EFFECT OF RN⁻ GENE ON COOKING YIELD OF PORK IN A MODEL SYSTEM IN PRESENCE OF PHOSPHATE

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INTRODUCTION

RN gene which stands for "rendement Napole" in French or Napole yield, is a dominant gene. It increases glycogen content by 70% in white or glycolytic muscles with a consequent larger than normal extent of postmortem pH fall in the ham muscles (Fernandez and Monin, 1994). From another compositional aspect, it decreases protein content by 5-7% (Sellier and Monin, 1994). Upon cooking of cooked cured Paris ham, these caused a decrease of 5-6% in the technological yield in comparison with normal meat but which is twice as much loss than that caused by PSE (Sellier and Monin, 1994).

In France, ham quality standards are high and the cooked cured Paris ham represents 70% of the French ham consumption (Fernandez and Monin, 1994). This ham is processed with a level of brine addition below 15% which does not require addition of phosphates or other ingredients commonly used in other countries in order to increase the water holding capacity of highly injected meat. The Napole yield, which has served to demonstrate the RN gene and its effects, was developed from a 100 g semimembranosus sample, as a model system in order to evaluate the technological yield of Paris ham processing. Consequently, the brine used in the procedure contains only nitrited salt and is kept at a low level (20%) (Naveau *et al.*, 1985).

In North America, however, much higher brine levels containing functional ingredients are used, and 25-50% brine addition can be regarded as medium range injected hams (DMV International, 1995). Under these conditions, the cooking yield of cured meat from RN⁻ pigs may be somewhat different than what has been documented in France. However, there is no information on the behaviour of meat from RN⁻ pigs processed in presence of functional ingredients. Therefore, we have used a modified Napole yield system which contained the most common ingredients used in ham processing in North America in order to compare samples of semimembranosus (SM), biceps femoris (BF) and vastus intermedius (VI) from 17 RN⁻ pigs and 28 RN⁺ pigs.

MATERIAL AND METHODS

Pigs from 60 to 90 kg liveweight were classified in RN⁻ and RN⁺ groups on the basis of the glycolytic potential values measured on a biopsy sample obtained from the loin muscle, and expressed as lactate equivalents per gram of wet muscle weight according to the following equation (Monin and Sellier, 1985):

$$GP\ (\mu mol/g) = 2\ ([glycogen] + [glucose] + (glucose\text{-}6\text{-}P]) + [lactate]$$

GP values above 220 indicated RN⁻ pigs and GP below 200 were classified as RN⁺. Samples were also free of the halothane gene as determined by the method of Houde and Pommier (1993). Selected pigs were slaughtered under standard commercial practices. After 48 h postmortem, a sample of each of semimembranosus (SM), biceps femoris (BF) and vastus intermedius (VI) was removed from the right ham for the measurement of the modified Napole yield (MNY). In this model, which was adapted from the Napole yield developed by Naveau *et al.* (1985), a 80 g sample of meat trimmed of visible fat and connective tissue was cut into 1 cm cubes and soaked in 40% (w/w) brine for 24 h at 4°C. The brine was made of 200 ppm sodium nitrite, 2.26% NaCl, 1% glucose extract and 0.5% Na-tripolyphosphate on the basis of the final product. Preliminary trials have shown normal pork to take up this brine. After the 24 h soaking period, the cured meat samples were cooked in boiling water for 9 min (68°C internal temperature). Then, they were drained and cooled for 2.5 h. Modified Napole yield was calculated as follow :

$$MNY\ (\%) = \frac{weight\ of\ drained\ cooked\ cured\ meat}{weight\ of\ raw\ meat} \times 100$$

Ultimate pH measurement of the muscles was also taken with a combination puncture pH electrode. Extractable sarcoplasmic proteins were measured on fresh semimembranosus muscle according to Lundström *et al.* (1988) while a frozen sample was kept for an ulterior determination of the total protein content. Statistical analysis were carried out with the GLM procedure of SAS.

