EFFECT OF THE HALOTHANE GENE IN HETEROZYGOTE PIGS ON HAM MEAT QUALITY

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SUMMARY

Technological characteristics and meat quality traits of the thigh to be processed into Parma dry ham were evaluated on 43 heterozygous (Nn) pigs and 117 homozygous (NN) pigs at the halothane locus. Hams from Nn pigs showed lower fat covering, faster rate of pH fall and lower water holding capacity. Colour of ham muscles was not negatively affected by the halothane gene and carrier pigs displayed a redder and a less pale meat in comparison to the homozygous (NN) pigs. These results suggest that the use of Nn pigs to produce Parma dry ham may presents problems to the process industry as the characteristics found on their hams can lead to higher weight loss during seasonig processing.

Introduction

Several investigations have shown that the halothane gene, when is heterozygous, has a positive effect on carcass lean yield but an adverse effect on the meat quality. The carrier pigs (Nn) show meat characterized by lower water retention, paler colour and a higher incidence of PSE when compared to the non carrier pigs (NN) (Jensen and Barton Gade, 1985; Lundstrom et al., 1985; Simpson and Webb, 1989; Lundstrom et al., 1989; Shater et al., 1991).

The use of heterozygote slaughter pigs may be convenient in such situations where the economic advantage due to higher carcass leanness rewards the disadvantage due to the impaired meat quality. In Italy, where the quality of meat is of basic importance for the production of raw, salted and seasoned ham, the use of Nn pigs could adversely affect the technological process and the final characteristics of the seasoned ham. In spite of the importance of these aspects for the processing industry, the effect of heterozygous halothane gene on the heavy pigs (160-170 kg live weight) used to produce thighs to be processed into seasoned ham has yet to be determined. Moreover, recently Sather et al. (1991) have suggested that the n allele of the halothane gene could became dominant when slaughter weight increases, and consequently in heterozygotes its detrimental effect on the meat quality might be more evident .

The aim of this research was to evaluate the effects of the halothane gene in heterozygote heavy pigs on the meat quality of fresh thighs to be processed into seasoned ham.

Material and Methods

One hundred and sixty pigs (Duroc x Cotswold), raised in the same farm and slaughtered on four different days in the same commercial abattoir were examined. The animal material consisted in 71 barrows and 89 gilts. After carcass weighing, by Fat-o-Meat'er (SFK, Denmark) fat depth between the 3rd and 4th lumbar vertebrae (3/4 LV) and fat and *longissimus dorsi* muscle depths between the 3rd and 4th from last rib (3/4 L.R.) were measured. Estimated carcass lean percentage was calculated according to the EEC carcass grading standard (Russo et al., 1989). After carcass cutting a sample of intermuscular fat was collected on each left thigh to determine the halothane genotype (HAL). The DNA extraction was performed according to Keller and Manak (1989). DNA typing for the halothane locus was carried out by polymerase chain reaction (PCR) technique (Russo et al., 1993). The HAL genotype resulted NN for 117 pigs and Nn for 43 pigs.

On each left thigh hot weight at 1 h. *post mortem* and the refrigerated and trimmed weight at 24 h *post mortem* were recorded. The refrigeration and the trimming losses were expressed as percentage on hot weight

and on refrigerated weight of hams respectively. As regards meat quality measurements, at 45 min. *post mortem* pH (pH_1), internal light reflectance by Fiber Optical Probe (FOP, TBL, Leeds, UK) (FOP_1), electrical conductivity by Tecpro Quality Meter (TQM, Tecpro, Munich, Germany) (TQM_1) and colour (CIE LAB, 1976) by a colorimeter Minolta Chromameter II (light source C, 8 mm diameter) on *semimembranosus* and *biceps femoris* muscles were recorded. At 24 h *post mortem* measurements of pH (pH2), FOP (FOP2), TQM (TQM2) and colour were repeated on the same muscles. The a* and b* values obtained at the two measuring times were used to calculate the Chroma ($a^{*2} + b^{*2}$) and the Hue (arctag b*/a*) values. On a subsample of 97 hams (54 NN, 43 Nn) during the trimming operation, a sample of *biceps femoris* muscle was collected. On such sample the total pigment content (Hornsey, 1956) and the water holding capacity by Filter Paper Press method (Grau and Hamm, 1957) were determined. Water holding capacity was expressed as ratio of the meat film area and the total area (M/T) (Hofmann et al., 1982). After trimming a subjective evaluation of the ham meat quality regarding colour, exudate and texture was performed by an expert of the abattoir.

The data were processed by an analysis of variance model including the fixed effects "halothane genotype", "sex", "day of slaughter" and their interaction. Since no significant ($P>0.05$) interaction was found for any of the traits examined the final model included only the main effects.

