THE EFFECT OF THE HALOTHANE GENE ON PERFORMANCE, CARCASS AND MEAT QUALITY IN A FAT AND A LEAN LINE OF PIGS

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SUMMARY

The performance, carcass and meat quality of two lines of pigs in which the halothane allele (n) was segregating were studied. The lines were a lean line selected for rapid lean growth and an unselected fat line. Heterozygous (Nn) and homozygous normal (NN) segregants in both lines were compared in an environment of high temperature and pre-slaughter transport stress. Relative to the fat line, the lean line grew faster, ate more, was a more efficient converter of food and produced leaner carcasses. It also produced less acid and darker lean with less water loss. The halothane allele had a much greater effect in the lean than the fat line. It reduced appetite, growth rate and food conversion ratio and increased the acidity, paleness and water loss from lean. In both lines, but particularly in the lean line, the halothane allele increased the incidence of death in transit to slaughter.

INTRODUCTION

Pigs homozygous (nn) for the halothane allele have been shown to have more lean in their carcasses but they also tend to display the PSE (pale, soft, exudative) condition (Webb and Simpson, 1986). In addition they are more susceptible to death from stress (PSS), (Rungren et al. 1990). Information on the performance of the heterozygote pig (Nn) is equivocal. The quantity of lean in the carcass of the Nn pig tends to be intermediate between the nn and NN segregants, but this varies with breed (Aberle et al. 1976) and growing environment (Sehested et al. 1988). Under conditions of stress, some of the undesirable conditions of the nn type, PSS and PSE, appear to be expressed in the Nn animal (Barton-Gade 1984).

High levels of stress occur in Australia where farm to abattoir distances are long and ambient temperatures high. Halothane testing in pig testing stations and on farms suggests that 30% of Large White and Landrace pigs in Australia carry the halothane allele, mostly as heterozygotes (Nn). This paper reports a comparison of the normal (NN) and heterozygous (Nn) segregants in a fat and a lean genetic line of pigs. The pigs were grown in a tropical environment and measurements made of their growth performance before their long distance transport to slaughter following which carcass and meat quality traits were assessed.

MATERIALS AND METHODS

The lean and fat lines of pigs, each of 36 sows, were formed from the same synthetic foundation herd of Large White and Landrace origin (McPhee et al. 1988). The lean line had undergone five generations of selection for high rate of lean growth as assessed by post-weaning growth rate and low backfat depth. The fat line was maintained as an unselected control over the same period. Prior to the start of this experiment, selection was carried out in both lines to increase the frequency of the halothane allele, carriers of the allele being identified by the halothane test and blood typing (Kramer et al. 1991). Sows in each herd were farrowed in batches at two month intervals. From the halothane assessed progeny, 168 pigs comprising seven batches x three segregants (NN, Nn, nn) x two lines (fat, lean) x two sexes x two pigs were placed on trial for performance, carcass and meat quality assessment. Non-experimental pigs were raised under commercial conditions. Transit death rates were recorded on 1590 of these pigs consigned by overnight road transport (600 km, 8 hr) for slaughter.

Experimental pigs were housed individually in pens at 25 kg and fed a wheat, fish, soya (14MJ, 1.0% lysine) diet *ad libitum* to 90 kg. Measurements were taken of weight gain, food conversion ratio, and daily food intake. Carcass measurements included dressing percent, length, subcutaneous fat depth and cross-sectional area of the eye muscle. Measurements of meat quality included, the acidity of the eye-muscle measured 45 min and 24 hr post-slaughter ($pH_{(45)}$ and $pH_{(ult)}$), the percentage of a lean sample lost through drip and cooking, the percentage of a lean sample recovered after curing. Reflectance, a measure of paleness and wetness, was assessed by fibre optic probe.

RESULTS

This paper reports results on the NN and Nn segregants only. Performance, carcass and survival data on these segregants in the lean and the fat lines are given in Table 1. Relative to the fat line, the lean line grew faster, ate more and was a more efficient converter of food. Although lean line carcasses had lower dressing percentages, they were longer with less fat and larger eye muscle areas. The presence of the halothane allele reduced food intake, growth rate and food conversion ratio, these effects being mainly confined to the lean line. The halothane allele also increased the death rate in transit from farm to abattoir. This rate averaged 2.8 ± .6% in summer (October-March) and 1.2 ± .4% in winter (April-September).

Table 1. Least square means ± s.e. of performance, carcass and survival traits of normal (NN) and heterozygous (Nn) halothane segregants in the lean and fat lines of pigs.

Line (L)	Lean		Fat		Sig. diff. ($p < .05$)
Segregants (S)	Nn	NN	Nn	NN	
Gain (kgd^{-1})	0.89 ± .01	0.95 ± .02	0.78 ± .01	0.79 ± .01	L, S
FCR	2.55 ± .04	2.82 ± .05	2.99 ± .04	2.99 ± .04	L, S, L x S
Intake (kgd^{-1})	2.28 ± .05	2.64 ± .05	2.31 ± .05	2.36 ± .05	L, S, L x S
Dress (%)	80.4 ± .5	81.4 ± .5	82.9 ± .4	82.3 ± .4	L
Fat (mm)	13.5 ± .8	14.3 ± .9	21.6 ± .8	22.6 ± .7	L
Length (cm)	81.9 ± .5	82.1 ± .5	79.5 ± .5	79.4 ± .4	L
Eye musc (cm^2)	39.0 ± .7	40.6 ± .8	36.8 ± .7	37.0 ± .7	L
Transit death (%)	5.3 ± .2	1.1 ± .5	2.7 ± .7	1.1 ± .4	S

The meat quality measurements on Nn and NN segregants in the lean and the fat lines are given in Table 2. Relative to the fat line, the lean line had less acid meat both at 45 min and 24 hr after slaughter. Meat from the lean line also had lower drip and cooking losses, a higher cured yield and lower reflectance. The halothane allele increased acidity at slaughter and the loss in weight through drip, cooking and curing. Reflectance was also increased by the allele.

