THE USE OF NEAR INFRARED REFLECTANCE SPECTROSCOPY TO ASSESS TENDERNESS, COLOUR AND pH IN LAMB LONGISSIMUS MUSCLE

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Background

The quality of meat and meat products is highly variable in many properties. Of all quality factors in meat cuts, tenderness is frequently rated as being the most important factor for the consumer (Hildrum et al., 1995). The actual techniques and methods to determine tenderness, colour and pH are extremely time consuming, expensive and destructive. Near infrared reflectance spectroscopy (NIRS) determine the structural makeup and predicts the quality of different products by measuring how its absorbs near infrared light. NIRS is a consistently reliable and rapid alternative to traditional wet chemistry. This method seems to be a promising technique to assess organolepctic properties in meat (Hildrum et al., 1995; Park et al., 1998).

Objectives

The aim of this study was to investigate the use of NIRS for the assessment of tenderness, pH and colour on intact lamb muscles.

Materials and Methods

Muscle Longissimus dorsi was removed after slaughter from 170 Corriedale breed of lambs (mean live weight: 26 kg, range 20 - 40). Samples were packed in polyethylene bags and stored in a conventional freezer (temperature -20 ^{0}C). The pH was measured on intact cuts by using an inserting combined electrode. The colour of meat samples was analysed using CIE *L* (lightness), CIE *a* (redness), CIE *b* (yellowness) system using a colorimeter (Minolta, Japan). Tenderness of samples was determined by Warner Bratzler peak shear force as reference method on fresh/thawed samples after cooking/grilling of the meat. Samples were scanned intact in a NIRS monochomator instrument between 400 – 2500 nm (NIRSystems 6500, MD, USA). The mathematical treatments and predictive equations were developed using ISI software (ISI 3.1, USA). Intact samples were scanned in a rectangular cup (100 mm x 50 mm) approximately 15-mm thickness. Reflectance data were stored as log (1/R) (where R: reflectance) at two nm intervals. Predictive equations were developed using modified partial least squares (MPLS) regression (Shenk and Westerhaus, 1993) with internal cross-validation (NIRS 2, 1995) and scatter correction using Standard Normal Variate (SNV) and detrend transformations (Barnes et al., 1989). Cross validation was used to avoid overfitting of the equations. Calibration statistics calculated included the standard error of calibration (SEC), the coefficient of multidetermination in calibration (R^2_{CAL}), the standard error of cross validation (SECV) and the coefficient of determination in cross validation (R^2_{VAL}) (Shenk and Westerhaus, 1993). The optimum calibrations were selected based on minimising the standard error of cross validation (SECV).

Results and Discussion

Table 1 shows the NIRS calibration statistics for organoleptic properties on lamb muscle samples. The models were accurate for CIE *L* 0.92 (SECV: 0.9), CIE *a* 0.86 (SECV: 0.86), CIE *b* 0.87 (SECV: 0.5) and pH 0.93 (SECV: 0.07), respectively. On the other hand poor coefficient of determination in calibration were found for tenderness 0.35 (SECV: 0.90). Shear force did not correlate well with NIRS. Figures 1 and 2 illustrated the relationship between NIRS predicted values for the calibration set and chemical data for pH and shear force, respectively. The more accurate the predictive equation, the more closely all points cluster near the theoretical 1:1 (solid line) correspondence. It was not clear if the information in the near infrared spectra that relates with tenderness could be useful to practical determination of lamb tenderness.

Conclusions

The experiment showed that NIRS gave a fast and good estimate of colour parameters (CIE *L, a* and *b*) and pH on intact lamb muscles. Tenderness gave poorest NIRS calibration statistics. Further work will be done to improve the accuracy of the tenderness prediction.

References

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Table 1. NIRS calibration statistics for organoleptic characteristics on intact lamb muscle samples.

	mean	SD	N	SECV	R^2_{cal}
pH	5.8	0.2	134	0.07	0.93
CIE L	33.8	2.6	160	0.9	0.92
CIE a	17.5	1.3	156	0.6	0.86
CIE b	6.2	1.2	164	0.5	0.87
WBSF	3.1	1.0	165	0.9	0.35

SD: standard deviation; n: number of samples used to built the calibration models; SECV: standard error in cross validation; R^2_{cal}: determination coefficient of calibration.

Figure 1. NIRS predicted data versus actual data for pH in lamb muscles.

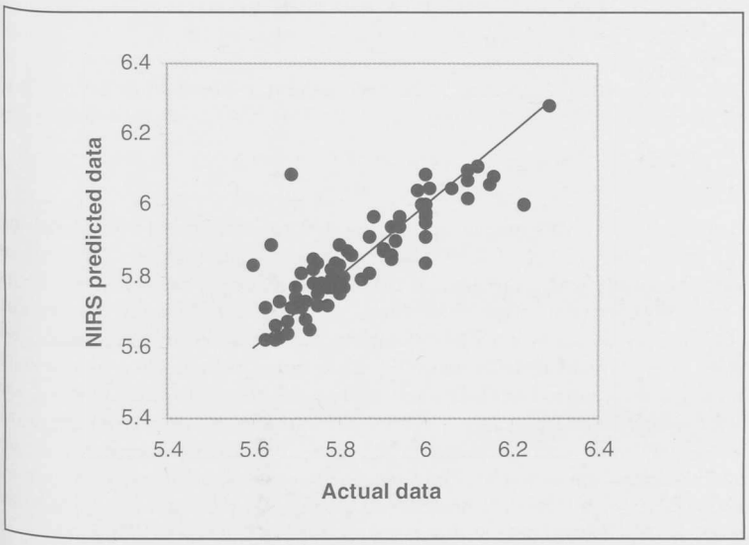

Figure 2. NIRS predicted data versus actual data for shear force in lamb muscles.