The Relationship between pH and the Electrical Properties of Bovine M. *longissimus dorsi*

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OBJECTIVES

Recent work has determined that a relationship exists between the rate of pH decline and meat quality attributes (O'Halloran et al., 1995). Despite the fact that normal ultimate pH (pH_u) of bovine *longissimus dorsi* is between 5.4 and 5.6, meat quality varies considerably. Therefore, the development of a sensitive measurement, taken within 48 hours *postmortem,* to predict meat quality would be highly beneficial to the meat industry. This work aims to relate the pH decline with the electrical properties of *postmortem* bovine M. *longissimus dorsi*. Since the rate of pH decline has been shown to relate to meat quality, it would be of great interest to relate the electrical properties, over 48 hours *postmortem,* to the rate of pH decline.

BACKGROUND

The ability to make on-line measurements of meat quality would greatly improve the efficiency of meat merchandising and processing for the general benefit of both the producers and consumers. Because this idea has been around for a long time, much research and development has been carried out to develop various probes for categorising meat 'on-line'. Most of these are based on the optical and electrical properties of muscle. Since the 1930s, various workers have related the electrical characteristics of muscle, such as impedance and conductivity to meat quality properties such as water holding capacity (WHC) and colour. However, it is only recently that instruments have become available which exploit these relationships to predict quality on the slaughterline (Bendall and Swatland, 1988). The relationships between the electrical characteristics and indices of quality are complex and there is disagreement as to whether, and how soon after slaughter they can reliably differentiate between meat of normal and inferior quality (Warriss *et al.*, 1991). According to Warriss *et al.* (1991), the electrical characteristics of muscle change with time *postmortem* and may be used to predict meat quality. Both conductivity and impedance measurements are indicators of membrane integrity (Kleibel *et al.*, 1983). Changes in membrane permeability enhance the ion transport i.e. the flow of current through a muscle. Therefore, enhanced conductivity or impedance is an indirect measurement of enhanced drip loss or muscle softness which is a consequence of leaky membrane structures which allow fluids to move between the intracellular and extracellular spaces (Pliquett *et al.*, 1990). Some workers have produced favourable evaluations of the use of commercially available instruments which measure conductivity (Seidler *et al.*, 1987; Oliver *et al.*, 1990). In contrast however, recent Canadian studies have found poor relationships between the subjectively assessed colour-structure of pork loins and their measured electrical characteristics (Fortin and Raymond, 1988). Warriss *et al.* (1991) also found that the relationship between PQM (Tecpro) values and reflectance, colour and water holding capacity (WHC) were not very strong. Much research has been carried out to determine the relationship between the pH fall of postmortem beef muscle and related quality attributes and according to O'Halloran *et al.* (1995), the rate of pH decline correlates well with beef tenderness. It would therefore, be of great interest to relate the electrical properties of muscle to the rate of pH fall.

EXPERIMENTAL METHODS:

Hereford cross heifers (n = 16) of similar age, size and grade, were slaughtered and hung conventionally. The right hand side *longissimus dorsi* (LD) muscles were used for all measurements and sampling. pH (Orion pH meter and combined electrode) and temperature (Grant Squirrel data logger) measurements were taken at intervals up to 24 hours *postmortem*. Conductivity measurements (Pork Quality Meter (PQM) Intek, Germany) and impedance measurements (Meatcheck 160, Sigma Electronic, Germany) were taken at hourly intervals up to 8 hours and then at days 1, 2, 7 and 14.

RESULTS AND DISCUSSION

Table 1 shows simple correlations between pH and the electrical conductivity and impedance measurements taken at various times *postmortem*. Significant correlations were obtained between pH at 7 hours postmortem and electrical conductivity and impedance measurements taken up to 7 days *postmortem*. Although pH_u within the 16 animals in this experiment only varied by 0.11 pH units, differences in impedance values varied from 6 to 76 dimensionless units at 24 hours, 5 to 66 dimensionless units at 48 hours and 3 to 39 dimensionless units at 7 days. This clearly demonstrates that impedance values differ more substantially between animals at 24 hours, 48 hours and 7 days *postmortem* than pH. Furthermore, these impedance values are significantly correlated with muscle pH fall at 7 hours *postmortem*. Therefore, as the rate of pH fall has been shown to be related to meat quality attributes (O'Halloran *et al.*, 1995), the relationship between quality attributes in beef and electrical impedance is of great interest. Previous work by Pliquett *et al.* (1995) on impedance measurements of beef also suggested that when measured at a specific time *postmortem*, impedance characterised meat quickly and reliably, in terms of WHC and drip loss .

Similar results were obtained from electrical conductivity data. Conductivity values varied at 24 hours, 48 hours and 7 days from 2.2 to 13.7mS/cm, 2.3 to 13.5mS/cm and 6.7 to 15.9mS/cm respectively. Significant correlations were obtained between these measurements and pH at 7 hours *postmortem.* Warriss *et al.* (1991) also carried out an experiment to relate conductivity measurements to pH and reported that conductivity measurements made at 45 minutes and 20 hours *postmortem* were moderately correlated with initial pH (pH_{45}). Garrido *et al.* (1995) also reported that conductivity measurements were better at detecting PSE meat (fast glycolysing muscle) than pH_{45} or pH_u measurements. Oliver *et al.* (1990) also suggested that electrical conductivity measurements can be used to predict

PSE and normal pig meat at different times and can replace the traditional pH muscle measurements. Further work is required to relate electrical conductivity and impedance measurements with meat quality attributes.

Table 1 : Simple correlation coefficients of electrical properties of meat at various times *postmortem* with pH at 7 hours *postmortem*.

ELECTRICAL CONDUCTIVITY					ELECTRICAL IMPEDANCE				
7 hours	24 hours	48 hours	7 days	14 days	7 hours	24 hours	48 hours	7 days	14 days
-0.735*	-0.614*	-0.620*	-0.630*	-0.277**	0.666*	0.643*	0.700*	0.583*	0.355**

(*P < 0.05, **P > 0.05).

CONCLUSIONS

Significant correlations were obtained between the rate of pH fall and conductivity and impedance measurements. As pH fall can only be measured within 24 hours *postmortem,* it appears from these results that impedance and conductivity measurements can detect different rates of pH fall after 24 and 48 hours *postmortem*. This may be of great value in predicting meat quality attributes.

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