## Relationship between halothane status and meat quality in Landrace and Large White pigs

**PATRICIA BARTON-GADE and MAIKEN BALTZER**

Danish Meat Research Institute, Maglegårdsvej 2, DK-4000 Roskilde, Denmark

SUMMARY: The aim of this experiment was to assess the effect of halothane genotype (positive or negative) on a number of relevant meat quality characteristics. The experimental material consisted of pure-bred Landrace and Large White pigs fattened on Danish testing stations. Pig were fed ad-libitum and slaughtered at a live weight of approximately 100 kg after a standardised pre-slaughter treatment designed to provoke PSE in susceptible animals.

In the experimental period there were 188 litter groups with halothane positive pigs corresponding to a frequency of 2.2% for Landrace and 1.0% for Large White. A number of pigs died during fattening or transport/lairage and some were unthrifty, so that the actual number of pigs investigated for meat quality was reduced to 100 Landrace (44 positive) and 58 Large White (27 positive).

None of the halothane positive Landrace pigs developed normal meat quality. 89% were PSE and 11% more or less DFD. Positive Landrace pigs also had a tendency to both PSE- and DFD-meat within the same carcass and even within the same muscle. Positive Large White pigs showed a similar figure for PSE (89%) but very little tendency to DFD. 21% of the halothane negative Landrace and 16% of negative Large White pigs developed PSE meat, typically in longissimus dorsi. The genotype of the negative pigs was not known but most of them were probably heterozygotes. Halothane status had no effect on the % protein, % water and % fat in semimembranosus or total pigment content in the biceps femoris and longissimus dorsi muscles. A within litter comparison carried out on a sub-set of this material confirmed the findings obtained on the total material.

INTRODUCTION: Previous work carried out with Danish Landrace showed that halothane positive animals almost always developed PSE-meat after slaughter (Barton-Gade, 1984, Barton-Gade and Olsen, 1984). Animals free of the halothane gene developed PSE-meat relatively seldom and heterozygotes were intermediate. Furthermore, halothane positive animals were relatively unaffected by pre-slaughter treatment - they developed PSE-meat regardless. Heterozygotes and animals free of the halothane gene, on the other hand, were much more affected by pre-slaughter treatment amd meat quality could be substantially improved with a considerate treatment. Only a few halothane positive Large White pigs have been investigated for meat quality and the results seem to show a similar picture to Landrace with the exception that Large White did not seem to show the same susceptibility to DFD-meat.

In 1987 it was decided to stop routine measurements of meat quality in Danish breeding work and replace these with halothane testing combined with blood and enzyme typing for Landrace and Large White. The coloured breeds, Duroc and Hampshire were not included as the incidence of the halothane gene is very low in Duroc and has never been observed in Danish Hampshire.

The aim of this work was to investigate litter groups with halothane sensitive animals for a number of relevant meat quality characteristics, partly to confirm the results for Large White using a larger material, partly to see what effect this change in breeding evaluation would have on other meat quality characteristics.

MATERIALS & METHODS: All pigs were halothane tested about 1 week after arrival at the testing station ( approx. wt. 30 kg) during the period from March 1987 to March 1989. Landrace and Large White litter groups, where at least one of the two pigs was halothane sensitive, were investigated for water holding capacity (soluble sarcoplasmic and myofibrillar protein) in the biceps femoris, semimembranosus and longissimus dorsi muscles, ultimate pH in 7

muscles, % protein, % water and % fat in semimembranosus and total pigment content in biceps femoris and longissimus dorsi, as described by Barton-Gade, 1984, 1987. Pigs were fed ad libitum and slaughtered at a live weight of about 100 kg. All pigs received a standardised pre-slaughter treatment (Barton, 1974).

Shear force values and sarcomere lengths were not investigated, as previous work had shown that there was no relationship between these characteristics and subjectively evaluated tenderness scores when muscle was PSE (Barton-Gade & Bejerholm, unpublished material).

When possible, figures for daily gain and % meat in the side were obtained from the progeny testing results. The results were investigated using an analysis of variance (SAS, 1988) with halothane status (positive or negative) and breed as variables.

