THE EFFECT OF THE ANGLE OF INSERTION OF A REFLECTANCE PROBE ON PREDICTION OF PORK MUSCLE QUALITY

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SUMMARY

The reflectance of meat is optically anisotropic, as the angle of illumination of incident light onto the muscle fibre influences measurements of reflected light and muscle colour. This trial was designed to investigate the prediction of ultimate pork quality from reflectance probe measurements on meat at 24h *postmortem* and to compare two methods of probe insertion. Forty-one boned pork loins were selected at 24h *postmortem* to represent a range in quality of the *longissimus thoracis* (LT). The quality measurements made on the LT were pHu, drip loss over 72h and surface lightness (CIE-L*) using a chromameter. The 'Colormet' probe was inserted either from the dorsal surface or into the cranial end of the LT. The loin samples represented a range in meat quality from pale and exudative to dark and dry. The capability of the Colormet probe to predict meat quality measurements was reduced when the probe was inserted dorsally rather than in the cranial end for all quality traits as the coefficient of determination (R^2) was reduced from 0.58 to 0.28 for prediction of pHu ($P<0.001$ for both), from 0.38 to 0.18 for prediction of 72h drip loss ($P<0.001$, $P<0.01$ respectively) and from 0.66 to 0.40 for prediction of surface lightness (L*) ($P<0.001$ for both). These results suggest that the Colormet probe can be used to predict surface lightness and meat pHu with reasonable accuracy if the probe is inserted from the cranial end of the LT but the prediction of surface lightness and pHu using dorsal insertion of the probe was poor as was prediction of drip loss, using either insertion method.

INTRODUCTION

The pig industry has been a leader in the objective measurement of carcass composition and paying on that basis in the animal industry in many countries. Payment on a carcass merit basis has enabled messages to be passed back from the consumer to the processor and producer. There is a demand in the meat industry for payment on preferred meat quality characteristics but this cannot occur until meat quality can be accurately and reliably measured. Lean meat colour is a quality characteristic which is of particular concern to the pig meat processor because consumers are known to discriminate against meat which is excessively pale or dark on visual and organoleptic tests (WACHHOLZ *et al.* 1978; TOPEL *et al.* 1976). The probes developed for measuring meat quality on the intact carcass have utilised the technology of electrical capacitance, electrical transmittance and more recently, fibre optics. The optical anisotropy of meat makes probe placement and orientation a major source of experimental error (SWATLAND, 1989), particularly as the muscle fibres of the *longissimus thoracis et lumborum* (LTL) (the muscle generally used for quality assessments) are arranged at approximately 45° to the vertebral column.

This trial was designed to investigate the efficacy of the Colormet optical reflectance probe for predicting meat quality and the effect of the angle of probe insertion.

MATERIALS AND METHODS

Forty-one boned pork loins were selected at 24h *postmortem* during three visits to a boning room. The loins were selected to represent a range in colour of the *longissimus thoracis* (LT) from pale to dark. The cranial end of the LT, at about the 4th costa, was used to measure surface lightness (CIE-L*) after a 30 min bloom, using a Minolta chromameter CR200b (Minolta Camera Company, Pty Ltd, Japan), and meat ultimate pH (pHu) (Jenco 6009 portable pH meter with automatic temperature compensation and Ionode IJ42 combination spear electrode with intermediate junction). The Colormet reflectance probe (Instrumar Pty. Ltd., Ontario, Canada) was inserted about 4-5cm into the cranial end of the LT and also dorsally, between costae 5 and 7, and the probe lightness value (CIE-L*) was automatically down-loaded onto a portable computer. A 50g sample of the LT was removed, trimmed of fat and epimysium, weighed and suspended in a plastic bag at 4-6° C in a portable refrigerator. On arrival at the meat laboratory, the 50g samples suspended in plastic bags were transferred to a chiller (4° C) and left suspended for an additional 68h. After a total of 72 hours suspension, samples were removed from the bags, blotted dry and reweighed. Means, standard deviations and ranges were determined for all variables and linear regression equations were fitted between each of the meat quality and probe lightness variables. The relationship between drip loss over 72h and probe lightness (L*) was fitted using quadratic, exponential, and log transformations of x (probe lightness).

