MOISTURE-ENHANCED PORK – MICROBIAL SAFETY AND EATING QUALITY

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Introduction

There is an increasing demand for moisture-enhanced pork in Denmark, as well as in Europe and North America. The moisture-enhancement process guarantees a uniform, tender and juicy product. However, during the brine injection process, the sterile deep tissue can become contaminated with bacteria from the meat surface. Greer *et al.*, (2004) have shown that the number of *Listeria monocytogenes* increased by 2.34 log cfu/100 ml brine after 2.5 h production. This indicates that there is a risk of contamination with *L. monocytogenes* in the deep tissue. *L. monocytogenes* and *Yersinia enterocolitica* are both capable of growing in pork containing 0.8% sodium chloride and stored at 5°C. In order to inhibit these pathogens, it is necessary to add sodium lactate or sodium acetate to the brine.The addition of lactate and acetate salts can increase the tenderness and juiciness of enhanced pork and can significantly reduce the aerobic plate counts (APC) during display compared with untreated controls (Jensen *et al.* 2003).
The aim of the experiment was to evaluate the ability of brines containing sodium lactate and sodium acetate to inhibit the growth of *L. monocytogenes* and *Y. enterocolitica* during 21 days of storage at 5°C. Furthermore, the eating quality of the brine with inhibitory effect was evaluated.

Materials and Methods

Microbial safety experiment:
Nine pigs (sows, weight 74.0-78.0 kg and lean meat percentage 57.0-60.0%) were slaughtered according to standard commercial procedures in a Danish abattoir. pH was recorded at 24 h postmortem in the factory. *M. longissimus dorsi* (LD) and *M. biceps femoris* (BF) were removed, transported to the Danish Meat Research Institute (DMRI) and stored at 2°C. The meat was 2 days old when injected.
At DMRI, the LD and BF were moisture-enhanced and obtained weight gains of 12.1-22.5% (desired gain = 20%) with three different brines: (1) basic brine containing salt, starch and maltodextrin, (2) basic brine with the addition of sodium acetate (0.14%), sodium sesquicarbonate, sodium ascorbate and trisodium citrate, and (3) basic brine with the addition of sodium lactate (2.5%), sodium acetate (0.14%), sodium sesquicarbonate, sodium ascorbate and trisodium citrate. To obtain approximately 10^3 cfu/g in the product, the brines were inoculated with a 3-strain cocktail of *L. monocytogenes* or a 2-strain cocktail of *Y. enterocolitica* O3. The moisture-enhanced LD and BF were cut into approx. 15 cm-long pieces, vacuum-packed and stored for 21 days at 5°C.
After 0, 7, 14 and 21 days' storage, three meat samples for each combination of bacteria, muscle and brine were evaluated for odour and appearance and were then analysed for the presence of listeria or yersinia bacteria on the surface (cfu/cm^2) and in the deep tissue (cfu/g) on Oxford agar (Oxoid) or CIN agar (Oxoid). The APC and the number of *Pseudomonas* were analysed after 0 and 21 days.
The bacterial counts were log transformed and analysed by PROC GLM and grouped using the Duncan procedure (SAS version 9.13). The model included muscle type and brine composition and interactions as fixed effects. Levels of significance: $p > 0.05$= non-significant (ns), $0.05 > p > 0.01$ = *, $0.01 > p > 0.001$ = ** and $p < 0.001$ = ***.
Eating quality experiment:
Pigs were selected and processed in the same way as in the microbial experiment, but only brines 1 and 3 were used. After injection, the pork was frozen to -18°C during storage and thawed for 24 h before sensory analysis. The pork was cut into 2 cm-thick boneless chops and cooked on a frying pan to a core temperature of 75°C. An untreated pork chop was used as a control. The odour, tenderness and juiciness of the untreated and the brine injected chops were evaluated on a 15-point unstructured scale (0 = low intensity, 15 = high intensity) by an 8-member trained sensory panel.
Data were analysed using mixed models (SAS 8.2, 1999-2001). The model included the ageing period, muscle type, cooking temperature, brine composition and interactions as fixed effects, and assessors and pig number as random effects. Non-significant interactions were deleted from the model. Least squares means (Lsmeans) were calculated and separated using the probability of difference. The same significance levels as in the microbial experiment were used.

Results and Discussion

Microbial safety experiment:
The statistical analysis showed no significant difference between the muscles. On days 7 and 21, moisture enhancement with brine 3 resulted in a significantly lower number of *L. monocytogenes* in the deep tissue compared with brines 1 and 2. On day 14, moisture enhancement with brine 3 resulted in a significant lower number of *L. monocytogenes* in the deep tissue compared with brine 1 (control). Enhancement with brine 3 prevented growth of *L. monocytogenes* during 21 days of storage at 5°C.

The difference between brine 3 and brines 1 and 2 was more pronounced in the surface samples. On all days, the number of *L. monocytogenes* on the surface of brine 3 treated pork was significantly lower than surface samples from moisture-enhanced pork injected with brines 1 and 2. There was no significant difference between brines 1 and 2. Identical results for moisture-enhancement with brine 3 were obtained in the experiment with *Y. enterocolitica*. Moisture enhancement with brine 2 resulted in an inhibition of the growth of 14 days on the surface and 21 days in the deep tissue.

On day 0, the number of *Pseudomonas* in the deep tissue was 1.5 log cfu/g, and after 21 days, the number of *Pseudomonas* in the moisture-enhanced pork injected with brines 1-3 was 6 log cfu/g, 3 log cfu/g and 3 log cfu/g, respectively. This indicates that the addition of sodium lactate and sodium acetate in brines 2 and 3 delayed the growth of *Pseudomonas*. The same tendency was seen in surface samples.

Eating quality experiment:

Uninjected LD chops were statiscally significantly more tender (8.2 points) than BF chops (6.2 points). Brine injection with the two brines resulted in significantly more tender meat than control samples: brine 3 (11.7 points) > brine 1 (10.5 points) > controls (7.7 points). Furthermore, the brine injection had no effect on the uniformity between muscle types, because the difference between LD and BF was maintained.

The juiciness of the meat was the same in uninjected LD and BF chops, and brine injection with brine 1 had only a small effect on BF chops, while LD chops were significantly juicier after brine-injection. However, brine injection with brine 3 resulted in juicier BF chops, while the juiciness of LD chops was the same as the juiciness obtained with brine 1.

The meat flavour was not affected by brine injection with brines 1 and 3, while salt taste and bitter taste were increased by brine injection, especially with brine 3. Finally, vinegar odour was not detected in the control samples and pork injected with brine 1, but was detected (3.6 points) in pork brine injected with brine 3.

Conclusions

The addition of 0.14% sodium acetate and 2.5% sodium lactate to a brine containing salt (0.8% in product), starch and maltodextrin inhibited the growth of *L. monocytogenes* and *Y. enterocolitica* during 21 days of storage at 5°C. Furthermore, the growth of *Y. enterocolitica* was inhibited when the pork was moisture-enhanced with a brine containing salt (0.8% in product), starch and maltodextrin and 0.14% sodium acetate during14 days of storage at 5°C.

The addition of sodium lactate (2.5%) and sodium acetate (0.14%) to brines delayed the growth of *Pseudomonas* in moisture-enhanced pork. Furthermore, this brine composition resulted in improved tenderness, juiciness and salt taste, as expected. Unfortunately, it also resulted in a more intense bitter taste and vinegar odour compared with an untreated control sample. Compared with brine 1, the addition of sodum acetate and sodium lactate resulted in improved tenderness and a higher intensity of salt taste and vinegar odour.

References

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