Results and Discussion

Table 1 reports the least square means of carcasses and ham measurements carried out in pigs with different halothane genotype together with the levels of significance for the model used. As far as carcass measurements are concerned, at LR position Nn pigs show a significantly lower backfat and a higher *longissimus dorsi* muscle thickness. Moreover, carcass lean content was significantly higher for these pigs that presented almost two percentage points more than the NN pigs. These results confirm the positive effect of the halothane gene on the carcass quality as observed by Jensen and Barton Gade (1985) and Webb et al. (1985). Hams obtained from Nn carcasses show a significantly lower trimming loss. This is due to the lower fat covering of such hams, thus during trimming a small amount of fat is removed to give the product its required typical shape. This aspect could be unfavourable for Parma ham processing as the leanest hams show higher weight loss during the seasoning period and higher incidence of defects in the final products (Russo et al., 1989; Nanni Costa et al., 1993). A significant effect was found for the sex in carcass measurements as well as in trimming loss. It is due to the well-known superiority in the carcass characteristics of gilts in comparison to barrows. The day of slaughter also significantly influences some carcass traits and ham weight loss. This effect can be due to the difference in carcass characteristics among the groups of pigs slaughtered in the four days.

The effect of the halothane genotype on the ham meat quality measurements recorded at 45 min *post mortem* is reported in table 2. In both muscles the Nn pigs presented a lower pH_1 value. This confirms previous observation (Jensen and Barton Gade, 1985; Murray et al., 1989) that these pigs show a more rapid *post mortem* pH fall than the NN pigs. A significant difference between the genotypes was also found in colour measurements. Carrier pigs displayed a redder and less pale meat in comparison to the homozigous NN pigs as the higher a* and Chroma values ($P<0.01$) and the lower L* value ($p<0.05$) show. Jensen and Barton Gade (1985) did not find any difference between Nn and NN pigs in subjective evaluation of colour at the same time after slaughter. Slightly higher values of electrical conductivity were found in the Nn genotype although the difference was significant only for *biceps femoris* muscle. Internal reflectance values were similar for both Nn and NN pigs. Several quality measurements including pH_1 and colour were significantly affected by the sex and the day of slaughter.

The effect of the halothane genotype on the ham meat quality measurements recorded at 24 h *post mortem* is reported in table 3. Even at this time the genotype significantly affected the colour parameters. Meat of Nn pigs was redder and less pale showing for both ham muscles higher a* and Chroma values and for the *semimembranosus* muscle lower L* value. A higher value for a* parameter has been found for Nn pigs in the *longissimus dorsi* muscle by Murray et al. (1989). The present finding for L* does not agre with the results of Pommier et al. (1992) who did not record for the same muscle any difference between Nn and NN pigs. Shater et al. (1991) and Pommier and Houde (1992) observed higher L* values on the *longissimus dorsi* muscle of Nn pigs. Since for both genotypes the *biceps femoris* pigment content has shown the same value, the redder and less pale colour found in the hams obtained from Nn pigs could be due to a lower level of fat infiltration in the examined muscles as consequence of higher leanness of the carcasses (see table 1). A lower level of intramuscular fat has been found by Murray et al. (1989) in the *longissimus dorsi* muscle of carrier pigs.

Nn pigs have shown for both muscles significantly higher values for electrical conductivity, and in the *biceps femoris* muscle a lower water retention. Such latter result is very similar to what other Authors have

found on the *longissimus dorsi* muscle (Lundstrom et al., 1985; Lundstrom et al., 1989; Murray et al., 1989; Pommier and Houde, 1992).The halothane genotype does not seem to affect the ultimate pH, as already observed by Jensen and Barton Gade (1985), and Pommier et al. (1992) nor the FOP values (Lundstrom et al., 1989).

The day of slaughter showed an evident influence on the measurements recorded at 24 h post mortem. This result highlights that the behavioural conditions before and during the slaughter and the following process on the carcasses could greatly affect the final quality of the meat. The effect of the sex on the final meat quality resulted much less important compared to what was noted 45 min post mortem.

As for the subjective evaluation of the meat quality, four hams were seriously PSE and were not sent into seasoning. Three out of these came from Nn pigs and one from NN pigs. Other four hams were slightly PSE (1 Nn and 3 NN) and they were classified as not suitable for the production of Parma branded ham. Furthermore four thighs coming from Nn pigs showed a poor water retention and, at the same time, a normal colour. On the whole, the incidence of abnormal situations of the muscles was higher in Nn pigs, as others investigations have also assessed. Moreover, the presence of the PSE in NN pigs confirms that such defect may appear also in the absence of halothane gene.

Conclusions

The results obtained confirm the positive effect of the halothane gene on the carcass and ham leanness. On the other hand, a negative effect was also confirmed on the rate of pH fall, on the water holding capacity and on the incidence of meat with abnormal characteristics. No negative effect of the gene emerged on the colour of the main two muscles of the ham. Such data enable us to express an unfavorable opinion on the possible use of HAL heterozygote pigs to produce raw, salted and seasoned ham. The leanness of their thighs together with a reduced water holding capacity of meat may adversely affect the technological process increasing the weight loss during the seasoning period. However, more complete results will be supplied later on when the hams under examination will have completed their seasoning process, at present in progress.

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Tables caption

Table 1. Results of carcass and ham measurements in pigs of different halothane genotype (least squares means)

n.s.: not significant; * $P<0.05$; ** $P<0.01$.

Table 2. Results of meat quality measurements on *semimembranosus* and *biceps femoris* muscles at 45 min *post mortem* in pigs of different halothane genotype (least squares means)

n.s.: not significant; * $P<0.05$; ** $P<0.01$.

Table 3. Results of meat quality measurements on *semimembranosus* and *biceps femoris* muscles at 24 h. *post mortem* in pigs of different halothane genotype (least squares means)

n.s.: not significant; * $P<0.05$; ** $P<0.01$.