RESULTS AND DISCUSSION

The purpose of this study was not to evaluate how the modified Napole yield could classify pigs according to their RN genotype but to determine the effect of the gene on the behaviour of meat processed in presence of functional ingredients as used in North America. Glycolytic potential values measured in the LD muscle are presented in Table 1 along with results for pH measurements and modified Napole yields obtained for each of SM, VI and BF muscles.

Table 1: Effect of RN⁻ gene on technological parameters of pork muscles ($\bar{X} \pm$ S.D.)

	RN⁻	rn⁺	P ≤
n	17	28	
GP (LD) (µmol/g)	251.76 ± 32.95	147.37 ± 21.72	0.001
pHµ (SM)	5.65 ± 0.24	5.95 ± 0.26	0.001
pHµ (VI)	5.77 ± 0.33	6.10 ± 0.35	0.004
pHµ (BF)	5.64 ± 0.23	5.87 ± 0.23	0.002
MNY (SM) (%)	111.55 ± 10.56	120.38 ± 10.74	0.010
MNY (VI) (%)	114.66 ± 8.11	120.86 ± 8.13	0.017
MNY (BF) (%)	104.51 ± 7.65	114.40 ± 8.40	0.001
Protein content (% wet weight) (SM)	21.04 ± 0.69	21.79 ± 0.72	0.05
Extractable sarcoplasmic proteins (SM) (mg/g wet weight)	53.01 ± 6.34	62.24 ± 6.32	0.001

Since pigs used in this study were halothane negative (NN), the effects reported herein can be linked to the RN⁻ genotype. For each of the three muscles evaluated, ultimate pH values were lower in RN⁻ pigs (P≤ 0.01) (Table 1). Although these values were not as low as those attributed to the RN⁻ gene in the French studies, the modified Napole yields were lower by an average of 8.3% in RN⁻ muscles (P ≤ 0.05). This result is of the same magnitude as the 7% and 8% decreases in standard Napole yield caused by RN⁻ gene as reported by Lundström *et al.* (1996) and Fernandez *et al.* (1990) for the LD and SM muscle respectively. However, according to Fernandez and Monin (1994), the lower protein content in meat from RN carrier would be much more influential in decreasing the technological yield than the lower ultimate pH of the meat which would explain about a third of the calculated difference. In our study, meat from RN⁻ carriers contained 0.75% less total protein on the wet weight basis (P ≤ 0.05) and also had lower extractable sarcoplasmic proteins (P ≤ 0.001) (Table 1). As reported by Lundström *et al.* (1996), RN⁻ carriers would also have a lower amount of total extractable myofibrillar and sarcoplasmic proteins which could be partly attributed to a smaller protein content, but which could also be due to a slightly higher degree of denaturation postmortem. It is therefore difficult to establish the relative importance of the different protein fractions and the lower ultimate pH on the functionality of a ham product. Barton-Gade (1985) indicated that decreasing protein content by 0.25% approximately equalled 1% less yield in cooked cured USA hams. Our results do not allow to conclude which one of the pH effect or protein content is the most detrimental on the cooking yield of cured pork. Nevertheless, RN⁻ pigs would appear to be of concern for the North American pork processing industry as the differences in modified Napole yield between RN⁻ and rn⁺ pigs for each of the three muscles evaluated in this study were not different than the values obtained in Europe from the calculation of the standard Napole yield. It could be argued that the 40% brine addition employed in our study which is twice the level used in the standard Napole yield might have counteracted the contribution of the ingredients on juice retention. However, it must be realized from both a marketing and an organoleptic point of view that there would be very little incentive in using functional ingredients for the processing of ham with a low level of brine added. Therefore, in the aforementioned processing context, functional ingredients were unable to significantly improve the impaired quality of the raw material. A similar conclusion by Honkavaara (1989) indicated that phosphates could only compensate to some extent for the low technological quality of PSE meat. Notwithstanding the preceding discussion, if one ingredient was to be used in order to improve the technological quality of RN⁻ meat, then, at a conservative brine level, addition of some sort of protein could perhaps complement the functional activity of the other ingredients but still at the expense of the marketing and profitability of such ham product.

CONCLUSION

Despite important differences in the further processing industry of pork, the RN⁻ gene should be taken seriously considering the use of the Hampshire breed for commercial pig production in North America.

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