DETERMINATION OF POTENTIAL INHERENT VARIABILITY WHEN MEASURING BEEF QUALITY

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Background

Optimisation of potential online methods for determining beef quality during the early *post mortem* period is regarded as a crucial area of research in today's beef industry. Numerous physical methods have been developed, in addition to sensory evaluation, in order to evaluate the difference in meat quality and understand the origins of variation (Lepetit *et al.,* 2001). Developing on-line physical instrumentation to rapidly and efficiently detect beef colour and beef tenderness is paramount, with pH, colour and electrical measurements being some of the methods assessed. While recognising the significance of these potential measurements as on-line quality indicators, it is necessary to determine inherent variability due to factors such as muscle location, depth of insertion, probe type, fibre direction, type of meter and bloom time.

Objectives

To determine the influence of various inherent factors (muscle location, depth of insertion, probe type etc.) on the potential quality predictors (pH, colour and conductivity) and meat quality measurements.

Materials and methods

Bovine M.*longissimus thoracis et lumborum* (LTL) muscles were used for the purpose of these experiments. All muscles were aged for 7 days *post mortem* and all visible fat was removed. To date the use of three different pH meters, a Pork Quality Meter (PQM) conductivity meter, a portable (Miniscan) and benchtop Hunter Lab colour meter (Ultrascan) have been examined. The pH, colour and conductivity measurements were taken in 3 locations along the length (cranial, medial and caudal) and in 3 locations along the width of the muscle (9 sampling locations in total). The pH readings were taken at 2.54 cm intervals along the length of the muscle taking 3 measurements in each steak (typically there were 5 steaks within each location). Conductivity measurements were taken at different fibre directions (parallel and perpendicular), and probe depths (partial (2.5 cm) and full (5 cm) insertion). Similar locations as for pH were considered. The colour measurements were carried out according to the procedure of Strange et al. (1974) after standardising the colorimeters. All colour measurements were recorded at various bloom times, from 1 hour to 5 hours blooming at 4°C; in order to determine the contribution of bloom time to the results after they had been wrapped, immediately following excision in an oxygen permeable PVC wrap. Locational differences were also determined for colour. Three pH meters were used; a glass probe (Orion), an Ion Sensitive Field Effect Transistor (ISFET) solid probe (Sentron), and a glass probe encased in metal (pH Star, SFK). The influence of location on the following quality attributes was also determined; Warner Bratzler shear force (WBSF), driploss, cook loss and sarcomere lengths. WBSF was carried out according to the procedure of Shackelford et al. (1991) using the Instron Model 5543. Driploss was carried out according to Honikel and Hamm (1994) and cook loss was determined by measuring the weight of the steak before and after cooking and then expressed as a percentage of its original weight. Sarcomere length was determined according to the laser diffraction method (Cross *et al.,* 1980).

Results and discussion

The location within the LTL muscle did not significantly influence pH ($P \geq 0.05$) (Table 1). In a study carried out by Paterson (2000) it was noted that there was only small differences in the pH values in different locations along the LD and none of these differences were shown to be statistically significant. The type of probe used had a significant influence on pH readings (Table 2). The Sentron was significantly different ($P \leq 0.001$) from the other two probe types. Steaks analysed for colour are generally left to bloom for 3 hours, but in this experiment colour measurements were recorded at 1, 3 and 5 hours, to monitor the effects of bloom time on the readings. The type of colorimeter (Miniscan and Ultrascan) used had a significant influence ($P \leq 0.01$) on the colour parameters (CIE L* a* and b* values) at 1, 3 and 5 hours bloom time. Brewer *et al.,* (2001) examined two different colorimeters and found that differences between the two meters were attributed to differences in illuminant between and within instrument. The same D65 illuminant was used for both the Miniscan and the Ultrascan. Possible causes for the different readings between the two colorimeters are currently an issue being discussed with the manufacturer. While the bloom times had no significant influence on the L*a*b* values, an interaction between colorimeter and time was observed. Wulf and Wise (1999) reported that bloom time had a lesser effect on the CIE L* value than it has on a* and b* values, although Renerre and Mazuel (1985) indicated that the b* value was not an important indicator of meat blooming. The location at which the colour measurements were taken did not significantly influence (Table 1, $P \geq 0.05$) the colour readings of the muscle. Partial insertion of the PQM into the muscle resulted in higher ($P \leq 0.05$) conductivity readings (13.03mS/cm) than full depth insertion (12.58mS/cm). The direction in which the probe was inserted and the location, at which the measurements were taken, did not significantly effect the conductivity readings. Meat is electrically anisotropic, which means that it's electrical properties change depending on the direction of the electrical field in the sample. It is possible that the anisotropic effects may be more pronounced in the earlier *post mortem* period.

