WATER LOSS FROM PORK DURING COOKING

– DOES PH DURING COOKING HAVE AN IMPACT?

K. Rosenvold, M. Baltzer and M.D. Aaslyng and S. Støier
Danish Meat Research Institute, PO Box 57, 4000 Roskilde, Denmark

Background

Eating quality of pork is a combination of appearance, flavour, tenderness and juiciness. The cooking procedure (centre temperature, heating time/temperature and heating method) has an impact on juiciness, and an increase of centre temperatures will decrease the juiciness (Bejerholm & Aaslyng, 2003). In a recent study (Aaslyng et al., 2003) as much as 50% of the variation in juiciness was explained by the variation in cooking loss in *Longissimus dorsi*. Both juiciness and cooking loss are affected by the pH_u and waterholding capacity (WHC) of the raw meat.

Aaslyng et al. (2003) also showed – in 10 different raw meat qualities – that while there was a large variation in cooking loss when measured at 60°C and 70°C, this difference was gone when the same samples were heated to 80°C. In addition, higher final cooking loss was registered in samples with low WHC and low pH_u. On the other hand, there was no difference in cooking loss when WHC and pH_u of the meat was medium or high. This indicated the presence of a threshold value for pH_u and/or WHC above which cooking loss is influenced neither by WHC nor pH_u.

Based on the above, it was speculated whether the observed differences in cooking loss were influenced by different pH courses in the meat during cooking. Hence, an experiment was carried out that followed the pH course and cooking loss during cooking of *L. dorsi* and *Biceps femoris* samples with high, normal and low pH_u.

Objectives

The objective of this study was to investigate a possible relation between the pH course and cooking loss during cooking of pork samples with high, normal and low pH_u.

Materials and methods

A total of 12 *L. dorsi* samples - four high, four normal and four low pH_u samples - and eight *B. femoris* samples – four high and four normal pH_u samples – were included in the experiment. The selection of samples was based exclusively on pH_u in commercial slaughter pigs. The samples were stored frozen and were defrosted for 20-24 hr at 4°C prior to cooking. Cooking procedure: Whole roasts in oven (convection oven) at 90°C. When the centre temperature in the samples reached 70°C, the oven temperature was increased to 105°C. The centre temperature, weight and pH were measured prior to cooking and at regular intervals during the cooking until a centre temperature of 90°C was reached. pH was measured using a Knick Portamess 910 pH meter with a Mettler Toledo Lot 406-m&-S7/25 until centre temperatures of approx. 55°C were reached, as the pH meter was unreliable above this temperature. The pH electrode was calibrated prior

Table 1 pH_u (measured prior to cooking) and final cooking loss (measured when the centre temperature had reached 90°C) in *L. dorsi* and *B. femoris* samples with high, normal or low pH_u[a].

	L. dorsi			*B. femoris*	
pH-group	high	normal	low	high	normal
pH_u	5.84 ± 0.04[a]	5.58 ± 0.04[b]	5.40 ± 0.03[c]	5.99 ± 0.03[a]	5.62 ± 0.03[b]
final cooking loss	36.7 ± 1.7[a]	39.5 ± 1.4[a]	47.8 ± 1.4[b]	43.9 ± 1.1[a]	45.6 ± 1.1[a]

[a] Least squares means and SEM are shown. Different letters for pHu and final cooking loss within muscle indicate significant differences ($p < 0.05$) between the high, normal and low pH-groups.

to each measurement in buffers equilibrated to the centre temperature ± 5°C of the sample at the specific measurement. Cooking loss was calculated on the basis of the measured sample weights.

The statistical analysis was carried out with the Statistical Analysis System, version 8.2 (SAS Institute, Cary, NC, USA). The MIXED procedure was applied when calculating the least square means and standard error of all the variables. A model including the fixed effects of pH group (high, normal, low) and centre temperature as well as their interaction, the repeated effect of centre temperature with sample as subject was applied for pH and accumulated cooking loss.

Results and discussion

pH_u (measured prior to cooking) of the three *L. dorsi* and the two *B. femoris* pH groups is listed in Table 1, showing that the pH values of the different pH groups were significantly different when the experiment was initiated.

The pH course during cooking is shown in Figure 1 for *L. dorsi* and in Figure 2 for *B. femoris*. During cooking, the pH courses of the high and normal pH_u samples were almost identical although taking place at different levels. In *L. dorsi,* pH fell approximately 0.3 pH units from 0°C until centre temperatures of 35-45°C were reached. When the centre temperature increased further, the pH slowly increased as well – approximately 0.2 pH units. In contrast, the pH fell less than 0.2 pH units in the low pH *L. dorsi* group, and the minimum pH was reached before the centre temperature reached 20°C. In *B. femoris*, pH fell approximately 0.2 pH units from 0°C until the centre temperatures reached 35-45°C. When the temperature increased further, pH in both pH groups increased again, with the highest increase in the normal pH_u group.

