TECHNOLOGICAL MEAT QUALITY AND THE FREQUENCY OF THE RN-GENE IN PUREBRED SWEDISH HAMPSHIRE AND YORKSHIRE PIGS

ENFÄLT A.C., LUNDSTRÖM K., LUNDKVIST L., KARLSSON A. and HANSSON I.

Department of Food Science, Swedish University of Agricultural Sciences, Uppsala, Sweden

S-IVA.08

SUMMARY

Glycolytic muscles from Hampshire pigs carrying the dominant RN-gene are known to have a higher glycogen content and a lower ultimate pH than muscles from pigs lacking the gene, giving a lower technological yield. The aim of the present investigation was to study the technological meat quality of purebred Swedish Hampshire and Swedish Yorkshire pigs, and to ascertain whether the RN-gene is present in these breeds. The animals used were entire male and female pigs from the Swedish pig progeny testing scheme (Hampshire, n=126; Yorkshire, n=100).

The results show that the Napole yield (yield after curing and cooking) deviated from a normal distribution in both breeds, indicating the presence of the RN-gene. In the Yorkshire breed, however, the glycolytic potential was normally distributed. When the Hampshire pigs were classified into RN-phenotype according to their glycolytic potential, 92% of the individuals were found to be carrying the gene (RN^-RN^- or RN^-rn^+), thus indicating a preliminary gene-frequency for the RN-gene of 0.72.

A significantly lower technological meat quality in *M. longissimus dorsi* was found for the Hampshire breed regarding the following traits: Napole yield, pH, water-holding capacity and cooking loss, whereas the shear force value was lower, indicating a more tender muscle. Whether or not these differences are affected by the varying expression of the RN-gene or by genuine breed differences must await further investigation.

Introduction

Technological and sensorial meat quality is affected by both environmental and genetic factors. The halothane gene was earlier the only major gene known to affect the quality of pig meat, by causing the development of PSE meat (Pale, Soft, Exudative). A new major gene affecting technological meat quality, the RN-gene, has been identified in a French composite line including Hampshire (Naveau, 1986). Animals carrying this dominant gene (RN^-) have a higher content of muscle glycogen and a lower ultimate pH in glycolytic muscles (Monin et al., 1987; Fernandez et al., 1992) and also a lower protein concentration (Estrade et al., 1993). These differences in composition and structure ultimately lead to a reduced technological yield, as is especially evident in cured, cooked ham (Monin et al., 1987, Fernandez et al., 1991). The presence of the RN^- gene in a population is characterized by a bimodal distribution of the glycogen content and the Napole yield (Fernandez et al., 1992).

Meat from purebred Hampshire pigs has been shown to be more tender and juicy than meat from Yorkshire pigs (Fjelkner-Modig, 1985). Whether these differences are due to actual breed differences or to the RN-gene is still unknown. The aim of the present investigation was to study the technological meat quality of purebred Swedish Hampshire and Yorkshire pigs, and to ascertain whether the RN-gene is present in these breeds.

Materials and Methods

The animals used in this study were purebred entire male and female Hampshire (n=136) and Yorkshire (n=100) pigs from the Swedish pig progeny testing scheme. Two pigs from the same litter (one of each sex) were raised together in one pen, and were slaughtered when the mean weight of the pen was 104 kg, or the heavier of the two weighed 115 kg. The carcasses were assessed 48 hours *post mortem* according to the procedure used in the Swedish pig progeny testing scheme (Andersson, 1980).

Meat quality determinations were carried out at cutting, at the last rib in the LD muscle. Meat colour was measured as surface reflectance with the EEL reflectance spectrophotometer (Diffusion Systems Ltd, London, England) equipped with three different filters: 400-700 nm (EEL-Y), 550 nm (EEL-605) and 680 nm (EEL-609), respectively, and as internal reflectance with a fibre optic probe (FOP; TBL Fibre Optics Group Ltd, Leeds, England). Ultimate pH (pH_u) was measured using a Mettler Delta 340 pH-meter equipped with a Xerolyte^R electrode. Water-holding capacity (WHC) was measured as drip loss during 4 days (Barton-Gade et al., 1993), and as filter paper wetness (Kauffman et al., 1986), which is a subjective method using scores from 0 to 5, where 0 denotes a dry filter paper and 5 a saturated filter paper. Shear force measurements were made with the Warner Bratzler apparatus on muscles matured for 4 days before freezing. Samples were boiled to an internal temperature of 72°C. Samples for determination of glycolytic potential were taken at cutting and stored at -20°C until analysis.

Napole yield was defined as the yield after curing and cooking, according to Naveau et al. (1985). Glycolytic potential (GP) was defined by Monin and Sellier (1985) as: GP = 2([glycogen]+[glucose]+[glucose-6-phosphate]) + [lactate], and is expressed in µmol lactate equivalents/g of fresh tissue. The analyses were performed as described by Talmant et al. (1989).