The location at which the WBSF measurements were taken did not have a significant influence (Table 1, $P \geq 0.05$). According to Wheeler (1994) and Wheeler *et al.,* (1996), location within the LD from which the steak was obtained is not critical, as long as the cores are parallel to fibre direction. In this study the location at which the cook loss measurements were taken did not have a significant effect (Table 1, $P \geq 0.05$). The mean cook loss value obtained was 28.21% along the length of the muscle. Location had no effect on driploss (Table 1, $P \geq 0.05$). Cross et al. (1980) state that there is a direct correlation between state of muscle contraction and ultimate meat quality, therefore postrigor sarcomere length is an important indicator of meat toughness (Willems & Purslow, 1996). The mean sarcomere length was 2.02µm and there was no significant difference (Table 1, $P \geq 0.05$) found along the location of the muscle. The compositional analysis of the muscle was relatively uniform. However the moisture and intramuscular fat did vary along the location of the muscle (Table 1, $P \leq 0.05$), but this may not be of practical significance, considering there was very small differences between the average means.

Conclusions

Location had no effect on any of the attributes measured in this trial, i.e. pH, colour, electrical conductivity, WBSF, cook loss, driploss, sarcomere length and compositional analysis. The type of pH meter used had a significant influence on pH readings, the Sentron was significantly different from the other two pH meters. The type of colorimeter used had a significant influence on the colour parameters. The depth of insertion of the conductivity probe significantly influenced the results. On line meat evaluation enables us to integrate laboratory

science with industrial technology when measuring meat quality, rapidly, reliably and realistically. Aided with the knowledge that the location along the LD at which the quality measurements are recorded does not significantly influence the results, should help optimise these measurements.

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Table 1. Mean values of pH, colour, conductivity (cond), Warner Bratzler shear force (WBSF), Sarcomere length (SL), cook loss, driploss, moisture, fat, ash and protein percentages across the cranial, medial and caudal sections of bovine LTL muscle, 7 days post mortem.

	Cranial	Medial	Caudal	s.e.	n
pH	5.67	5.66	5.66	0.07	10
CIE Colour L*	31.58	31.80	31.93	2.54	10
CIE Colour a*	21.54	21.54	22.05	1.47	10
CIE Colour b*	17.79	18.16	18.52	1.66	10
Cond. (mS/cm)	13.34	13.22	12.46	1.81	11
WBSF (N)	44.30	46.80	42.60	5.87	10
SL (µm)	2.02	2.01	2.03	0.08	9
% Cook loss	27.54	28.73	28.37	1.17	10
% Driploss	1.68	1.78	1.84	0.23	10
% Moisture	74.73^{a}	74.84^{a}	74.42^{b}	0.35	11
% Fat	1.85^{a}	1.59^{b}	1.81^{a}	0.22	11
% Ash	1.15	1.13	1.16	0.07	11
% Protein	22.72	22.65	22.76	0.28	11

Different superscripts, within each row, stand for significant differences, P≤0.05. s.e. : standard error.

Table 2. Mean pH values of bovine LTL muscle, at 7 days post mortem measured using a Orion, pH-Star and Sentron meters..

	ORION	pH STAR	SENTRON	s.e.	n
pH	5.72^{a}	5.68^{a}	5.60^{b}	0.07	10

Different superscripts, within each row, stand for significant differences, P≤0.05. s.e. : standard error.