RESULTS: In the experimental period there were 118 litter groups with halothane sensitive animals. 73 were Landrace and 45 Large White. Of these there were respectively 8 and 3 litter groups where both pigs were sensitive. 2.2% of Landrace pigs tested were halothane sensitive and 1.0% of Large White. Both sexes were more or less equally distributed with respect to halothane status. This material was further reduced, as a number of pigs died during fattening and/or transport or were rejected for consumption because of early PSE-development. 23% of both breeds were removed in this way. A further 13% of Landrace and 18% of Large White were unthrifty, or rejected for other causes. The final experimental material for meat quality determination thus consisted of a number of whole and half litter groups, in all 100 Landrace pigs and 58 Large White, of which 44 and 27 were halothane sensitive respectively.

The analysis of variance on the total material (not shown in this paper due to lack of space) showed that water holding capacity was highly affected by halothane status. Ultimate pH values were only significantly affected in semispinalis capitis. Chemical composition and total pigment content were not affected by halothane status. Surprisingly, there were no significant effects on daily gain and only Landrace showed a higher % meat in the side for positive pigs. There were significant breed effects for most ultimate pH-values (highest in Landrace) as well as total pigment content (also highest in Landrace). There were no significant interactions.

None of the halothane sensitive Landrace pigs developed a normal meat quality. 89% were more or less PSE and 11% more or less DFD. 49% of the PSE-pigs were also DFD in one or more of the muscles investigated, 3% of which were both PSE and DFD within the same muscle. Halothane sensitive Large White pigs did not show the same tendency to DFD, 89% being PSE and 11% having a normal meat quality. 21% of the halothane negative Landrace and 16% of negative Large White pigs were PSE. The figures for DFD were respectively 41% and 6%.

Within litter comparison. A comparison such as the one above can be subject to error, as litter group effects can have affected the results. 22 of the Landrace litter groups and 12 of the Large White groups, however, had one positive and one negative animal, so that a within litter comparison was possible. The results of the analysis of variance for this material are shown in Table 1.

The within litter comparison confirmed the results from the total material. Halothane status significantly affected water holding capacity, to a lesser degree ultimate pH and had no effect on daily gain, meat content, chemical composition or total pigment content.

Table 1: Results of the analysis of variance for the within litter comparison

Significance: * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

| Description | Halothane | | Breed | | Significance | | |
|---|---|---|---|---|---|---|---|
| | + | - | Landrace | Large White | Halothane | Breed | H x B |
| No. of pigs | 34 | 34 | 44 | 24 | | | |
| Daily gain, | 984 | 930 | 933 | 981 | | | |
| % meat in side | 67.4 | 66.6 | 66.6 | 67.3 | | | |
| WHC - biceps femoris | $0.134^b$ | $0.170^a$ | 0.157 | 0.147 | *** | | |
| WHC - semimembranosus | $0.126^b$ | $0.179^a$ | 0.157 | 0.148 | *** | | |
| WHC - longissimus dorsi | $0.102^b$ | $0.160^a$ | 0.132 | 0.130 | *** | | |
| Ultimate pH - semimembranosus | 5.58 | 5.53 | 5.58 | 5.53 | | | |
| Ultimate pH - biceps femoris | 5.63 | 5.57 | $5.65^b$ | $5.55^a$ | | * | |
| Ultimate pH - quadriceps | 5.68 | 5.68 | $5.76^b$ | $5.60^a$ | | ** | |
| Ultimate pH - longissimus dorsi | $5.54^b$ | $5.46^a$ | 5.50 | 5.50 | * | | |
| Ultimate pH - semispinalis capitis | 5.94 | 5.89 | $6.01^b$ | $5.81^a$ | | ** | |
| Ultimate pH - serratus ventralis | 6.05 | 5.97 | 6.05 | 5.97 | | | |
| Ultimate pH - triceps brachii | 5.80 | 5.74 | 5.80 | 5.74 | | | |
| % protein - semimembranosus | 21.86 | 21.96 | 21.85 | 21.97 | | | |
| % water - semimembranosus | 76.13 | 75.77 | 75.91 | 76.00 | | * | |
| % fat - semimembranosus | 1.51 | 1.59 | $1.69^b$ | $1.40^a$ | | | |
| Pigment - biceps femoris | 36.0 | 35.6 | $38.7^a$ | $33.0^b$ | | ** | |
| Pigment - longissimus dorsi | 18.5 | 18.4 | 19.1 | 17.8 | | | |

Halothane positive Large White pigs tended to be more PSE and less DFD than halothane positive Landrace pigs especially in ham muscles (Table 2).