RESULTS

The loin samples represented a range in meat quality from pale and exudative to dark and dry, as indicated by the range in surface lightness, pHu and drip loss (Table I). The mean surface lightness was higher than the probe lightness. The mean probe lightness was slightly lower when the probe was inserted dorsally rather than into the cranial end of the LT.

The correlations between drip loss over 72h, meat pHu and surface lightness were highly significant (drip loss-pHu, r = -0.63; drip loss-surface lightness, r = 0.63; pHu-surface lightness, r = -0.85; P<0.001 for all).

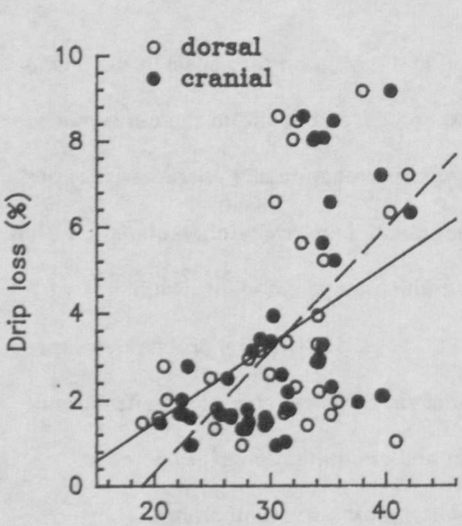

FIGURE 1: Drip loss vs probe lightness

dorsal; y = −2.1+0.2x, R^2= 0.18,

RMS = 5.2, P<0.01;

cranial; y = −5.4+0.3x, R^2= 0.38,

RMS = 4,0. P<0.001.

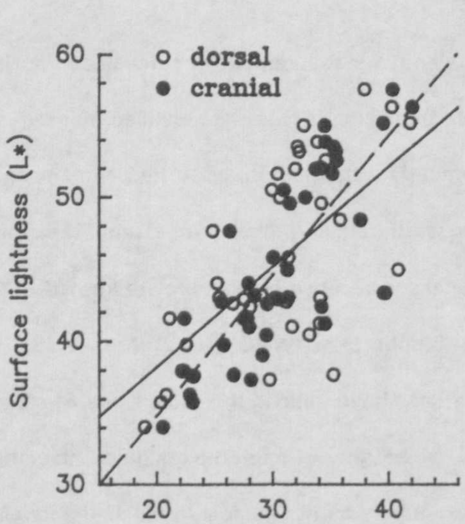

FIGURE 2: Surface lightness vs probe lightness

y = 24.3+0.7x, R^2= 0.40,

RMS = 25.7, P<0.001;

y = 15.4+1.0x, R^2= 0.66,

RMS = 14.8, P<0.001.

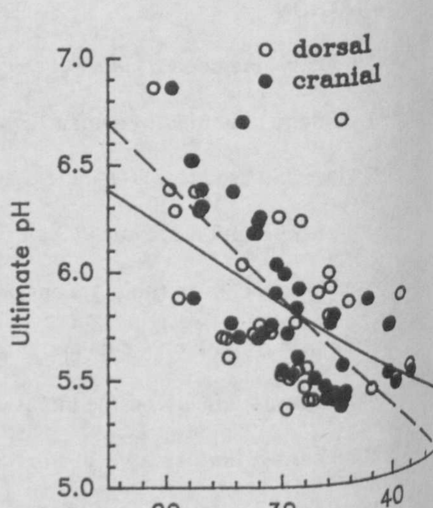

FIGURE 3: Ultimate pH vs probe lightness

y = 6.9 − 3.6x, R^2= 0.28,

RMS = 0.11, P<0.001;

y = 7.5 − 5.5x, R^2= 0.58,

RMS = 0.07, P<0.001.