The statistical analysis was carried out with the Statistical Analysis system (SAS Institute, 1989), using the GLM procedure. The model used included the fixed effect of breed and sex. The RN-phenotypes in the Hampshire breed were classified as suggested by Lundström et al. (1994), where the RN^--phenotype had a GP $\geq$180 µmol per g.

Results and Discussion

The distributions for the Napole yield deviated from a normal distribution in both the Hampshire and the Yorkshire breed (Fig. 1), whereas glycolytic potential deviated only in the Hampshire breed, indicating the presence of the RN-gene in this breed. The distribution did not reveal any obvious valley which could be used as a threshold between the phenotypes, which is why the threshold suggested by Lundström et al. (1994) was used. Using this classification, 92% of the Hampshire animals were found to be carrying the gene (RN^-RN^- or RN^-rn^+), indicating a preliminary gene-frequency for the RN-gene of 0.72. The presence of the RN-gene in Swedish Hampshire pigs is consistent with results published by Fernandez et al. (1992), who demonstrated a bimodal distribution for the glycolytic potential in crossbred Swedish slaughter pigs (Landrace x Yorkshire sows mated with Hampshire boars). The lack of evidence for the existence of the RN-gene in Swedish Yorkshire pigs (≈Large White) supports the results of Talmant et al. (1989), who found a normal distribution for the GP in purebred French Large White pigs. The disparity between the distributions found for GP and Napole yield in Yorkshire cannot be explained at present. If the RN-gene exists in the Yorkshire breed, as might be expected from the distribution in the Napole yield, the gene must have differing modes of expression in the two breeds. The Napole yield for the assumed Yorkshire RN-phenotype would in that case be on the same level as the rn^+rn^+-phenotype in the Hampshire breed.

The technological meat quality parameters in the two breeds studied are listed in Table 1. Fresh meat from Hampshire pigs had a less good WHC than Yorkshire, as evidenced by the greater drip loss and filter paper wetness. The higher GP in Hampshire in the present study tallied with French results (Monin et al., 1987). The smaller yield after boiling is consistent with earlier Swedish findings (Fjelkner-Modig and Tornberg, 1986). The lower WHC in meat from Hampshire pigs may be due to a structural change, as indicated by the higher reflectance registered with both the FOP (900 nm) and EEL-609 (680 nm). The lower pH_u values in Hampshire are consistent with earlier investigations (Monin and Sellier, 1985; Monin et al.1987). A more tender meat from Hampshire pigs was also found by Fjelkner-Modig (1985).

Whether or not the breed differences found in this study are due to the varying expression of the RN-gene or to genuine breed differences is a question requiring further evaluation.

Conclusion

The RN-gene seemed to be present in purebred Swedish Hampshire pigs in a very high frequency (0.7). At present we have insufficient evidence that the RN-gene is present in purebred Swedish Yorkshire pigs. In comparison with Yorkshire, the Hampshire breed had lower pH_u, WHC and Napole yield, and greater cooking loss, GP and reflectance at 900 and 680 nm. However, the shear force value was lower, indicating a more tender muscle.

References

Andersson, K., (1980). Report 46. Thesis, Department of Animal Breeding and Genetics, Swedish University of Agricultural Sciences.
Barton-Gade, P.A., Demeyer, D., Honikel, K.O., Joseph, R.L., Poulanne, E., Severini, M., Smulders, F.J.M. and Tornberg, E., (1993). Proc. 39th International Congress of Meat Science and Technology, Calgary. S4p02.wp.
Estrade, M., Vignon, X. & Monin, G., (1993). Meat Science, 35: 313-319.
Fernandez, X., Lefaucheur, L., Gueblez, R., Monin, G., (1991). Meat Science, 29: 121-128.
Fernandez, X., Tornberg, E., Naveau, J., Talmant, A. and Monin, G., (1992). J. Sci. Food Agric. 59: 307-311.
Fjelkner-Modig, S., (1985). Dissertation, University of Lund.
Fjelkner-Modig, S. and Tornberg, E., (1986). Meat Science, 17: 213-231.
Kauffman, R.G., Eikelenboom, G., Wal, P.G. van der, Merkus, G. and Zaar, M., (1986). Meat Science, 18: 191-200.
Lundström, K., Andersson, A., Maerz, S. and Hansson, I., (1994). 40th International Congress of Meat Science and Technology, The Hague.
Monin, G. & Sellier, P., (1985). Meat Science, 13: 49-63.
Monin, G., Mejenes-Quijano, A., Talmant, A. & Sellier, P., (1987). Meat Science 20, 149-158.
Naveau, J., (1986). J. Rech. Porcine en France, 18: 265-276.
Naveau, J., Pommeret, P. and Lechaux, P., (1985). Techni-Porc, 8: 6-13.
Statistical Analysis Systems Institute., (1989). SAS Institute Inc., Cary, NC.
Talmant, A., Fernandez, X., Sellier, P. & Monin, G., (1989). Proc. 35th International Congress of Meat Science and Technology, Copenhagen, Denmark. 1129-1132.

Table 1. Technological meat quality in Yorkshire and Hampshire pigs
Figure 1. Distribution of the Napole yield in Yorkshire and Hampshire pigs.