The final cooking loss (measured when the centre temperature had reached 90°C) is shown in Table 1. In *L. dorsi*, the final cooking loss in the low pH group was significantly higher than in the high and normal pH groups. There was no significant difference in final cooking loss between the high and normal pH group in either *L. dorsi* or *B. femoris*.

The accumulated cooking loss is shown in Figure 1 for *L. dorsi* and in Figure 2 for *B. femoris*, respectively. In *L. dorsi*, cooking loss

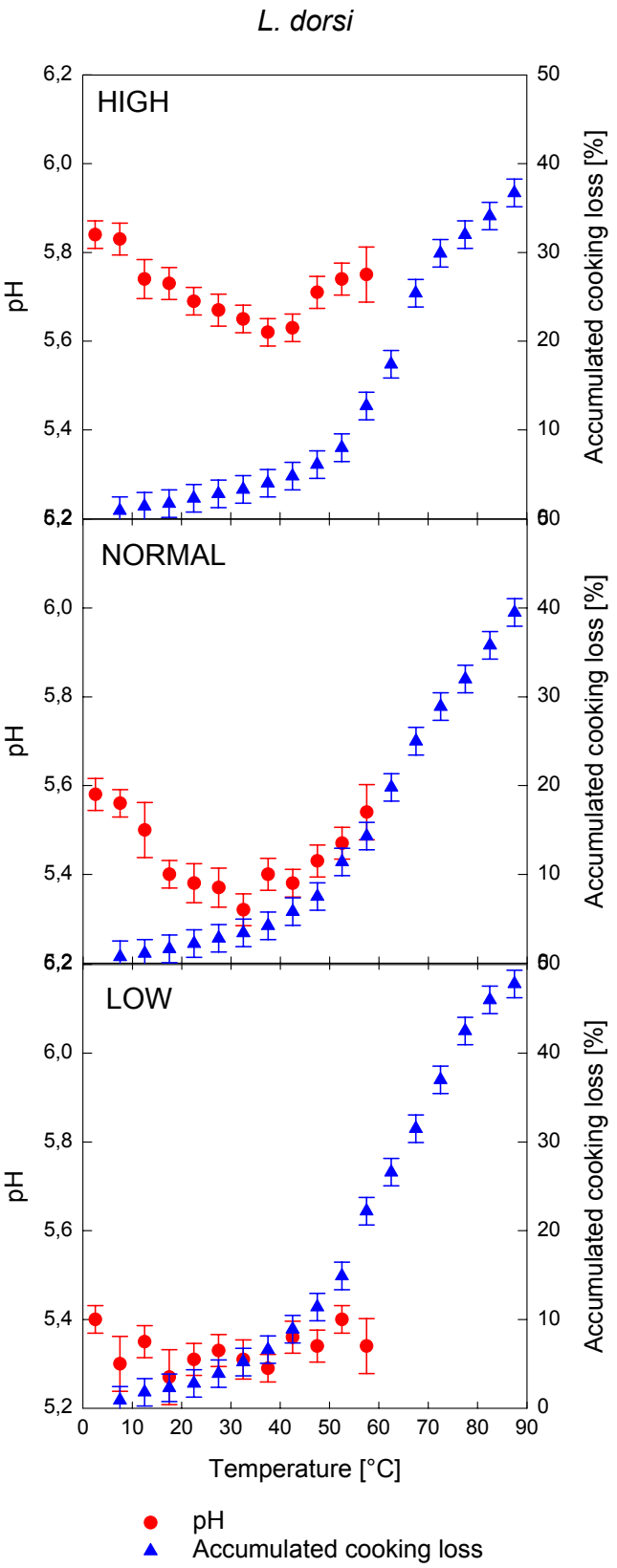

Figure 1 pH and accumulated cooking loss measured at centre temperature intervals of 5°C during cooking of *L. dorsi* samples of high, normal and low pH_u.

of the low pH group exceeded 1% cooking loss per 5°C temperature increase already at 30°C, and the highest cooking loss per 5°C temperature increase was observed in the temperature interval of 55-60°C. In contrast, the centre temperature in the normal and high pH groups was above 40°C and 45°C, respectively, before the cooking loss exceeded 1% per 5°C temperature increase and the highest cooking loss was observed in the temperature interval of 65-70°C for both groups. Thus, the water was lost at a lower temperature in the low pH group and the total cooking loss was higher.

The final cooking loss was higher in *B. femoris* than in *L. dorsi*, but below 40°C the cooking loss pattern observed in *B. femoris* was almost identical to that observed in *L. dorsi*, as the temperature was above 40°C before the cooking loss exceeded 1% per 5°C temperature increase and the highest cooking loss was observed in the interval of 65-70°C. However, in the temperature interval between 40°C and 65°C significantly more water was lost from the normal pH group compared to the high pH group and compared to the high and normal group of *L. dorsi*. From the high pH group water was lost at higher temperatures why the final cooking loss was not significantly different in the two groups.