Table 2. Least square means ± s.e. of meat quality traits of normal (NN) and heterozygous (Nn) halothane segregants in the lean and fat lines

Line (L)	Lean		Fat		Sig. diff. ($p < .05$)
Segregants (S)	Nn	NN	Nn	NN	
$pH_{(45)}$	6.29 ± .05	6.56 ± .05	6.20 ± .05	6.39 ± .05	L, S
$pH_{(ult)}$	6.10 ± .07	6.32 ± .07	5.94 ± .07	5.88 ± .07	L
Drip (%)	2.89 ± .31	1.40 ± .30	2.98 ± .29	2.90 ± .29	L, S, L x S
Cook loss (%)	31.0 ± 1.2	25.6 ± 1.1	33.0 ± 1.1	32.4 ± 1.0	L, S, L x S
Cure yield (%)	92.4 ± .8	94.4 ± .8	89.5 ± .8	91.5 ± .8	L, S
Reflectance (units)	26.8 ± 1.8	20.9 ± 1.7	32.1 ± 1.6	27.0 ± 1.7	L, S

DISCUSSION

The location of the experiment, central Queensland, offers advantages to the pig producer, for example, low heating, housing and food costs. Two locational disadvantages, shared by some other pig growing areas in Australia, include high summer temperatures and long transport distances to slaughter. These stresses revealed themselves in the present experiment through high transit death rates, particularly in summer, and high carcass pH values, implying depleted glycogen reserves at slaughter.

The experiment has separated the effect of the halothane allele from the effects of other genes accumulated through selection for high growth rate and low backfat depth in the lean line. These line differences dominate the results, not only for rate of lean growth, the trait directly under selection. Selection has also apparently resulted in responses in other traits, for example, eye muscle area. For meat quality traits, selection apparently lowered acidity, reduced water loss and darkened colour, all characteristics of the DFD (dry, firm, dark) condition.

The carcass results of this study agree with those of Aalhus et al. (1991) who found no lean yield advantage of Nn over NN segregants. For the traits which were influenced by the halothane allele, the effect was greater in the lean than the fat line. This may result from the higher growth rate and mass of lean in the lean line, the allele being active in lean tissue. Relative to NN segregants in the lean line, the Nn segregants had a depressed appetite and this reduced growth rate and food conversion ratio but this did not occur in the fat line. Although not statistically significant, the halothane allele appeared to increase the transit death rate to a higher degree in the lean than the fat line.

Of all the segregants studied, the NN segregants of the lean line had the darkest and driest and least acid lean, clearly DFD. The Nn segregants of both lines and the NN segregants of the fat line all had similar meat quality characteristics, with some tendency toward DFD, particularly in the Nn segregants of the lean line. The absence of a marked effect of the halothane allele on the meat quality of these three segregants is in agreement with Murray et al. (1989) who found that glycogen depletion through pre-slaughter fasting reduced the allele's effect on meat quality. The NN segregants of the lean line, on the other hand, displayed unusually high rates of lean growth and food intake indicative of a high metabolic rate (Webster, 1989). This would result in an unusually high rate of glycogen depletion during fasting and could account for the high pH values and incidence of DFD observed for this segregant.

Thus, the main meat quality problem under the stressful pre-slaughter conditions of this study was DFD. Its primary cause was not the halothane allele but the other genes accumulated by selection in the lean line which resulted in rapid lean growth and high appetite possibly associated with a high metabolic rate.

REFERENCES

AALHUS, J.L., JONES, S.D.M., ROBERTSON, W.M., TONG, A.K.W. and SATHER, A.P. (1991). *Anim. Prod.* **52:** 347

ABERLE, E.D., RIGGS, B.L., ALLISTON, C.W. and WILSON, S.P. (1976). *J. Anim. Sci.* **43:** 816

BARTON-GADE, P. (1984). EEC "Seminar on Meat Quality", *Bristol.* **1:** 3

KRAMER, H.L., MCPHEE, C.P., NOBLE, J.W. and DANIELS, L.J. (1991). "Manipulating Pig Production", Aust. Pig. Sci. Assn. Albury, NSW, 250

MCPHEE, C.P., RATHMELL, C.A., DANIELS, L.J. and CAMERON, N.D. (1988). *Anim. Prod.* **47:** 149

MURRAY, A.C., JONES, S.D.M. and SATHER, A.P. (1989). *Can. J. Anim. Sci.* **60:** 811

RUNDGREN, M., LUNDSTROM, K. and EDFORS-LILJA, I. (1990). *Livest. Prod. Sci.* **26:** 231

SEHESTED, E., SYRSTAD, O., FROYSTEIN, T. and STANDAL, N. (1988). *Acta. Agric. Scand.* **38:** 67

WEBB, A.J. and SIMPSON, S.P. (1986). *Anim. Prod.* **43:** 493

WEBSTER, A.J.F. (1989). *Anim. Prod.* **48:** 249