NEAR INFRARED SPECTROSCOPY AS A MEAT QUALITY INDICATOR

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OBJECTIVES

Recent work by Hildrum *et al.* (1995) on the use of near infrared spectroscopy (NIR) for the prediction of beef sensory properties achieved promising results using spectral data between 1100 and 2500nm. The objective of this study was to investigate the use of near infrared spectroscopy in the wavelength range 750-1100nm, for the prediction of selected meat quality attributes.

BACKGROUND

One of the biggest problems inherent in the beef industry today is the high variability of its product. The texture of meat is of utmost importa to consumer acceptance; therefore in order to remain competitive, the meat industry must be able to produce a product, the quality of which high and consistent. There are numerous reports on methods for measurement of meat tenderness (Lepetit and Culioli, 1994). However, most destructive and time consuming. A need for the development of efficient, non-destructive and accurate methods for assessing meat tenderne therefore exists. Since its first application to grain analysis about 30 years ago, near-infrared reflectance (NIR) spectroscopy has been us successfully for a long time in several fields of food and feed analysis (Ben Gera and Norris, 1968; Law and Tkachuk, 1977; Duvenage, 19 Its main use so far has been in the analysis of chemical composition of foods, as it allows for a rapid and non-destructive quantification of ma food components (Osborne and Fearn, 1986). In recent years however, applications of NIR for the prediction of functional properties and qual attributes in foods have emerged (Downey *et al.*, 1990; Siriex and Downey, 1993; Beck *et al.*, 1991). Various workers have demonstrated hig correlations between NIR spectra and various quality attributes (Hildrum *et al.*, 1995; Mitsumoto *et al.*, 1991; Beck *et al.*, 1991), showin promise for NIR as a meat quality indicator.

EXPERIMENTAL METHODS

Heifers (n=39) of similar age, size and grade were used. Following excision of the *longissimus dorsi* (LD) muscle at 1 day *postmortem*, sampl (2.5cm thick) were taken for NIR analysis (NIR 6500 system with fibre optic interactance probe attachment (CAMO A/S, Norway)) at 1, 2 and 14 days *postmortem.* Data analysis was performed in the THE UNSCRAMBLER software (version 5.33). Partial least squares (PL regression analysis was used for predicting beef quality characteristics from NIR spectra; no data pre-treatments were applied. Samples wer taken at 2, 7 and 14 days *postmortem* for measurement of Warner Bratzler shear force (WBSF) measured with a Universal Instron testin machine (Shackelford *et al.*, 1991), cookloss, colour (Strange *et al.*, 1974) and sensory analysis (American Meat Science Association Guidelin (AMSA) 1978). Driploss determination was carried out 2 days *postmortem.*

RESULTS AND DISCUSSION

The value of NIR spectra as predictors of meat quality was investigated by attempting to predict quality attributes measured at 14 da *postmortem* from spectra measured at 1 and 2 days *postmortem*. Correlation coefficients (r) and standard errors of prediction (SEP) obtained shown in Table 1. The prediction of WBSF, Hunter L and b colour values, cookloss and sensory juiciness from 1 day NIR spectra yielded hig correlation coefficients as shown in table 1. SEP values were also quite low in most cases showing promise for use of NIR as an indicator meat quality. Although correlations were lower for the prediction of sensory tenderness and texture, with further work this relationship may b improved thereby allowing NIR to predict meat quality more accurately. The prediction of the quality attributes from 2 day spectra generall yielded weaker or unchanged correlations.

Table 1 : Correlation coefficients (r) and standard errors of prediction (SEP) between 1 and 2 day NIR spectra and various selected meat quali characteristics measured at 14 days *postmortem.*

Quality characteristics (14day)	1day spectra		2day spectra	
	r	SEP	r	SEP
Warner Bratzler shear force	0.79	0.53	0.40	0.79
Hunter L value	0.90	0.98	0.75	1.46
Hunter a value	0.23	1.66	0.19	1.68
Hunter b value	0.99	0.10	0.83	0.73
Cookloss	0.63	2.00	0.75	1.73
Tenderness	0.41	0.59	0.46	0.58
Juiciness	0.63	0.61	0.46	0.70
Flavour	0.21	0.28	0.25	0.28
Texture	0.39	0.28	0.42	0.28
Acceptability	0.21	0.33	0.34	0.32

