# 5-P75

## The quality of pre-rigor and post-rigor brine injected hams from pigs with or without the RN⁻-allele

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### Background

Introducing Hampshire into the Swedish two-way crossbred pig (Landrace x Yorkshire) in the late 70s increased meat quality not only was the stress-related PSE-frequency lowered but purebred Hampshire was also found to produce more tender and juicier meat (Fjelkner-Modig & Persson, 1986). The Hampshire breed has also been found to be associated with the dominant RN⁻-gene (Naveau, 1986; LeRoy *et al.*, 1990; Fernandez *et al.*, 1992), characterised by a high glycogen content and a low ultimate pH. These meat properties will, in the case of cooked ham or loin, cause lower yields (Monin *et al.*, 1987; Lundström *et al.*, 1998; Enfält *et al.*, 1997; Lundström *et al.*, 1998). One way to obtain higher yields is to inject brine pre-rigor, instead of post-rigor (Reichert *et al.*; 1986, Hamm, 1977). Injecting salt pre-rigor inhibitis the glycolysis which results in a pH above 6.0, rather than falling to 5.6 (Young *et al.*, 1988). So far, no study has been undertaken to evaluate whether the lower yield obtained in hams from pigs carrying the RN⁻-gene could be prevented by injecting the brine pre- instead of post-rigor.

### Objectives

The purpose of this investigation was to study the effects on the technological and sensory meat quality of injecting brine pre- and post-rigor in a ham muscle (*M. biceps femoris*) from pigs with or without the RN⁻-allele.

### Methods

The pigs were selected from commercial herds producing crossbred pigs for slaughter using purebred Hampshire or Hampshire x Yorkshire boars and Swedish Landrace x Yorkshire sows. The material (15 pigs) was chosen randomly from pigs with a pH-value above 6.1, measured 30 minutes postmortem in *M. longissimus dorsi* (LD) at the last rib. From the selected carcasses, the right *M. biceps femoris* (BF) was cut out, for pre-rigor injection, whereas the left stayed on the carcass, being chilled normally. The brine was injected into the warm BF within 60 minutes postmortem and into the chilled BF 24 hours postmortem. The warm hams were Pökelpressed and tumbled immediately after injection and then stored at 4°C overnight. Pre- and post-rigor injected ham muscles were cooked simultaneously as part of the ordinary production of a commercial plant, to an internal temperature of 68°C. The cooked hams were sliced into 1.2 mm thin slices and then vacuum-packed (10 slices/package). The pH-value 24 h postmortem was registered in LD for the post-rigor injected hams and in BF for the pre-rigor injected hams. The weight loss during cooking was detemined. The LYH-pigs were classified as RN⁻-carriers and non-carriers (based on the glycogen content). Sliced hams were kept vacuum-packed at -1.5°C for a maximum of 3 weeks before sensory analysis. Two slices from each ham were randomly served to the assessors at a temperature of 6-8°C. The panel, consisting of 9 members, judged the intensity of the following parameters on a scale from 1 to 9 (1=no or very little; 9=very much): inhomogeneity in surface appearance, stringiness, crumbliness, consistency, initial juiciness, ultimate juiciness, salinity, acidity and meat flavour. The results were statistically evaluated with SYSTAT (Wilkinson, Leland version 7.0) using the t-test and analysis of variance.

