Application Note 101: Determination of Chemical Lean in Raw Meat Samples

1. Introduction

1.1Background.

The use of Near Infrared Transmission (NIT) spectroscopy in for the determination of fat quantity (Chemical Lean) in meat is a well-established process[1]. Recent literature has investigated the effects of sample processing on spectral data[2] and also the determination of protein and moisture non-destructively using reflectance spectroscopy[3].

This report outlines the preliminary studies performed in order to calibrate a 38-element silicon diode array NIR spectrometer for the determination of chemical lean in homogenised meat samples. This research was carried out in conjunction with Rockdale Beef Company with the following aims.

1.2 Aims

1) To develop a sampling method which produces a high level of repeatability and reproducibility for a variety of users.
2) To calibrate the NIT-38 NIR analyser to measure Chemical Lean in meat samples to an accuracy comparable to the current method used.
3) To evaluate the performance of the analyser for the measurement of Meat Meal constituents.

1.3Instrumentation and Sampling Procedures

1.3.1 The NIT-38 analyser and Squeeze Cell

The instrument used in this study was an NIT-38 NIR Transmission analyser (NIR Technology Australia) with an automatic sample transport. The instrument scans the wavelength region 720-1100nm at a resolution of 10nm.

The suggested sampling device was a cell with an elongated sample window of 10mm pathlength. The cell was hinged (squeeze cell) to allow a meat sample to be placed in the centre of the glass and the lid could be closed to provide an even distribution of sample in the cell.

1.3.2 Sample Preparation

The meat samples obtained were placed in a heavy-duty homogeniser and processed for a specific time to provide uniformity in sample presentation. Approximately 80g of the sample was placed in the centre of the cell and the lid brought down to enclose the sample. Any excess sample was removed from the

edges to allow the cell to close completely without any pressure. If too little sample was presented, more was added to fill the gaps.
The sample was then scanned on the NIT-38 analyser, 5 sub-scans per analyses and the average of these scans was presented as the final result. The spectral data was saved on the instrument and was uploaded at the completion of the study for calibration purposes.

1.4 Reference Methods.

The current method used for the determination of chemical lean requires the homogenisation of a meat sample in the heavy duty processor and weighing out two subsamples into separate beakers. The samples and beakers were weighed on a balance accurate to two decimal places. The samples were covered with a porous lid and placed in a microwave oven on high for 3 minutes.

The samples were reweighed and the mass difference calculated. This value was then referred to a correction table where the chemical lean was determined. The NIR method will hopefully reduce the number of steps and hence time for the measurements.

1.5 Spectral Data.

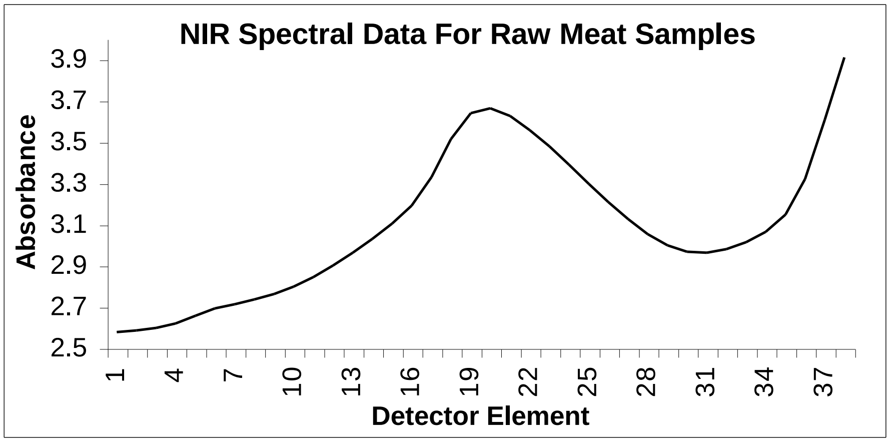

Figure 1: NIR spectrum of a raw meat sample.

Figure 1 shows the spectral characteristics of a meat sample. The large peak a around detector element 20 corresponds primarily to moisture content, therefore by monitoring this region of the spectrum, results corresponding to the microwave technique should be able to be calibrated for, as this method calculates chemical lean based on moisture loss.

2. Results.

2.1 Preliminary Calibration Results

The spectral data from the instrument was uploaded, the laboratory data was added to this and a Partial Least Squared (PLS) regression was performed on the data with no pre-treatment. Table 1 provides a summary of this data along with statistical analysis and figure 2 shows the predictive ability of the calibration.

