CALIBRATION TEMPERATURE OF pH-ELECTRODES – EFFECT ON PREDICTION OF MEAT QUALITY

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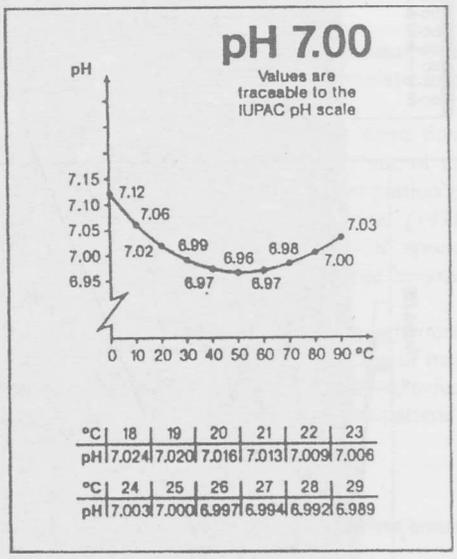
Keywords: pH, calibration, classification

Background

pH measured in the pig carcass both early *post mortem* and 24 h *post mortem* is widely used as an indicator of meat quality, as is can be used to predict driploss (Schäefer et al., 2001), and to classify meat into PSE, DFD and normal meat (Bendall and Swatland, 1988).

pH is very dependent on temperature, and thus the calibration of pH-electrodes is also influenced by temperature. Figure 1 shows the temperature dependency of buffers (pH 7.00, Radiometer, DK) that are used for calibration of pH-electrodes. As regards the electrodes, compensation can be made for the influence of temperature on the slope. On the other hand, no compensation can be made for the pH shifts caused by altered reference potentials or a change of pH in the inner solution in the glass bulb. Finally, almost nothing is known about the influence of temperature on the pH of a sample. It is therefore essential that the temperature is registered together with the pH value (Metrohm). It is recommended that samples, buffers and electrodes should all have the same temperature. Some compensation can be done, but it is not possible to calculate the pH of a sample measured at one temperature back to the sample pH at another (reference) temperature. Theoretically speaking, the sample measurements and calibration should be performed at the same temperature. However, a temperature difference of 2 to 5°C will be acceptable in most cases (Radiometer).



°C	18	19	20	21	22	23
pH	7.024	7.020	7.016	7.013	7.009	7.006

°C	24	25	26	27	28	29
pH	7.003	7.000	6.997	6.994	6.992	6.989

Figure 1 pH dependence on temperature (Radiometer).

Objective

The aim of the present study was to investigate the effect of pH-electrode buffer temperature on pH measured 1 to 120 min in *post mortem* pork and to evaluate its effect on prediction of meat quality.

Materials and Methods

Female slaughter pigs (N = 20) of crossbreed between Danish Landrace x Large White sows, and Pietrain x Duroc boars (half the pigs were carriers and half the pigs were non-carriers of the halothane gene) were slaughtered at the experimental slaughter plant at The Danish Institute of Agricultural Sciences, Denmark. Half the pigs were subjected to treadmill exercise, which in combination with the effect of the Halothane gene ensured a large variation in pH, temperature and drip loss in the meat. pH was measured with two PHM201 pH meters (Radiometer, Denmark) equipped with Metrohm probe type LL glass electrodes WOC (Metrohm, Switzerland). The electrodes were calibrated in pH 4.01 and 7.00 IUPAC buffers (Radiometer). One electrode was calibrated in buffers equilibrated to 15°C (slaughter plant ambient temperature) and the other electrode was calibrated in buffers equilibrated to 35°C. The electrodes were stored at the two temperatures before and in-between the measurements. The temperature of the meat was measured with a Testo 110 thermometer (Testo, Germany). pH and temperature were measured five times *post mortem* (1 min, 15 min, 30 min, 1 h and 2 h) and at each time point pH was measured with the two different electrodes calibrated at either 15°C or 35°C. The stability of the calibration was regularly checked in buffer 7.00. If the electrodes were found to be unstable, the electrodes were recalibrated, which is the normal procedure. Drip loss was measured in a 2 cm thick slice suspended in a net in a plastic bag stored at 4°C over 48h. Partial least squares (PLS) regressions were applied in the data analysis and carried out with the software "The Unscrambler" version 7.6 (Camo AS, Oslo, Norway). Models included $pH_{60\ min}$ measured after calibration at either 15°C or 35°C (**X**) to explain drip loss (**Y**). Full cross validation (leave one out) and Martens' uncertainty test were applied.

