Influence of cross-breeding combination and intramuscular fat content on eating quality of pork

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Background

The eating quality of Danish pork is increasingly coming into focus. The suitability of four cross-breeding combinations for production of table meat has been investigated. It has been seen in earlier investigations that the intramuscular fat content (IMF) has a positive influence on the eating quality (Barton & Bejerholm, 1986, De Vol *et al.*, 1988). Crosses with varying IMF have been included in this investigation in order to establish whether a certain level of marbling contributes to a good eating quality.

Objectives

It was the aim of the investigation to examine which cross-breeding combinations provide the best eating quality and to examine the importance of IMF for the sensoric quality. The Halothane-status of the animals was also considered in the evaluation of the influence of crosses and IMF on the sensoric quality.

Methods

The pigs in the experiment were progeny of Danish Landrace/Large White Yorkshire sows (LY) served by Hampshire/Duroc boars (HD), Duroc boars (DD) with a high sub-index for IMF, PIC 416 boars (PIC) and Duroc/Large White Yorkshire boars (DY). The boar breed is used to characterise each cross-breeding combination. From each litter a female and a castrate were selected for the investigation. In total approx. 180 animals of each cross combination were used for sensoric assessment. The Halothane-status of the experimental animals was examined via blood sampling. The pigs were slaughtered at a live weight of approx. 115 kg equal to a carcass weight of approx. 90 kg. The experimental pigs were slaughtered at a commercial abattoir.

Quality measurements and analysis. Carcass weight and lean meat content were recorded. pH_2 and internal reflection value measured with MQM equipment (Borggaard *et al.*, 1989) were determined in the *longissimus dorsi* muscle (LD) 20-24 hours *post mortem*. Drip loss in LD was measured in samples taken 24 hours *post mortem* (Rasmussen & Andersson, 1996). Samples of LD were selected for IMF analysis (Soxtec method).

Sensoric assessment. Loin samples were vacuum packed and matured for 4 days at 4ºC and subsequently stored at -20ºC until the sensoric assessment. The loins were thawed at 4ºC for approx. 20 hours before being cut into chops (22 mm thick). The chops were fried on a griddle plate at 155-160ºC for 8 minutes to a centre temperature of 65ºC. The sensoric panel consisted of 9 assessors. Each panellist assessed hardness at first bite, juiciness, meat flavour, sourish taste, piggy taste and tenderness in the indicated order. Each trait was assessed on an intensity scale from 0 to 15. Before the assessments, the panel was trained on samples expected to cover the range of variation. Due to the large number of samples the assessments were carried out over 61 sessions.

Statistics. When comparing the cross-combinations the mean panel value of each trait has been used, and the data were analysed with the following model:

Sensoric trait = cross-combination + sex + Halothane + day of slaughter + session + *father(cross)* + *litter* + *residual variation*

Results and discussion

Halothane status. 65% of the PIC crosses carried the Halothane gene (Nn) compared to 5 to 13% for the three other combinations.

Sensoric quality. The tenderness was described by two traits: Hardness at first bite (bite resistance) and tenderness when finishing the chewing of the sample. The two traits were strongly correlated. More than 98% of the assessments for tenderness were in the upper half of the scale. Meat from DD and HD had the lowest bite resistance and the highest intensity for tenderness (table 1). DY had the highest bite resistance and least tenderness and was significantly different from DD. There were no cross differences with respect to juiciness. The sensoric traits meat flavour, sourish taste and piggy taste had only slight variations. Meat from HD had the highest level of sourish taste. Presence of the Halothane gene resulted in a higher bite resistance, but the effect was weak (p = 0.018). There was no effect of the Halothane status on the other sensoric traits.

Table 1. *Sensoric traits (ls means) for the four cross combinations*

	HD	DD	PIC	DY
Bite resistance	3.65 ^{ab}	3.65 ^{a}	3.65 ^{a}	3.89 ^{b}
Tenderness	10.50 ^{a}	10.50 ^{a}	10.41 ^{ab}	10.20 ^{b}
Juiciness	9.50	9.50	9.34	9.36
Sourish taste	1.34 ^{a}	0.83 ^{c}	1.11 ^{b}	0.93 ^{bc}

Table 2. *Meat quality traits (ls means) for the four cross combinations*

	HD	DD	PIC	DY
IMF, %	1.65 ^{b}	1.93 ^{a}	1.44 ^{c}	1.49 ^{c}
Drip Loss %	5.4 ^{a}	4.4 ^{b}	6.0 ^{a}	4.9 ^{b}
pH_2	5.52 ^{a}	5.59 ^{b}	5.56 ^{ab}	5.60 ^{b}
Internal reflection value	61 ^{b}	59 ^{bc}	66 ^{a}	57 ^{c}

Values in the same row with different suffixes are significantly different (Table 1 - p< 0.05) (Table 2 - p<0.001)

Meat quality traits. The results of the meat quality measurements were analysed with the same statistical model as the sensoric traits, except that the session variable was excluded. The differences between cross combinations are shown in table 2. DD had the highest content of intramuscular fat while PIC and DY had the leanest meat. PIC and HD had the highest drip loss. The internal reflection value, which is a measure of meat quality, was highest for PIC followed by HD. The lowest level was found in meat from DY. HD had the lowest level of pH_2 in the loin.

