PREDICTING THE TENDERNESS OF BEEF USING pH-MEASUREMENTS EARLY POST-MORTEM

Anders Göransson, Halina Agerhem, Åsa Josell

Swedish Meats R&D, P.O. Box 504, SE-244 24 Kävlinge, Sweden

Background.

Through measuring meat quality using instrumental methods such as Warner-Bratzler shear force measurements or senso evaluations, it is possible to verify tenderness. For the meat industry it would be an advantage if the information about tenderness w obtained before cutting the meat. It is therefore of the utmost importance to introduce methods which can predict meat tenderne early pre-rigor. In the literature, pH measured at a fixed time has been used to predict tenderness in beef *(Marsh et al., 1987; Pl et al., 1993; Hwang et al., 1999). Marsh et al. (1987)* suggested a pH of 6.1 at 3 hours post-mortem to obtain optimum tenderne Instead of looking at one single pH-value measured at a specific time, an alternative way would be to follow the complete pH-f during the rigor process.

Objective.

The aim was to investigate the possibility of predicting meat tenderness early post-mortem using the rate of pH-fall measur on-line in an abattoir.

Materials and Methods.

The material in the investigation consisted of 59 young bulls and heifers (Swedish Lowland breed), 29 non-electrical stimulated and 30 electrically stimulated carcasses (80V, 30 seconds, 15Hz, 30 minutes post-mortem). Pairs of *M. longissimus dor* (LD) were excised from each animal the day after slaughter.

The pH was measured using a Knick Portamess 911 pH-meter with a Xerolyte glass combination electrode. pH-measureme were carried out on-line in the slaughterhouse at 3, 5, 8, 24 and 48 hours post-mortem.

The meat samples for the Warner-Bratzler shear force measurements were sliced into 3.5 cm thick pieces, vacuum packed a frozen after ageing. The frozen samples were thawed for 24 hours at +4°C and then cooked in a waterbath for 80 minutes at 74° followed by 25 minutes in an ice bath. The samples were cut in the fibre direction from each piece, each sample having a cros sectional area of 15 × 7 mm^2 (1.0 cm^2) and a length of 20 mm. Shear force measurements were performed on an Instron 4301, with modified cutting device developed by *Bouton and Harris (1978)*. The thickness of the blade was 1.0 mm with a square opening 26 × 21 mm^2. A mean value of the ten measurements was used for each piece. Shear force measurements were performed on sampl aged for 9 days post-mortem. The ageing temperature was +4°C.

A consumer evaluation was also carried out in order to correlate the Warner-Bratzler shear force measurements to how the me was perceived by naive consumers *(Agerhem et al., 2000)*.

Results and Discussion.

pH measurements

In Fig. 1, the mean values of the pH-time course in the LD muscles are shown for non-electrically and electrically stimula animals. The electrically stimulated muscles showed a significantly faster pH-fall than the non-electrically stimulated muscles. T electrically stimulated muscles also received a lower ultimate pH than non-electrically stimulated muscles and the difference w significant at 48 h post-mortem (p<0.000). The experimental data in Fig. 1 were fitted to a single exponential decay model as follow

$$pH(t) = pH_{\infty} + (pH_0 - pH_{\infty})\cdot\exp(-t/\tau) \quad (1$$

where pH_{∞} is the ultimate pH value reached at the end of the rigor process, pH_0 is the initial pH and τ is a time constant typical of t decline rate. In Table 1, the model parameters are given for the two groups of animals. It can be seen that the rate of pH-fall had faster development, indicated by a lower time constant, for the electrically stimulated carcasses than for the non-electrical stimulated ones.

Shear force measurements.

The mean shear force measurements carried out at 9 days post mortem are shown in Fig. 2. The electrically stimulated musc obtained lower Warner-Bratzler shear force values than non-electrically stimulated muscles, and the difference between the tw groups was significant (p<0.01).