Table I: Means, standard deviations (SD) and ranges for the quality characteristics of the samples of *longissimus thoracis*

Quality trait	Mean	SD	Range
Ultimate pH	5.83	0.39	5.37 - 6.86
Drip loss (%)	3.6	2.5	0.9 - 9.2
Surface L*	45.3	6.5	34.0 - 57.3
Probe L* -cranial	30.8	5.4	20.5 - 42.1
Probe L* -dorsal	30.4	5.9	18.9 - 41.9

The capability of the probe to predict objective quality measurements was significantly reduced when the probe was inserted dorsally rather than in the cranial end of the LT for all quality traits. Figures 1, 2 and 3 show the relationship between probe lightness, inserted dorsally or from the cranial end, and meat pHu, drip loss and surface lightness respectively. The insertion of the probe from the cranial end produced a higher coefficient of determination (i.e. R^2) and lower RMS (residual mean square) than dorsal probe insertion in all cases. The coefficient of determination for the relationship between 72h drip loss and probe lightness (inserted dorsally or into the cranial end) was low (R^2 = 0.18 and 0.38 respectively) but was not significantly improved by fitting an exponential, log or quadratic equation (results not presented).

DISCUSSION

In each figure it is evident that the prediction of meat quality traits from probe lightness was influenced by the method of probe insertion. There appears to be an increase in error associated with dorsal insertion of the probe, which is most likely caused by an increase in light scatter along muscle fibres. It is unfortunate that dorsal insertion is associated with increased error because the probe is designed for use on the intact carcass and the only accessible sites for probe insertion into the LTL are from the dorsal or ventral surfaces. The angle of illumination onto the muscle fibres differs between dorsal and cranial probe insertion, particularly because the muscle fibres run at 45° to the vertebral column. This experiment was designed to test practical methods of probe insertion and we did not attempt to insert the probe parallel to the muscle fibre orientation. SWATLAND (1988) investigated the interface between optical and muscle fibres and reported that the angle affected light scattering.

Table II shows a selection of results from references which investigated the use of the FOP (fibre optic probe) and Colormet probe. The method of probe insertion was not specified for any of the references given in Table II but dorsal insertion can be assumed for all except MURRAY et al. (1989) as they used intact carcasses. MURRAY et al. (1989) used meat samples but did not specify the angle of probe insertion into the LT. The coefficients of determination we obtained for prediction of surface lightness using cranial insertion of the probe were similar to reports for the FOP but lower than reported by MURRAY et al. (1989) for the Colormet probe. The coefficients of determination that we reported for the prediction of pHu using cranial insertion of the Colormet probe were higher than for the FOP. The results reported here concur with those of MURRAY et al. (1989) as both studies reported a higher correlation between probe measurements and pHu than previously reported for the FOP (Table II). It is not clear if the differences between the FOP and the Colormet in pHu prediction are due to inherent differences between the probes (the Colormet probe measures light reflectance in the visible spectrum over the wavelengths 400-700 nm, at 10 nm intervals, whereas the FOP measures at a single wavelength in the infra-red spectrum, at about 900 nm) or the methods used to insert the probes. In conclusion, these results provide evidence that the angle of insertion of the

Table II: Selected literature reports of the coefficient of determination (R^2) between optical probe measurements and pork muscle quality traits of drip loss, pHu and surface lightness.

Instrument	Surface lightness[1]	Drip Loss[2]	pHu	n	Authors
FOP[3]	0.74	0.61	0.55	76	WARISS et al. (1989)
FOP	0.89	0.64	0.68	55	MURRAY et al. (1989)
FOP	0.67	0.48	0.24	70	EIKELENBOOM and NANNI COSTA (1988)
FOP	0.74	0.52	0.14	53	SOMERS et al. (1985)
Colormet	0.91	0.53	0.65	55	MURRAY et al. (1989)
Colormet	0.67	0.35		72	KAUFFMAN (unpublished results)

[1] The surface lightness was measured using different machines, and was given as L*, Y, or EEL value.

[2] Drip loss was assessed by suspension at 2-4°C in all studies but the time varied from 24h to 48h.

[3] FOP = fibre optic probe

Colormet reflectance probe influences the accuracy of prediction of ultimate pork lean quality. The Colormet probe can be used to predict surface lightness and meat pHu with reasonable accuracy if the probe is inserted from the cranial end of the LT but the prediction of meat lightness and pHu using dorsal insertion of the probe was poor as was prediction of drip loss, using either insertion method. Investigation of probe insertion angle into other muscles would be desirable.

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