### Results and discussion

Nine pigs were classified as RN⁻-carriers ($RN^-rn^+$) and 4 as non-carriers ($rn^+rn^+$), with a glycogen, glucose and glucose-6-phosphate content above 30 µmol/g and below 20 µmol/g, respectively. Two pigs could not be classified as neither RN⁻-carriers nor non-carriers and were excluded from the study. The frequency in glycogen content for the 15 pigs is shown in Figure 1. The obtained frequency of RN⁻-carriers in this study reflects the frequency of RN⁻-carriers among commercial slaughter-pigs in Sweden. The ultimate pH differed significantly ($p \leq 0.010$) between the phenotypes for the post-rigor muscles (5.35 for RN⁻-carriers and 5.55 for non-carriers) but not for the pre-rigor muscles (6.06 and 6.26) (Table 1). The difference in ultimate pH between pre- and post-rigor injected muscles was significant (p=0,000). The ultimate pH was, however, measured in LD and not in BF for post-rigor injected muscles, and could be expected to be about 0.1 pH-steps higher if measured in BF. It can, nevertheless, be concluded that the glycolysis had been inhibited by pre-rigor injection since the pH in the pre-rigor group was above 6. From the pH measurement 1.5 and 3 hours postmortem presented in Table 1, it can be seen that inhibition of glycolysis did not occur until after more than 3 hours postmortem. After this period glycolysis was inhibited, probably due to denaturation of the glycolytic enzymes (Hamm 1977). As can be seen in Figure 2, the pre-rigor injected hams had lower cooking losses than the post-rigor injected ones, independently of phenotype. The difference in cooking loss due to phenotype was smaller for the pre-rigor, compared with the post-rigor injected hams. Analysis of variance using the model cooking loss = k+phenotype+pre-/post-rigor injection, showed that the influence of pre-rigor injection was 5 times higher than the influence of RN⁻-gene on the cooking loss. Results from the sensory test are shown in Table 2. The influence of the pre-/post-rigor injection and RN⁻-phenotype on the sensory parameters was evaluated with analysis of variance using the cooking loss = k+phenotype+pre-/post-rigor injection. Pre- or post-rigor injection significantly affected the sensory parameters crumbliness, consistency, initial and ultimate juiciness. Pre-rigor injected hams had a lower crumbliness and a higher concistency than post-rigor injected hams. This indicates that pre-rigor injected hams are firmer and have probably less slicing losses than post-rigor injected hams. The pre-rigor injected hams were also considered juicier than the post-rigor injected hams. It is interesting to note that hams from pigs with the RN⁻-allele had significantly higher juiciness compared with non-carriers and that the influence of RN⁻-genotype was greater than the effect of pre- or post-rigor injection. This result is in agreement with Johansson *et al.* (1998) who found that cured smoked loins from carriers of the RN⁻-allele were juicier than cured smoked loins from non-carriers. Genotype was also found to affect acidity significantly and hams from $RN^-rn^+$-pigs had a higher acidity than hams from $rn^+rn^+$-pigs (Table 2).

## Conclusions

Pre-rigor injected ham muscles (BF) had lower cooking losses than post-rigor injected ones for hams from either carriers or non-carriers of the $RN^-$-allele. The pre-rigor injected hams had significantly higher juiciness and consistency and lower crumbliness, compared with post-rigor injected ones. Hams from carriers of the $RN^-$-allele were juicier than hams from non-carriers, even though the cooking loss was higher for hams from carriers of the allele.

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**Table 1**.Differences in pH at 1.5, 3 and 24 h pm between pre- and post-rigor injected ham muscles from pigs with or without the $RN^-$-allele (mean ± standard errors).

| | Post-rigor injection[1] | | | | Pre-rigor injection[2] | | | |
|---|---|---|---|---|---|---|---|---|
| | $RN^-$ | | $rn^+rn^+$ | | $RN^-$ | | $rn^+rn^+$ | |
| $pH_{1.5}$ (1.5 h pm) | 5.83 | ±0.35 | 6.13 | ±0.25 | 6.23 | ±0.07 | 6.45 | ±0.11 |
| $pH_3$ (3 h pm) | 5.58 | ±0.23 | 5.96 | ±0.35 | 6.09 | ±0.18 | 6.37 | ±0.08 |
| $pH_{24}$ (24 h pm) | 5.34 | ±0.04 | 5.55 | ±0.15 | 6.06 | ±0.27 | 6.2 | ±0.14 |

