with synthetic line boars (exceptional for lactate level, loin muscle "eye" area and WHC).

Conclusions

1. Profitable effect of HAL^n gene on slaughtering performance traits in both analysed genetic groups was confirmed. Either, negative influence Hal^n allele on lactate level measured in *Longissimus Lumborum* of live animals and determinants meat quality and technological yield was noted.
2. Confirmed statistically unprofitable effect HAL^n allele on basic of meat quality determinants shows on predisposition of heterozygous fatteners to produce faulty meat PSE type. It's bringing in question opinion about recessive character of HAL^n allele with reference to meat quality traits.
3. Stronger expression HAL^n allele for pure-breed fatteners suggests that crossbreeding makes "soften" unprofitable effect HAL^n allele.
4. Unprofitable tendention according to meat quality traits of HAL^n carriers fatteners cause the need of elimination HAL^n allele from crossing programs in which this allele is used.

References

ELLIS M., MC KEITH F. 1996. Conference and Annual Meeting of National Swine Improvement Federation. Ottawa, Canada; Vol. 21.

FUJI J., OTSU K., ZORZATO F., DE LEON S., KHANNA V.K., WEILER J. E., O`BRIEN P. J., LENNAN D. H., 1991. *Science* 253; 448-451.

GRAU R., HAMM R., 1952. *Fleischwirtschaft* 4; 295-297.

HONIKEL K.O., FISCHER H., 1977. *Journal of Food Sciences* 42; 1633-1636.

KURYŁ J., KORWIN-KOSSAKOWSKA A.: 1993. *Animal Sciences Papers and Reports* 11; 271-277.

MONIN G, SELLIER P., 1985. *Meat Science* 13, 49-63.

NAVEAU J., POMMERET P., LECHAUX P., 1985. Techni Porc 8, 7-13.

POHJA N. S., NINIVAARA F. P., 1957. *Fleischwirtschaft* 9; 193-195.

SELLIER P., 1998. The genetics of the pig. (ed. M.F. Rothschild & A. Ruvinsky), CAB International, Wallingford, Oxon; 463-510.

Tables and figures

Table 1. The phenotypic effect of HAL^n allele in heterozygous fatteners for analysed carcass and meat quality traits

Traits	Genetic group							
	Pure polish landrace				Crossbreed fatteners			
	NN	Nn	Nn-NN	Nn-NN SD	NN	Nn	Nn-NN	Nn-NN SD
Number of animals	20	20			20	20		
Carcass length(cm)	82,75 (±2,26)	82,11 (±2,75)	-0,64	-0,25	79,69 (±2,78)	79,24 (±2,65)	-0,45	-0,17
Average backfat thickness (cm)	2,00 (±0,40)	2,01 (±0,39)	0,01	0,03	1,71 (±0,36)	1,68 (±0,40)	-0,03	-0,08
Weight of ham without backfat and skin (kg)	6,90 (±0,56)	7,37 (±0,50)	0,47**	0,89	7,18 (±0,46)	7,76 (±0,81)	0,58**	0,82
Loin muscle "eye" area (cm^2)	43,02 (±4,81)	46,26 (±6,07)	3,24*	0,6	47,74 (±4,64)	48,46 (±3,96)	0,72	0,17
Meat in primal cuts (kg)	19,03 (±0,97)	19,79 (±1,21)	0,76**	0,7	19,44 (±0,98)	20,39 (±1,41)	0,95**	0,74
Meat content in carcass (%)	51,34 (±2,23)	53,41 (±2,37)	2,07**	0,87	54,34 (±2,22)	56,22 (±3,10)	1,92*	0,68
Glycolytic potential (μmol/g)	206,86 (±14,29)	205,81 (±18.15)	-1,05	-0,02	174,34 (±19,59)	175,30 (±17,39)	0,96	0,05
Lactate (μmol/g)	6,20 (±1,12)	11,28 (±3,08)	5,08*	2,37	7,68 (±1,83)	13,41 (±2,58)	5,73*	1,56
pH_{45}	6,23 (±0,18)	6,07 (±0,16)	-0,16**	-0,95	6,31 (±0,27)	6,11 (±0,17)	-0,20**	-0,87
pH_{24}	5,55 (±0,13)	5,55 (±0,10)	0	0	5,53 (±0,11)	5,51 (±0,08)	-0,02	-0,22
pH_{45}-pH_{24}	0,68 (±0,18)	0,52 (±0,16)	-0,16**	-0,94	0,79 (±0,28)	0,60 (±0,20)	-0,19*	-0,79
R_1	0,923 (±0,078)	1,010 (±0,125)	0,087**	0,87	0,948 (±0,092)	1,016 (±0,084)	0,068*	0,76
Meat lightness	15,17 (±2,34)	16,40 (±3,05)	1,23	0,45	17,41 (±2,32)	16,83 (±1,90)	-0,58	-0,27
WHC (cm^2)	4,67 (±0,77)	5,75 (±1,37)	1,08**	1,01	5,21 (±1,22)	5,58 (±1,10)	0,37	0,32
RTN (%)	92,78 (±4,53)	90,82 (±5,39)	-1,96	-0,39	88,75 (±2,54)	87,76 (±3,03)	-0,99	-0,35
Technological yield of cured and smoked product[1)] (%)	115,22 (±4,61)	112,84 (±3,95)	-2,38	-0,54	104,41 (±6,43)	102,27 (±8,94)	-2,14	-0,28

*Explanations: the results are given as means values ± standard deviation (s.d.); the difference between Nn and NN animals is expressed in unit of analysed trait; * –difference significant at $p \leq 0{,}05$; ** –difference significant at $p \leq 0{,}01$; [1)] technological yield of product: loin-for polish landrace fatteners group and ham - for crossbreed fatteners group*