Table 2: Incidence of PSE- & DFD-meat in relation to halothane genotype within breed

| Description | | Landrace | | Large White | |
|---|---|---|---|---|---|
| | | + | - | + | - |
| No. of pigs | | 22 | 22 | 12 | 12 |
| WHC-biceps femoris | < 0.150 | 54.5 | 9.1 | 75.0 | 0 |
| WHC-semimembranosus | < 0.150 | 57.1 | 4.5 | 91.7 | 0 |
| WHC-longissimus dorsi | < 0.150 | 90.9 | 27.3 | 91.7 | 33.3 |
| WHC-pig | < 0.150 | 90.9 | 36.4 | 91.7 | 33.3 |
| Ultimate pH - semimembranosus | ≥ 5.80 | 4.5 | 13.6 | 8.3 | 0 |
| Ultimate pH - biceps femoris | ≥ 5.90 | 13.6 | 9.1 | 8.3 | 0 |
| Ultimate pH - quadriceps | ≥ 6.10 | 0 | 9.1 | 8.3 | 0 |
| Ultimate pH - longissimus dorsi | ≥ 5.70 | 4.5 | 4.5 | 0 | 8.3 |
| Ultimate pH - semispinalis capitis | ≥ 6.30 | 13.6 | 13.6 | 8.3 | 0 |
| Ultimate pH - serratus ventralis | ≥ 6.30 | 13.6 | 22.7 | 16.7 | 0 |
| Ultimate pH - triceps brachii | ≥ 5.90 | 36.4 | 27.3 | 8.3 | 0 |
| "White" muscles - DFD | | 13.6 | 18.2 | 8.3 | 8.3 |
| "Red" muscles - DFD | | 47.6 | 31.8 | 16.7 | 0 |

Halothane negative Large White pigs showed DFD meat only rarely.

DISCUSSION and CONCLUSION: The results of this experiment confirmed our earlier work as well as a within litter comparison reported recently in the literature (Lundström et al. 1989). Halothane positive animals alm always developed PSE-meat in one or more of the muscles studied and this was valid for both breeds. Landrac however, was much more susceptible to the DFD-condition than Large White. Thus, Landrace showed a higher DF incidence in total; PSE and DFD muscle often occurred within the same carcass and exceptionally even within the sam muscle.

Halothane negative animals in this experiment also showed a considerable PSE-incidence, mainly in the longissimu dorsi muscle. Ham muscles were affected to a much lesser extent. Halothane negative animals also showed less DF meat for Large White but more or less the same incidence as for positive animals for Landrace. The genotype of these animals is, of course, not known, but they are probably in most cases heterozygotes.

Very little has been reported in the literature on chemical composition and pigment content in relation to halothane genotype. The results of this investigation show that these characteristics are unaffected by halothane genotype - at least for Landrace and Large White pigs.

These results, together with the higher incidence of mortality during fattening and transport to slaughter sho that the introduction of halothane testing in Danish pig breeding can only be a positive development. Mortalit and PSE- (and to a lesser extent DFD-) incidence must be expected to decrease and other important quality characteristics must be expected to be unaffected. Indeed, the effects are now clearly apparent in the commercial pig population, where the annual statistics show that transport and lairage mortality as well as the incidence of carcasses rejected because of early PSE-development have been falling since the introduction of halothane testing.

REFERENCES

Barton-Gade, P.A. 1974: A standardised procedure for the pre-slaughter treatment of pigs to be tested for meat quality. Proc. 20th Europ. Meeting of Meat Res. Workers, Dublin, Ireland, p.p. 52-54.

Barton-Gade, P.A. 1984: Influence of halothane genotype on meat quality in pigs subjected to various pre-slaughter treatments. Proc. 30th Europ. Meet. Meat Res. Workers, Bristol, England, pp. 8-9.

Barton-Gade, P.A. 1987: Meat and fat quality in boars, castrates and gilts. Livestock Prod. Sci. 16: 187-196.

Barton-Gade, P.A. & Olsen, E.V. 1984: The relationship between water holding capacity and measurements carried out with the automatic meat quality probe. Scientific Meeting "Biophysical PSE-Muscle Analysis", April 26-27th, Vienna Technical University, Austria.

Lundström, K. Essén-Gustavsson, B., Rundgren, M., Edfors-Lilja, I & Malmfors, G. 1989: Effect of halothane genotype on muscle metabolism at slaughter and its relationship with meat quality: A within litter comparison. Meat Sci. 25: 251-263.

SAS Institute Inc. 1988: User's Guide. Release 6.03 Edition, Cary. NC, pp. 549-640.