INHERENT SAMPLING VARIABILITY IN QUALITY MEASUREMENTS OF PORK *M. longissimus thoracis et lumborum.*

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Background

The incidence of PSE meat in the Irish pork industry remains a serious problem resulting in economic losses. Therefore the industry is in need of a rapid on-line method of detecting meat quality early *postmortem* prior to further processing. Results to date, suggest pH, electrical conductivity and colour measurements may be useful in the on-line detection of pork quality. If such measurements prove successful, it will be important to provide the meat industry with standard operating procedures. In order to provide the meat industry with such procedures we need to evaluate the inherent sampling variation in these methods. Factors such as location within the muscle, the type of probe used, the depth and direction to which the probe is inserted and the length of time the meat is left to bloom, need to be examined. Although the *m. longissimus thoracis et lumborum* (LTL) muscle is often chosen as a reference muscle to predict the presence of PSE, it is necessary to evaluate possible quantitative differences in electrical, colour and quality parameters within the muscle.

Objectives

The purpose of this study was to determine the inherent variability of pH, conductivity, colour and meat quality attributes within the LTL muscle of pigs. Factors such as location within the muscle, probe sampling procedures and bloomtime were considered.

Materials and Methods

Three different pH probes were assessed; a robust PVC probe with stainless steel tip (Sentron); a glass electrode encased within a stainless steel sleeve (pH-Star) and finally, a glass electrode attached to an Orion pH meter. Conductivity was measured using a Pork Quality Meter (PQM) and the depth and direction of insertion of this two-pronged probe were assessed. pH and conductivity measurements were taken at 2.54cm intervals within the caudal, medial and cranial sections of the LTL muscle and at two locations across the width of the muscle.
Colour was assessed on the CIE L*a*b* scale using a HunterLab Miniscan XE and the % reflectance was determined using an Optostar Meat Colour Gauger. The LTL muscle was cut into 2.54cm chops. To evaluate the effect of 'bloom', instrumental colour was determined at 1,2,3,4 and 5 hours after cutting of a fresh slice.
Driploss was measured along the length of the muscle according to the method of Honikel and Hamm (1994). The percentage cookloss and Warner Bratzler shear force values (Shackelford, 1991) were determined on 2.54cm chops from the caudal, medial and cranial sections of the muscle. Compositional analysis was conducted to determine any variation in intramuscular fat, protein and moisture levels. Sarcomere lengths were determined according to the laser diffraction method (Cross *et al.*, 1980). Following consultation with a statistician, the experimental work was replicated nine times using LTL muscles that had been aged for 4 days post-mortem.

Results

The pH of the muscle did not vary significantly ($p>0.05$) within the different locations along the length (Table 1), or across the width of the muscle, which is in accordance with the findings of Ragland *et al.* (1996). However a study conducted by Lorenzen *et al.* (1991) indicated that there is variation in pH throughout the loin. pH values recorded using the Orion meter with glass electrode (5.61 ± 0.13) (mean ± standard deviation), differed significantly ($p<0.001$, S.E.D.=0.019) from those measurements taken using the Sentron (5.54 ± 0.08) and pH-Star (5.52 ± 0.08) meters.
Enhanced conductivity was observed in the cranial region of the muscle (Table 1). The PQM manufacturers recommend that the probe should be inserted fully, to a depth of 5cm, and that the two tips of the measuring cell should be at right angles to the myofibre direction. It is very important that these recommendations are followed, as this study confirmed that the direction and depth of insertion had a significant ($p<0.001$) effect on the conductivity values obtained (Table 2).
Uniform colour characteristics (CIE L*, a*, b* and % reflectance) were observed throughout the length of the *longissimus* muscle (Table 1). These results are contradictory to those of Lorenzen *et al.* (1991) who reported a variation in CIE L*a*b* values along the muscle. Chizzolini *et al.* (1993) stated that the perception of pork colour by the human eye is influenced primarily by the degree of lightness (L*). The L* value, which is the best predictor of the pink colour of porkmeat (Brewer *et al.*, 2001), increased significantly ($p<0.001$) after 3 hours bloomtime, but did not change with further blooming (Table 3). The redness (a*) of the pork increased ($p<0.001$) up to 3 hours after cutting and then remained constant. The yellowness attribute (b*) only increased significantly ($p<0.001$) after 2 hours blooming. Reflectance values were not influenced by bloomtime.
Intramuscular moisture, fat and protein values did not differ significantly ($p>0.05$) across the caudal, medial and cranial sections (Table 1), showing the consistent composition of the LTL muscle. No significant ($p>0.05$) differences in drip loss or cookloss were detected between the various regions. Lundstrom & Malmfors (1985) in contradiction to these results, found that less driploss occurred in the medial section of the muscle. However Ragland *et al.* (1996) stated that any differences observed in driploss should not be attributed to location within the muscle. Van Oeckel & Warnants (2001) found lower, more favourable, cookloss values in the *longissimus thoracis* (cranial region). In the past as pork longissimus muscle was consider tender not much pork tenderness research has been carried out (Wheeler *et al.*, 2000). In the current study, Warner Bratzler shear values did not vary significantly ($p>0.05$) within the LTL. Van Oeckel & Warnants (2001) reported lower shear force values towards the cranial end of the muscle. Longer sarcomere lengths ($p<0.01$) were observed in the caudal region of the LTL muscle (Table 1). However these differences may not be of practical importance as the variation is extremely small (2.24 to 2.11μm).

