EFFECT OF THE RN-GENE ON MEAT QUALITY AND LEAN MEAT CONTENT IN CROSSBRED PIGS WITH HAMPSHIRE AS TERMINAL SIRE

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SUMMARY

The effect of the dominant RN-gene (Rendement Napole) was studied in Hampshire crosses (Hampshire sires x Swedish Landrace-Swedish Yorkshire dams). The present material comprised 154 entire males and females slaughtered at 106 kg live weight. The RN-gene was classified according to the glycolytic potential in *post mortem* meat, or with the Napole yield (yield after curing and cooking). Napole classification gave 17% mis-classified samples.

In comparison with non-carriers of the RN-gene, gene carriers showed the following significant differences in *M. longissimus dorsi* meat quality traits: lower pH, higher surface and internal reflectance values, lower protein extractability, lower water-holding capacity, lower Napole yield and greater cooking loss. The prominent effect of ultimate pH-value on drip loss normally found in pork was absent in muscle from individuals carrying the RN-gene. In addition to the detrimental effect on meat quality, the RN-gene also had beneficial effects. Thus the carriers had lower (p=0.01) shear force value (Warner-Bratzler) and, at sensory testing, greater taste and smell intensity and more acidity (9-member untrained panel). RN-carriers also seemed to have a greater proportion of lean meat in the back and ham than non-carriers (p=0.02).

Introduction

At present in Sweden, almost 70% of all slaughtered pigs are 3-way crosses, with a Hampshire boar as terminal sire. The Hampshire breed was introduced in Sweden in the 1970s in order to increase the amount of heterosis in the slaughter pig population, but also to reduce the meat quality problems in our Landrace x Large White crosses. The musculature of purebred Hampshire pigs and crosses has a lower ultimate pH and lower protein content, but a higher glycogen content (Monin and Sellier, 1985; Fjelkner-Modig & Tornberg, 1986). The sensory qualities of meat from Hampshire purebred pigs have also been shown to be better than those of Swedish Landrace or Swedish Large White (Fjelkner-Modig, 1985). The recent discovery of a dominant major gene called Rendement Napole (RN) in the Hampshire breed (Naveau, 1986), which influences the glycogen content in glycolytic muscles by about 70% (Estrade et al., 1993), may provide an explanation for the above-mentioned breed differences.

The purpose of this investigation was to study the effect of the RN-gene on meat quality and lean meat content in Hampshire crosses.

Material and Methods

<u>Animals:</u> The present study material comprised 154 entire male and female pigs from a combined commercial herd in southern Sweden. The sires were purebred Hampshire, either homozygous or heterozygous for the RN-gene, and the dams were Swedish Landrace x Swedish Yorkshire. The pigs were sent to slaughter at an average live weight of 106 kg. A further 64 pigs from the same herd were included in the evaluation of the effect of the RN-gene on lean meat content. These pigs were only classified according to Napole yield.

<u>Carcass assessment:</u> Carcasses were transported to Uppsala and assessed for leanness on the fourth day after slaughter. The assessment was based on the proportion of lean + bone in ham and back, expressed as percentage of the whole carcass without head.

<u>Meat quality:</u> Meat quality measurements were also performed on the 4th day after slaughter on *M. longissimus dorsi* (LD), and when specifically stated, also on *M. biceps femoris* (BF). Meat colour was determined as surface reflectance on a cross-section of the LD muscle, using an EEL apparatus equipped with a

Y-filter (EEL; Diffusion Systems Ltd., London, England; 400-700 nm). Internal reflectance was determined in LD and BF using the Fibre Optic Probe (FOP, TBL-Fibres Ltd., Leeds, England). Ultimate pH (pH_u) measurements were performed in LD and BF. Water-holding capacity was measured as drip loss after 4 days. The Napole yield was determined according to Naveau et al. (1985), but on LD muscle. The muscle sample (100 g) was cut into 1 cm cubes, cured at 4°C in a 100 ml beaker with 20 ml NaCl with nitrite (0.6% nitrite, total concentration 13.6%) for 24 h, before boiling for 10 min at 100°C.

Muscle samples were frozen for later analyses of the following traits. Glycolytic potential (GP) was determined according to the formula suggested by Monin and Sellier (1985), as GP = 2 x ([glycogen] + [glucose] + [glucose-6-phosphate]) + [lactate], and expressed as µmol lactate equivalents per g muscle wet weight. Extractability of total muscle proteins (sarcoplasmic and myofibrillar proteins) and of sarcoplasmic proteins was determined on minced muscle, using the biuret method to determine the protein concentrations. Shear force in LD was measured using the Warner-Bratzler apparatus. The muscles were frozen 4 days after slaughter, and boiled to an internal temperature of 72°C after thawing overnight at 4°C. Cooking yield was determined on the shear force sample. Sensory testing was performed by a 9-member untrained panel on cold samples after cooking to 72°C.

Statistical analyses: All calculations were performed using the Statistical Analysis System (SAS Institute Inc., 1989). RN-phenotypes were classified using the valley between the bimodal peaks for the glycolytic potential, or Napole yield as threshold. Individuals with a glycolytic potential ≥180 µmol per g or with a Napole yield ≤85.5% were regarded as carriers of the gene. The model used to analyse the muscle traits included the fixed effects of RN-phenotype and sex as well as their interaction. The sensory analysis was performed only on muscle samples (n=41) from pigs after one sire heterozygote for the RN-gene. For the sensory traits, the random effect of panel member was also included in the statistical model, together with appropriate interactions, and the RN-gene was tested against panel member x RN-class as error line.