The aim of this experiment was to study whether the pH course during cooking had an influence on when cooking loss takes place. As discussed above pH in the low pH group hardly changed during cooking while water was lost already at low temperatures. In the normal and high pH group, pH decreased when cooking was initiated and increased again when temperatures got above approximately 45°C. However, water was not lost to any considerable extent until the temperature got above approximately 40°C i.e. when pH had started to increase again. Hence, the pH course does not seem to have any direct influence on when water is lost during cooking.

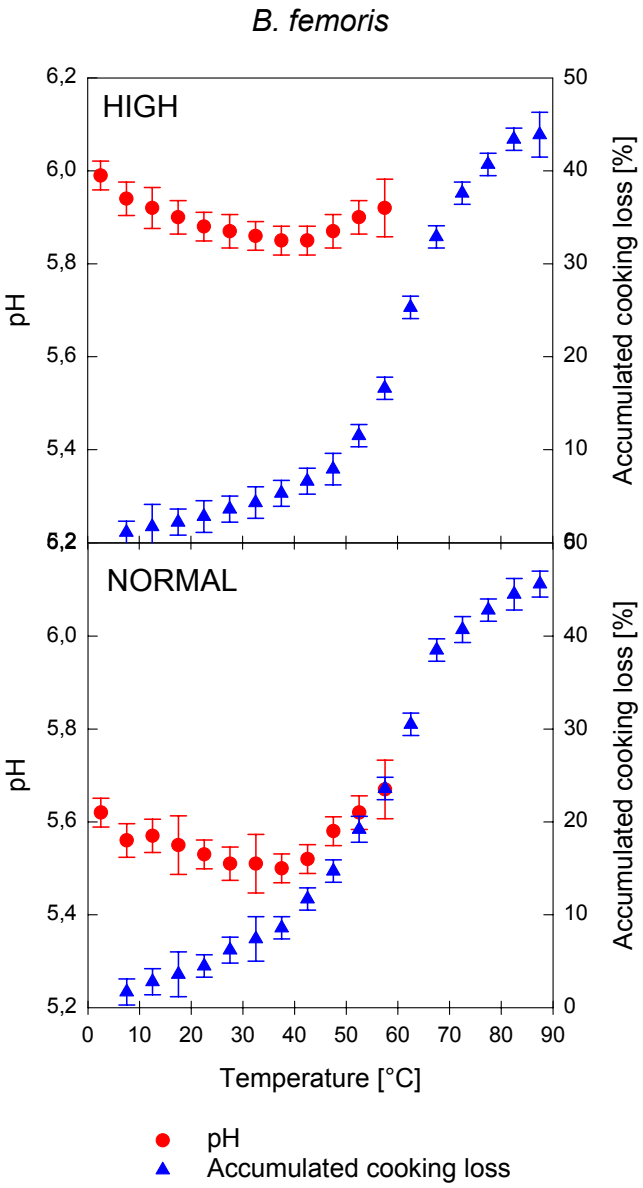

Figure 2, pH and accumulated cooking loss measured at centre temperature intervals of 5°C during cooking of *B. femoris* samples of high and normal pH_u.

The existence of a threshold value above which cooking loss is not influenced by WHC or pH has been suggested (Aaslyng et al., 2003). The final cooking loss was identical in the normal and high pH groups in *B. femoris*, but the water was lost at different temperatures in this muscle. In *L. dorsi* the water loss was almost identical in the two groups. This discrepancy between *L. dorsi* and *B. femoris* could be due to muscle differences, e.g. the final cooking loss being higher in *B. femoris* than in *L. dorsi*. However, the discrepancy may also be due to larger differences in pH_u between the two different pH groups in *B. femoris* compared to *L. dorsi* as well as considerably higher pH_u in the high pH group in *B. femoris* compared to the high pH group in *L. dorsi* (Table 1). These results indicate that pH_u does influence the water loss during cooking even at normal and high pH_u - although to a smaller extent than at low pH_u.

Conclusions

Final cooking loss in *L. dorsi* was higher in low pH_u samples compared with high and normal pH_u samples. In *B. femoris* there were no differences in final cooking loss between high and normal pH_u samples. However, there was no relationship between water loss during cooking and the changes in pH.

References

Aaslyng, M.D., C. Bejerholm, P. Ertbjerg, H.C. Bertram and H.J. Andersen. 2003. Cooking loss and juiciness of pork in relation to raw meat quality and cooking procedure. Food Quality and Preference 14, 277-288.

Bejerholm, C. and M.D. Aaslyng. 2003. The influence of cooking technique and core temperature on results of a sensory analysis of pork – depending on the raw meat quality. Food Quality and Preference 15, 19-30.