Conclusions

The results of this study indicate that there was no significant variation in pH and colour measurements within the LTL muscle. It is advisable that attention is paid to the location at which conductivity measurements are taken, and that the PQM probe should be inserted, to a depth of 5cm, at right angles to the direction of the muscle myofibres. This work also concluded that quality measurements (pH, colour, driploss, cookloss, Warner Bratzler shear force, and composition) are not dependent on location within the muscle. The optimum bloom time for excised chops is 3hours, after which point no significant changes are observed in the CIE L*a*b* and reflectance values. Further work in this area will focus on early post mortem measurements on the carcass.

Pertinent Literature

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Table 1: Mean values for electrical, colour and quality measurements taken in the caudal, medial and cranial sections of the pork LTL at 4 days post mortem.

	Caudal	Medial	Cranial	S.E.D.
PH	5.58	5.54	5.52	0.019
Conductivity (mS/cm)	16.24^{a}	15.59^{a}	17.46^{b}	0.884
Drip loss (%)	2.07	2.35	2.75	0.468
Cookloss (%)	33.28	33.35	33.31	1.825
WBSF (N)	31.5	34.6	32.5	3.41
Moisture (%)	74.58	74.68	74.53	0.256
Fat (%)	0.743	0.499	0.743	0.196
Protein (%)	23.52	23.50	23.72	0.280
Sarcomere length (μm)	2.24^{a}	2.11^{b}	2.07^{b}	0.046
Reflectance (%)	65	67	63	1.964
CIE L*	54.91	53.98	54.65	0.403
CIE a*	8.44	8.81	8.47	0.258
CIE b*	15.74	15.66	15.41	0.164

^{a,b} *Means in the same row with different subscripts are different (p<0.01) S.E.D.: standard error of difference*

Table 2: Mean conductivity values for different PQM insertion methods at 4 days post mortem in pork LTL.

	Partial insertion (2.5cm)	Full insertion (5cm)	S.E.D.
Parallel	12.81^{a}	16.43^{b}	
Perpendicular	14.02^{c}	17.71^{d}	0.511

^{a,b,c,d} *Means in the same row or column with different subscripts are different (p<0.001). S.E.D.: standard error of difference*

Table 3: Effect of bloomtime on colour characteristics at 4 days post mortem in pork LTL.

	Bloomtime					S.E.D.
	1 hour	2 hours	3 hours	4 hours	5 hours	
CIE L*	53.93^{a}	54.28^{a}	54.66^{b}	54.74^{b}	55.02^{b}	0.191
CIE a*	7.88^{a}	8.34^{b}	8.79^{c}	8.95^{c}	8.92^{c}	0.144
CIE b*	14.87^{a}	15.33^{b}	15.75^{b}	16.05^{b}	16.03^{b}	0.159
% Reflectance	62	62	61	60	58	3.70

^{a,b} *Means in the same row with different subscripts are different (p<0.001). S.E.D.: standard error of difference*