Results and discussion

In this study, RN-phenotypes were classified in meat post mortem according to the glycolytic potential, or with the Napole yield (yield after curing and cooking), using the valley between the bimodal peaks. A bimodal distribution can be regarded as evidence of the existence of a major gene in a population, and bimodal distributions were found for both the glycolytic potential and the Napole yield. In addition, a similar distribution was seen also for the sum of glycogen, glucose and glucose-6-phosphate, but not for lactate. When the glycolytic potential is used for classification, 57% of the pigs will be regarded as carriers of the RN-gene in this material. In comparison, Napole classification gave 17% samples that did not correspond with the GP-classification, and which can therefore be regarded as mis-classified.

Carcass characteristics and meat quality traits for carriers and non-carriers of the RN-gene are presented in Table 1. No differences were found for percentage of lean meat at grading or for carcass weight. The content of lean meat was, however, influenced by the RN-gene even though it could not be detected at grading, and RN carriers had a greater proportion of lean meat + bone in back and ham than had non-carriers (p=0.02). In contrast, no difference was found in the proportion of fat in the same cuts. In comparison with non-carriers of the RN-gene, gene carriers showed the following significant differences in *M. longissimus dorsi* meat quality traits: lower pH, higher surface and internal reflectance, lower protein extractability, lower water-holding capacity, lower Napole yield and greater cooking loss. The large effect of ultimate pH-value on drip loss normally found in pork was not present in muscle from individuals carrying the RN-gene (r=-0.11 between pH and drip loss for carriers and -0.53 for non-carriers). The same lack of pH-influence in RN-carriers was found for surface reflectance (EEL), but not for Napole yield or internal reflectance (FOP). Similarly, a significant correlation between pH and GP was found only in non-carriers. The biceps femoris muscle also showed the same pattern for pH and FOP between carriers and non-carriers as did the longissimus muscle, but the difference between genotypes was even greater. In addition to the detrimental effect on meat quality, the RN-gene also had desirable effects. Thus the carriers had lower (p=0.01) shear force values (Warner-Bratzler) and, by sensory testing, greater taste and smell intensity and a greater degree of acidity.

The presence of the RN-gene will cause an increase in the glycogen content in glycolytic muscles, by approximately 70% (Estrade et al., 1993). Consequently, the glycogen content (or glycolytic potential) in a glycolytic muscle can be used as marker for classifying an animal as carrier - or non-carrier - of the RN-gene. As the decrease in the Napole yield in RN-carriers is a consequence of the higher glycogen content in the muscle, this trait can be used to make a rough classification of RN-phenotypes. In the original Napole method, where M. semimembranosus was used as indicator muscle for estimating the yield of Paris ham (Naveau et al., 1985), a Napole yield <91 was used as the threshold value between RN-classes. The Napole yields obtained in this study on LD-muscle suggested a lower threshold between RN-classes, possibly due to differences between the semimembranosus and longissimus muscles. The correlation between GP and the Napole yield found here (r = -0.7) across RN-classes is, however, similar to the correlation presented for the French material (r = -0.5; Fernandez et al., 1990). The error in RN classification based on the Napole method instead of GP was attributable to mis-classified samples close to the threshold value.

The lack of relationship between pH and e.g. drip loss and GP in carriers of the RN-gene is of special interest. A similar pattern was observed by Fernandez and Gueblez (1992), who showed a curvilinear relationship between pH and GP, with a decrease in pH when GP increased up to a convergence point (GP=173 µmol/g). Above this threshold, pH remained constant (5.50) regardless of GP.

The lower shear force values in RN-carriers found in this study were consistent with the more tender meat from Hampshire pigs, in comparison with Swedish Yorkshire pigs (Fjelkner-Modig, 1985). It seems very likely that the positive effect of the Hampshire breed in those studies was due to the presence of the RN-gene. The lower pH in RN-carriers will make the meat more tender, as it has been shown that meat is toughest in the interval pH 5.8-6.0 (Fernandez & Tornberg, 1992), and more tender at both higher and lower pH-values. The high content of glycogen in the sarcoplasm around the myofibrils in RN-carriers (Estrade et al., 1993) may also directly affect tenderness, as it could have a diluting effect on the toughness caused by myofibrillar proteins. The positive effect of the RN-gene on taste and odour intensity has not been reported previously. Farmer & Mottram (1990) showed, however, that the formation of furanthiols and disulphides, which are important for the meaty flavour, increased at pH values below 5.5, compared with formation at higher pH-values. The slightly acid taste which we identified in RN-carriers, might be regarded as unwelcome by some people.

Conclusion

It can be concluded that in Hampshire crosses the RN-gene has both desirable and undesirable effects on the content of lean meat and on meat quality. Desirable effects are more lean meat in the carcass, stronger taste and smell and a lower shear force, while unwanted effects are greater losses with both fresh and processed muscle. Whether or not the higher degree of acidity is desirable or not is a moot point.

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Table 1. Carcass and meat quality traits in pigs with or without the RN-gene