In order to see any correlation between the shear force and the rate of pH-fall expressed as the time constant, τ, these tw parameters were plotted in Fig. 3, for all animals. It could be seen that a pH-fall having a time constant less than 5 hours showed higher probability of obtaining a more tender meat, than was the case for slower pH courses, i.e. higher τ-values. It can be seen in th figure that the most tender muscles with the lowest τ-values also are electrically stimulated. The mean τ-values for the no electrically stimulated carcasses is well over 5 hours (10.87 hours), but for the electrically stimulated carcasses the time constant w 5 hours approximately. From this investigation it is impossible to say if it is the effect on the pH fall or some other effect from t electrical stimulation that contribute to the improved tenderness. From a practical point of view it would be easier to measure only t pH-value at a certain time post mortem, but additional information obtained by following the pH-fall (expressed as a τ-value) mig predict the tenderness more accurately.

A translation of a time constant, τ, having a value of, for instance, 3 hours would result in a pH-value of approximately 5.7 5 hours post-mortem.

Conclusions.

A characteristic time constant describing the pH-fall during rigor was obtained from a non-linear curve fit model of the experimental measured pH. Electrically stimulated carcasses with a time constant below 5 in LD was found to obtain the most tender meat.

Acknowledgments.

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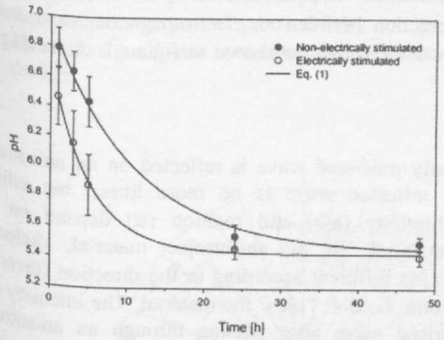
References.

Agerhem, H., Göransson, A. and Josell, Å. (2000) 46th ICoMST, Buenos Aires, Argentina.
Bouton, P. E. and Harris, P. V. (1978) J. Texture Studies, 9, 935.
Hwang, I. H., Shaw, F. D., Thomson, B. C. and Thompson, J. M. (1999) 45th ICoMST, Yokohama, 246.
Marsh, B. B., Ringkob, T. P., Russell, R. L., Swartz, D. R. and Pagel, L. A. (1987) Meat Sci., 21, 241.
Pike, M. M., Ringkob, T. P., Beekman, D. D., Koh, Y. O. and Gerthoffer, W. T. (1993) Meat Sci., 34, 13.

Table 1. Overview of the model parameters of Eq. (1).

	n	pH_∞	pH_0-pH_∞	τ [h]
LD non-electrically stimulated	29	5.439	1.529	10.870
LD electrically stimulated	30	5.428	1.263	5.102



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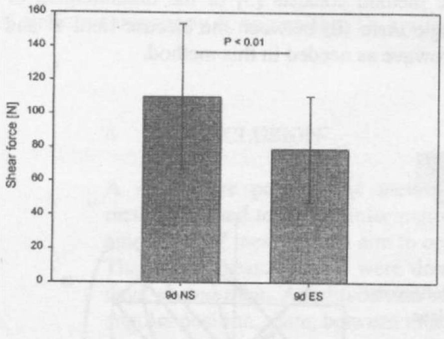

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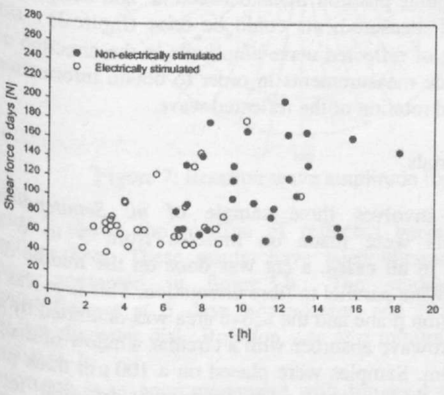

3.

Figure 1. pH fall of LD muscles. Comparison between non-electrically and electrically stimulated carcasses.

Figure 2. Comparison of shear force measurements between non-electrically and electrically stimulated LD muscles at 9 days post-mortem.

Figure 3. Correlation between Warner-Bratzler shear force measured at 9 days post-mortem and the time constant of the pH fall obtained from Eq. (1).