ASSESSMENT OF BEEF QUALITY TRAITS FROM YOUNG MALE DAIRY CATTLE USING NEAR INFRARED SPECTROSCOPY

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Abstract –This study aims to evaluate the potential of near infrared spectroscopy (NIRS) to assess physico-chemical quality traits of beef from young male dairy cattle. Samples were collected from three muscles (LT: *longissimus thoracis,* ST: *Semitendinosus* and GM: *gluteus medius*) and two sexes (bulls and steers). Wavelength of 400-1900 nm was used for calibration. R^2C of 0.41, 0.42 were obtained for prediction of WBSF after ageing for 7, 14 days, respectively. R^2C of 0.57, 0.49 for cook loss of day 7, 14, respectively. R^2C of 0.54, 0.42 for intramuscular fat (IMF), soluble collagen content, respectively. The results showed NIRS offered the potential for the development of rapid and non-destructive methods for the prediction of quality traits of this type of beef.

Key Words –Vis-NIR spectra, partial least squares regression (PLSR), physico-chemical quality traits

I. INTRODUCTION

The number of male calves from the Irish dairy herd has markedly increased following the abolition of EU milk quotas in 2015. This is a potential new resource for the industry if they can be reared economically to produce meat of acceptable eating quality. Although several conventional methods have been widely used to assess beef quality, including instrumental analysis, chemical analysis, and sensory evaluation, they are often time-consuming and expensive [1]. In contrast to conventional methods, near infrared spectroscopy (Vis-NIRS) is a promising technique for the determination of meat quality parameters because it is fast, sensitive, non-destructive and allows low cost predictions of numerous traits [2].

II. MATERIALS AND METHODS

Samples were collected from three muscles (LT: *longissimus thoracis,* ST: *Semitendinosus* and GM: *gluteus medius*) and two sexes (bulls, steers) of young Holstein-Friesian (HF) and Jersey × Holstein-Friesian (JEX) cattle. Spectra were collected from PVC clingfilm wrapped fresh intact steak samples (day 3) using a benchtop instrument (Model 6500, NIRSystems. Inc., Maryland, USA) in reflectance mode. The spectra were averaged from two scans using a New Bulb Brick with each surface for one replication. Unscrambler software v.10.3 (Camo, Trondheim, Norway) was used for data-pretreatments of standard normal variate (SNV), and Savitzky-Golay algorithm (2nd derivative with 2nd polynomial and 21 smoothing points). Warner Bratzler Shear Force (WBSF, Instron Universal Testing Machine Models 5543) and cook loss were determined on cores taken from steaks cooked in a water bath at 72 ºC to a core temperature of 70 ºC. IMF content of thawed minced beef samples was measured using the NMR Smart Trac rapid Fat Analyser (CEM Corporation, USA). Soluble collagen content was measured using a Waters Acquity UPLC system with an ACQUITY UPLC@BEH C18 (50 mm × 2.1 mm, particle size 1.7 µm).

III. RESULTS AND DISCUSSION

Prediction results (Table 1) of WBSF and cook loss were in agreement with others [1] [3]. However, the prediction ability of WBSF was worse than previously reported [4]. The low variability in the reference data (CV < 10) could explain the limited prediction ability for cook loss. The prediction accuracy for IMF content was moderate (R^2C = 0.54) but lower than reported by others using minced samples which would be more homogeneous than the intact samples used in this study (R^2C of 0.76-0.99) [4] [5]. The unsatisfactory prediction result for collagen content agrees with those reported by others [5].

Mean NIR spectra differences were detected for very tender (WBSF-d14 < 31.36 N) or tough (WBSF > 45.08 N) samples between 1450-2400nm (Figure 1a). Tough beef had higher absorbance than tender beef, in accordance with

others [3]. Beef samples with low IMF content (< 3%) had an overall higher absorbance than that those with higher IMF content (> 5%) (Figure 1b), probably due to increased light scattering from the fat.

Table 1 Description of laboratory reference values and statistics of prediction models (partial least squares regression PLSR) for physico-chemical quality traits of beef from young male dairy cattle.

Spectral Data	n	Range	Mean	CV	Loading	R^2C	RMSEC	RMSECV	RPD
WBSF-d7 (N)	166	19.2-75.4	41.9	30.1	5	0.41	9.66	10.8	1.17
Cook loos-d7 (%)	166	22.4-37.0	30.7	9.33	7	0.57	1.86	2.12	1.35
WBSF-d14 (N)	166	18.8-79.0	39.0	33.2	5	0.42	9.83	10.8	1.20
Cook loos-d14 (%)	166	23.7-39.4	31.6	9.45	6	0.49	2.13	2.33	1.28
IMF (%)	221	0.05-9.77	2.33	79.4	7	0.54	1.25	1.33	1.39
Soluble collagen (mg/g)	141	0.21-1.80	0.64	46.9	6	0.42	0.23	0.25	1.20

n = number of samples; CV = coefficient of variation; WBSF = Warner-Bratzler shear force; IMF = intramuscular fat.
R^2C = the coefficient of determination on calibration; RMSEC = root mean square error of calibration; RMSECV = root mean square error of cross-validation; RPD = ratio performance deviation calculated as SD/RMSECV.

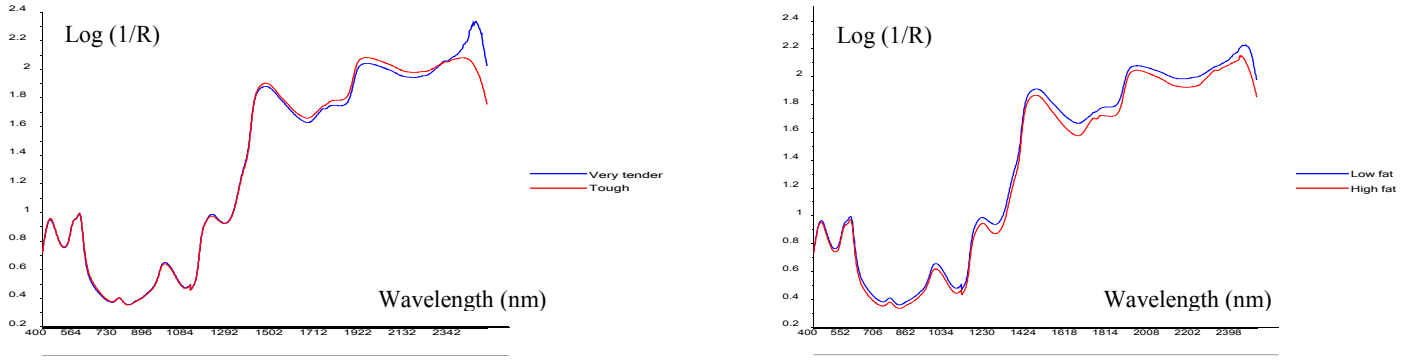

Figure 1 Averaged raw NIR spectra (full range 400-2500nm) from beef with high and low WBSF (a) and IMF% (b).

IV. CONCLUSION

Prediction results for WBSF and cook loss did not significantly change during ageing. Although the prediction ability of physico-chemical traits from intact samples was only moderately high, the present findings suggest that Vis-NIR (400-1900 nm) might be used for monitoring or screening purposes to assess some quality traits where rapid and non-invasive methods are required.

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