Table 1: Calibration statistics for the determination of chemical lean in meat samples (no data pre-treatment).

	n	*Outliers*	Range (%)	PC's	Calibration		Prediction	
					R	SEC (%)	R	SEP (%)
Raw Meat	790	60	55-95	7	0.93	1.99	0.93	2.01

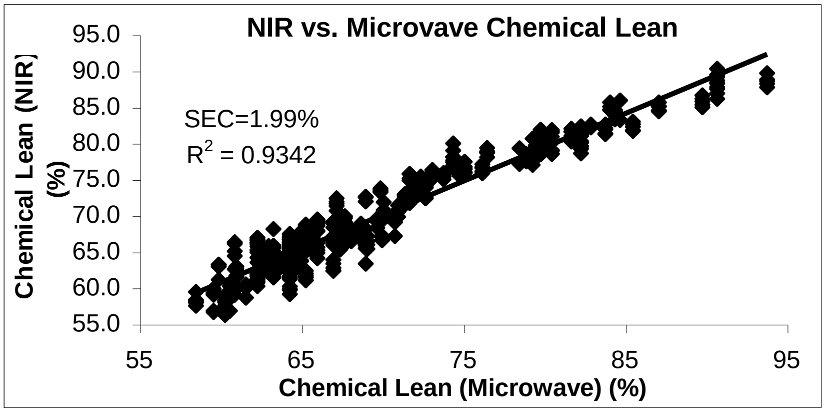

Figure 2: Predicted vs. measured chemical lean in raw meat (no data preprocessing).

It is apparent from figure 2 that there is a considerable degree of curvature in the model, R=0.93. The standard error of calibration SEC is around 2%, giving it comparible accuracy to the microwave method. If the data is separated in two and recalibrated so that one calibration measures between 55-75% CL and the second between 75-95% CL, the calibration and hence predictive statistics improve significantly.

The development of two calibrations though is not the desirable practice. According to Naes and Issakson, data pre-processing with a multiplicative scatter correction (MSC) followed by regression, should lead to a more linear calibration. Table 2 and figure 3 provide a summary of the results obtained for this calibration.

2.1.2 Multiplicative Scatter Corrected, PLS Calibration.

Table 2: Calibration statistics for the determination of chemical lean in meat samples (MSC pre-treatment).

					Calibration		**Prediction**	
	n	***Outliers***	**Range (%)**	**PC's**	**R**	**SEC (%)**	**R**	**SEP (%)**
Raw Meat	790	60	55-95	5	0.97	1.48	0.97	1.45

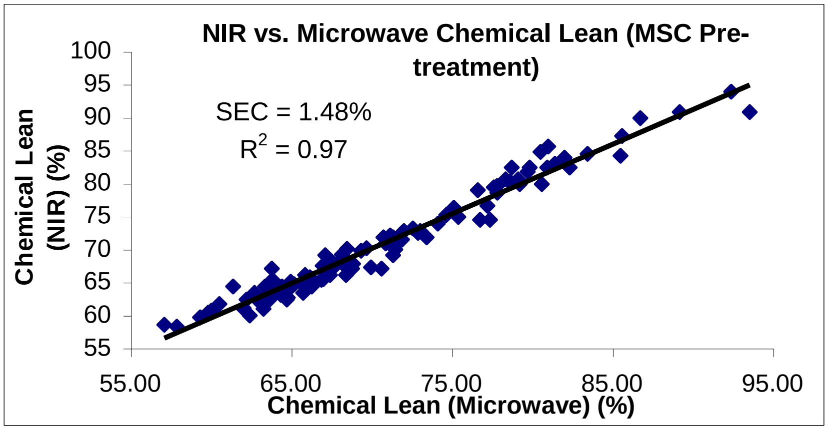

Figure 3: Predicted vs. measured chemical lean in raw meat (MSC pre-processing).

Application of MSC improves the calibration in all aspects. Figure 3 shows the calibration is now more linear and the SEC is now 1.48%. The other point to notice about this model is that it required less principal components (PC's) to describe the system. This reduces the likelihood of the model over-predicting future samples and also from becoming unstable.

3. Conclusion.

From the data obtained from this study, the determination of chemical lean in raw meat samples using the NIT-38 analyser is possible and a reproducible sampling technique has been developed. The standard error of calibration (i.e. accuracy) of the calibration is 1.48%, which is the level required for these measurements.

The results of the meat meal calibration will be presented in another document as the results have not been obtained yet.

4. References.

1) Naes, T. and Isaksson, T. *Applied Spectroscopy*, **1992**, *46*, 34-43.
2) Windham, W.B., Barton, F. E. and Lawrence, K. C. *Leaping Ahead with Near Infrared Spectroscopy*, Ed Batten, G. D., Flinn, P. C., Welsh, L. A. and Blakeney, A. B. **1995**, pp 287-290.
3) Kim, Y. B. and Yoo, I. J. *Leaping Ahead with Near Infrared Spectroscopy*, Ed Batten, G. D., Flinn, P. C., Welsh, L. A. and Blakeney, A. B. **1995**, pp 297-299.