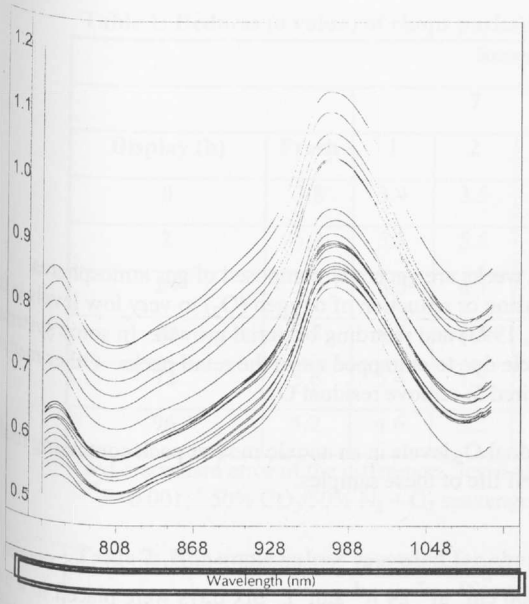

Figure 1: Typical meat reflectance spectra collected via surface interactance fibre optic probe

Correlations obtained in this study are similar to those of Hildrum *et al.*, 1995, who reported values of 0.58 and 0.47 for sensory tenderness and juiciness respectively as compared with 0.41 and 0.63 obtained in this study. Mitsumoto *et al.* (1991) demonstrated a high correlation (r=0.80) between WBSF and NIR measured using a fibre optic attachment and spectral data between 680 and1235nm, which is similar to the wavelength range (750-1100nm) used in this study. This relationship is similar to that achieved for 1 day spectra in this study (r=0.79). A markedly lower correlation (r=0.40) was achieved for 2 day spectra, the reason for which is unknown. Beck *et al.* (1991) demonstrated a high relationship between the Minolta L* value (r=0.93) and NIR spectra which is similar to the correlation coefficients (r=0.90 and r=0.75) achieved in this study between Hunter L colour values and NIR spectra taken at 1 and 2 days respectively. Overall, the results of this study demonstrate similar relationships between NIR spectra and various quality attributes as previously published results have shown.

CONCLUSION

NIR spectra collected at various times *postmortem*, particularly at 1 day, showed good potential for predicting meat quality at 14 days *postmortem*. High correlations with Warner Bratzler shear force, Hunter L and b colour values, cookloss and sensory juiciness were obtained. Weaker relationships were achieved for sensory tenderness and texture and 2 day spectra produced less accurate models than 1 day spectra. These results indicate that NIR could be a useful technique in predicting meat quality and may replace costly and time consuming chemical analysis. Further work is required, however, before NIR can be established as a reliable, on-line meat quality indicator. This could involve variation of sample prediction and/or chemometric procedures used in model development.

REFERENCES

BECK, G., DURR, R. and EICHINGER, H. 1991. Proc. 37th ICoMST, 1:7, 44.
BEN GERA, I. and NORRIS, K.H. 1968. J. Food Sci., 33, 64.
DOWNEY, G., ROBERT, P., BERTRAND, D. and KELLY, P.M. 1990. Applied Spectroscopy 44, 150-155.
DUVENAGE, E. 1986. J. Food Sci. Agric., 37, 384.
HILDRUM, K.I., ISAKSSON, T., NAES, T., NILSEN, B.N., RODBOTTEN, M. and LEA, P.1995. Journal of Near Infrared Spectroscopy 3, 81-87.
LAW, D.P. and TKACHUK, R.1977. Cereal chem., 54, 256.
LEPETIT, J. and CULIOLI, J. 1994. Meat Sci., 36, 203-208.
MITSUMOTO, M., MAEDA, S., MITSUHASHI, T. and OZAWA, S. 1991. J. Food Sci., 56, 1493-1496.
OSBORNE, B, G. and FEARN, T. 1986. Near Infrared Spectroscopy in Food Analysis, Longman Science and Technology, Harlow, Essex.
SHACKELFORD, S.D., KOOHMARAIE, M, MILLER, M.F., GROUSE, J.D. and REAGAN, J.O. 1991. J. Anim. Sci. 69, 171.
SIRIEX, A. and DOWNEY, G. 1993. Journal of Near Infrared Spectroscopy 1, 187-197.
STRANGE, E.D., BENEDICT, R.C., GUGGER, R.E., METZGER, V.G. and SWIFT, C.E. 1974. J. Food Sci. 39, 988-922.