[1] pH-measurements in LD
[2] pH-measurements in BF

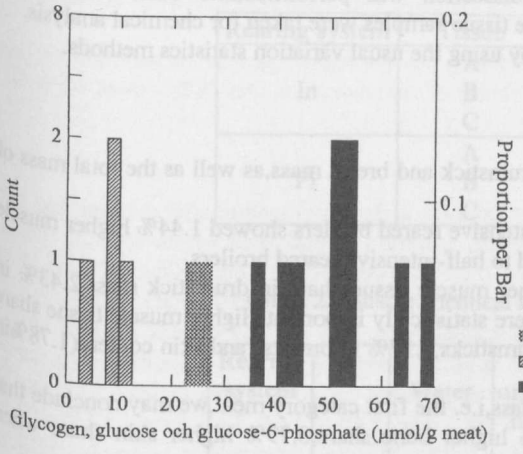


**Figure 1**. Distribution of glycogen, glucose and glucose-6 phosphate in samples from *M. semimembranosus* (n=15).

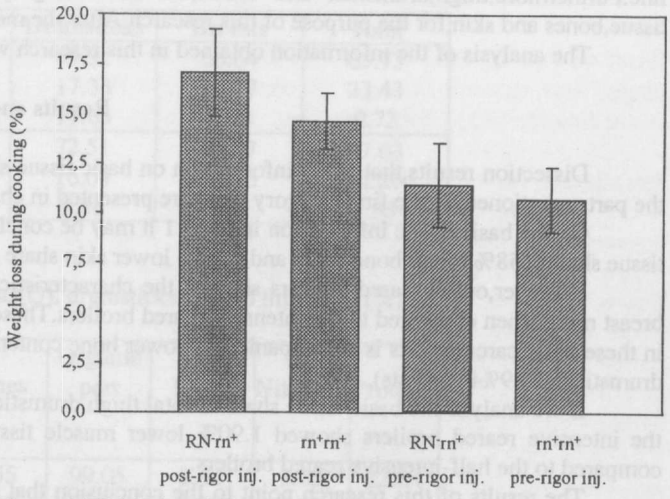


**Figure 2.** Weight loss during cooking in pre- and post-rigor injected BF from $RN^-rn^+$ (n=9) and $rn^+rn^+$ (n=4).

**Table 2**. Differences in sensory parameters between pre- and post-rigor injected BF-muscles from pigs with or without the $RN^-$-allele.

| Group | n | Inhomo-geneity | String-iness | Crumb-liness | Consi-stency | Initial juiciness | Ultimate juiciness | Salinity | Meat flavour | Acidity |
|---|---|---|---|---|---|---|---|---|---|---|
| mean | 26 | 4.34 | 3.14 | 2.49 | 5.40 | 3.97 | 5.23 | 6.02 | 3.84 | 1.76 |
| **Genotype** | | | | | | | | | | |
| p-value | | 0.410 | 0.401 | 0.348 | 0.352 | 0.009 | 0.004 | 0.254 | 0.491 | 0.031 |
| $RN^-rn^+$ | 9 | 4.42 | 3.19 | 2.42 | 5.14 | 4.18 | 5.44 | 6.16 | 3.87 | 1.86 |
| $rn^+rn^+$ | 4 | 4.25 | 3.08 | 2.56 | $5.15^{a,b}$ | 3.76 | 5.02 | 5.89 | 3.81 | 1.65 |
| **Injection** | | | | | | | | | | |
| p-value | | 0.267 | 0.121 | 0.002 | 0.003 | 0.010 | 0.011 | 0.944 | 0.175 | 0.654 |
| Pre-rigor | 9 | 4.23 | 3.03 | 2.24 | 5.69 | 4.16 | 5.40 | 6.03 | 3.89 | 1.74 |
| Post-rigor | 4 | 4.44 | 3.24 | 2.74 | 5.11 | 3.78 | 5.07 | 6.02 | 3.79 | 1.78 |
| $R^2$ | | 8.0 | 12.6 | 36.5 | 34.8 | 41.3 | 43.6 | 5.6 | 9.6 | 19.3 |