IMF and sensoric quality. The cross differences for sensoric quality were rather small. DD was selected with a high index for IMF because earlier investigations have shown that a high IMF has a positive influence on eating quality. In spite of this selection, DD did not differ very much from the other cross combinations. Some may feel that many investigations suffer from a confounding between IMF and Duroc and that the positive influence of IMF on sensoric quality in many cases is a Duroc-influence instead. We have tried to elucidate this situation.

Duroc genes were involved in three of the cross-combinations. The PIC crosses did not contain Duroc. Tenderness and sourish taste were the sensoric traits with most variation. The importance of IMF for tenderness was analysed with the following model:

Tenderness=b×IMF + sex + Halothane + cross + b_{cross}×IMF + b_{sex}×IMF + $b_{Halothane}$×IMF + *father(cross) + litter + residual variation*

There was a significant relationship between IMF and tenderness ($p < 0.001$) and the sex also had a significant influence. There were no interactions with respect to tenderness between the influence of IMF on the one hand and cross combination, sex and Halothane status on the other hand. The analysis also showed, that when IMF was included in the model, no significant cross differences were found for tenderness. It must therefore be assumed that the variation in IMF contributed to the explanation of the tenderness differences between cross combinations. The lack of interaction between cross combination and IMF indicates, that it is not a Duroc effect, but an independent influence of IMF on tenderness. The results of similar investigations with Danish Landrace (Ertbjerg *et al.*, 1997) support the assumption that the influence of IMF on tenderness is independent of breed/cross combination.

It has also been attempted to explain the sensoric traits from models including the following variables: Internal reflection value, drip loss, pH_2, IMF and lean meat content. The degree of explanation for tenderness was in the order of 10-15% where IMF was the most explaining variable. Sourishness could be estimated with a degree of explanation of approx. 25% with pH_2 as the most explaining variable. The sensoric quality thus could not be estimated with a reasonable degree of reliability from the generally used quality measurements. IMF explained only a minor proportion of the variation in sensoric quality. pH_2 had an influence on sourishness, but apart from this, pH_2, internal reflection value and drip loss all had a poor relationship to the sensoric quality. These results indicate a need to define objective, measurable characteristics which can be used as indication of the sensoric quality.
Further research is required to establish whether the influence of IMF on the sensoric quality is dependant on breed/cross combination. The cross combination differences on sensoric quality were rather limited in this investigation as was the influence of IMF. It is also relevant to examine whether the influence of IMF on the sensoric quality depends on the slaughter and carcass chilling processes, maturation, cooking method etc. It is possible, that different results with respect to the influence of IMF can be caused by differences in the pre-treatment of the meat.

Conclusion
Meat from DD(LY) and HD(LY) crosses was significantly more tender than meat from DY(LY) crosses. PIC(LY) crosses were in between without being significantly different from DD(LY) crosses. There were no significant differences between the crosses with respect to juiciness. Meat from HD(LY) and to some extent PIC(LY) crosses more often had a sourish taste than DD(LY) crosses. A higher IMF level had a positive influence on the sensoric traits, but in spite of some variation in marbling, the effect in this investigation was limited. The influence of the pre-treatment of pigs and meat on the sensoric quality requires further investigation.

Literature
Bejerholm, C. & Barton Gade, P.A. (1986). *Effect of intramuscular fat level on eating quality of pig meat*. Proceedings of the 32nd European Meeting of Meat Research Workers, Gent, the Netherlands, Vol II, 389-391.

Borggaard, C., Andersen, J.R. & Barton Gade, P. (1989). *Further Development of the MQM-Equipment for Measuring Water Holding Capacity and Intramuscular Fat On-line*. Proceedings of the 35th ICoMST, Copenhagen, Denmark.

DeVol, D.L., McKeith, F.K., Bechtel, P.J., Novakofski, J., Shanks, R.D.& Carr T.R. (1988). *Variation in composition and palatability traits and relationships between muscle characteristics and palatability in random sample of pork carcasses*. Journal of Animal Science, **66** (2), 385-395.

Ertbjerg, P., Støier, S., Larsen, L.M. & Møller, A.J. (1997). *Activities of calpain, calpastatin, cathepsin B+L and cystatin in Danish Landrace pigs anno 1976 and 1995*. Proceedings of the 43rd ICoMST, Auckland, New Zealand, 282-283.

Rasmussen, A. & Andersson, M. (1996). *New method for determination of drip loss in pork muscles*. Proceedings of the 42nd ICoMST, Lillehammer, Norway 286-287.