Results and Discussion

The result of measuring pH with pH-electrodes calibrated at 15°C and 35°C, respectively, in the same carcasses *post mortem* is presented in Figure 2. There was no significant difference between the two calibration temperatures used early *post mortem* (1 m and 15 m), although the pH value measured with electrode calibrated at 15°C was lower. However, when the difference between the two calibration temperatures was calculated as H^+-concentration, as presented in Figure 3, it was almost 10%. Later *post mortem*, the difference between the calibration temperatures increased, and pH was 0.17 and 0.14 pH units higher, when measured with an electrode calibrated at 35°C as compared with pH measured with an electrode calibrated at 15°C. This corresponds to a difference of approximately 30% in H^+-concentration.

pH is an essential phenomenon when discussing meat quality (Bendall & Swatland, 1988, Kauffmann *et al.*, 1993) and, although strictly speaking pH can only be considered an excellent indicator of meat quality, it is often referred to as a meat quality trait along others e.g. water-holding capacity and colour. pH measured 45 min *post mortem*, also known as pH_1, is widely used to

discriminate between normal meat and PSE meat. In an international survey, Bendall and Swatland (1988) found a high variation in pH_1 values. The variation was to some extent explained by breed differences, e.g. the Pietrain breed, known to carry the Halothane gene, had the lowest pH_1 values. However, the result of the present study shows that part of the variation between the studies may be a result of pH-electrode calibration at different temperatures. In laboratories where pH-electrodes are calibrated at room temperature, which will vary with the seasons, it may even be difficult to compare different studies.

After calibration at 15°C and 35°C, the normal distribution of pH measured 60 min *post mortem* (Figure 4) show a shift, which was dependent on calibration temperature. However, calibration at 35°C did not improve the correlation between $pH_{60\ min}$ and drip loss (Table 1). If pH 5.8 was to be used at a threshold value for prediction of PSE meat, calibration at 35°C would predict six animals to develop PSE meat, whereas calibration at 15°C would predict eight animals to develop PSE meat. Thus, in the present material pH-electrode calibration at 15°C resulted in a 10% increase in the prediction of PSE meat.

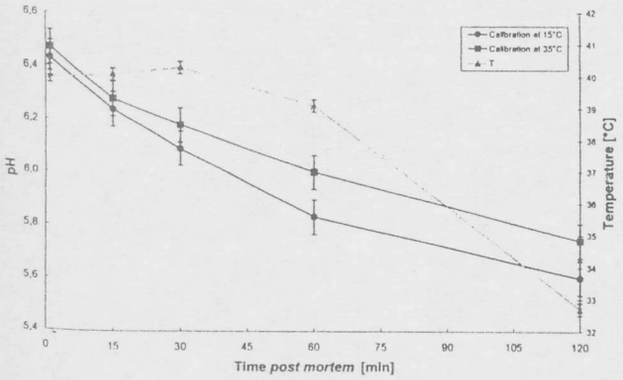


Figure 2 pH measured 1 m, 15 m, 30 m, 1 h and 2 h *post mortem* with pH-electrodes calibrated at 15°C and 35°C, respectively. Temperature measured at the same time points is also shown.

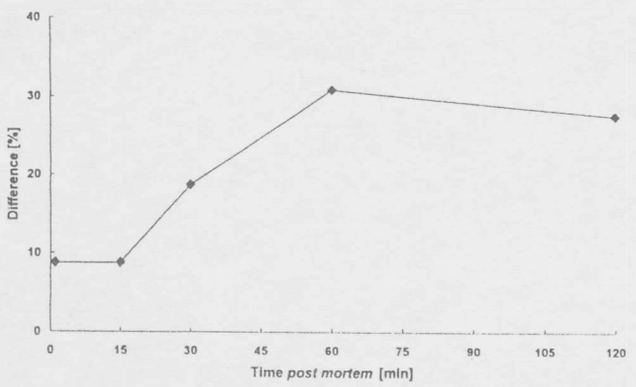


Figure 3 Difference between the two calibration temperatures, calculated as H^+ concentration.

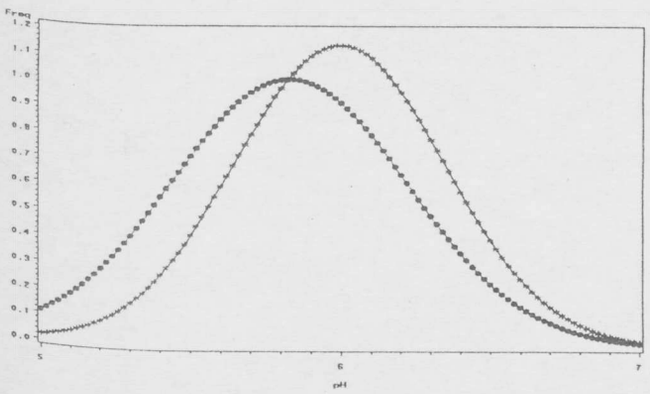


Figure 4 The normal distribution of pH measured 60 min *post mortem* after calibration at either 15°C (•) or 35°C (*).

Table 1 Explained variance for drip loss (Y), the validation correlation coefficients (R), the standard error of prediction (Sep) are shown for PLS1 models, which included $pH_{60\ min}$ measured after calibration at either 15°C or 35°C.

Calibration temperature	Y-var	R	SEP
15°C	57%	0.70	2.17
35°C	55%	0.67	2.26

Conclusions

Calibration temperature of pH-electrodes is essential for pH measurements, as the result is highly dependent on this temperature. This is especially important when using pH measurement for prediction of meat quality or when different experiments are compared.

References

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