Near Infrared Transmission Spectroscopy of High Fat/Moisture Foods

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Introduction:

Near Infrared Transmission (NIT) Spectroscopy might be overlooked by many users because most NIR reflectance analysers are not optimized for the 3rd overtone region of the NIR spectrum or just do not cover this region.. However for many food products, NIT spectroscopy offers an excellent means of analyzing high fat/high water content samples that are very difficult to measure using diffuse reflectance. This paper discusses the applications of NIT for the food industry.

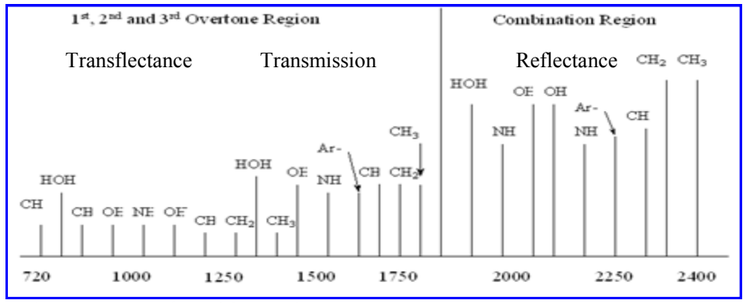

Figure 1. Near Infrared Spectral Range

3 Spectral Regions:

Figure 1 shows the wavelength range from 700 to 2500nm . Within the NIR spectrum, there are three regions: Transflectance 700-1100nm , Transmission 1000-1800nm, Reflectance 1800-2500nm. The 3rd overtone region, i.e., Transflectance, is the optimum s pectral range for measuring grains and high fat/high moisture samples. In this region, sample cells with pathlengths of between 5 and 50mm can be used to collect NIT spectra of dense and non homogenous materials such as grains, meat, dairy products and others. Figures 2 shows a schematic of how light is propagated through dense samples.

NIT Spectra of High Fat/High Moisture Foods:

Figures 3 and 4 show the NIT spectra of a dairy product and processed meats. The absorbance for these type of samples ranges between 2 and 4 Abs units. The advantage of transflectance over reflectance for these sample lies in the ability to increase the pathlength and thereby to optimise the spectra and increase the sensitivity.

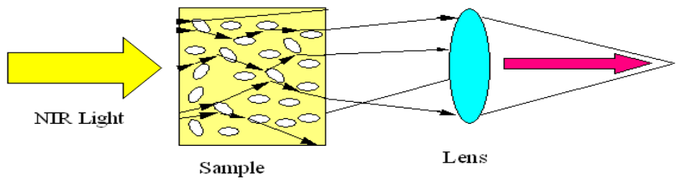

Figure 2. Near Infrared Transflectance Process

The second advantage comes from the fact that the light passes right thru the samples, thus the spectra represent the whole sample, not just the surface which are effected by separation of water and fat layers and sample compaction.

Procedure:

Butter Milk Mix: 379 samples of Butter Milk and Milk mixtures were scanned on a Series 3000 Food Analyser, NIR Technology Systems, Australia, using a 10mm pathlength cuvette. Each sample was analysed for fat and water content. Partial Least Squares (PLS) regression analyses were performed on the spectra to develop calibration for fat and water. Figure 5 and 6 show the calibration plots. The calibration statistics are show in table 1.

Table 1:	Constituent	SEC	R2
	Fat	0.14%	0.988
	Water	0.13%	0.990

Processed Meats: 27 samples of processed meat mixes, i.e., salami, pepperoni, Danish salami etc, were scanned using a 10mm pathlength squeeze cell in a Series 3000 Food Analyser, NIR Technology Systems, Australia. 10 spectra were collected for each sample of meat. Each sample was analysed for fat and moisture. Partial Least Squares (PLS) regression analyses were performed on the spectra. Figures 7 and 8 show the calibration plots for fat and moisture. Table 2 shows the calibration statistics.

Table 2:	Constituent	SEC	R2
	Fat	0.7%	0.999
	Moisture	0.8%	0.991

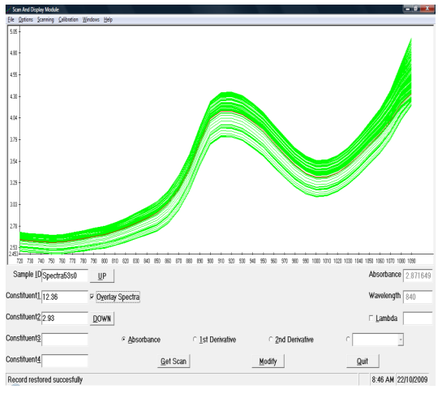

Figure 3. NIT Spectra of Butter Milk Mixes

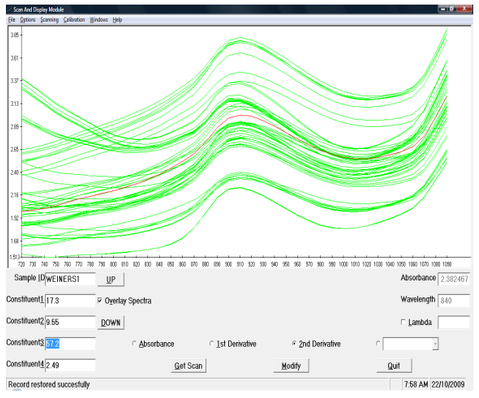

Figure 4. NIT Spectra of Processed Meats

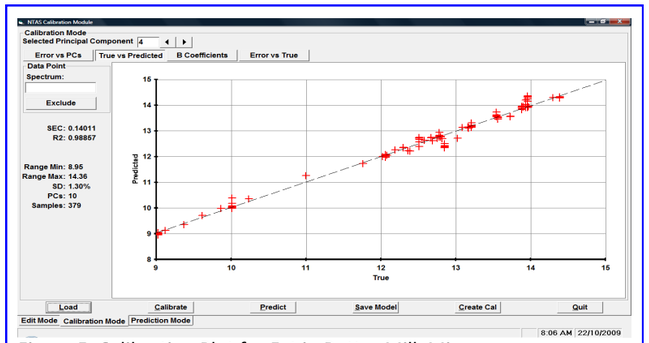

Figure 5. Calibration Plot for Fat in Butter Milk Mixes

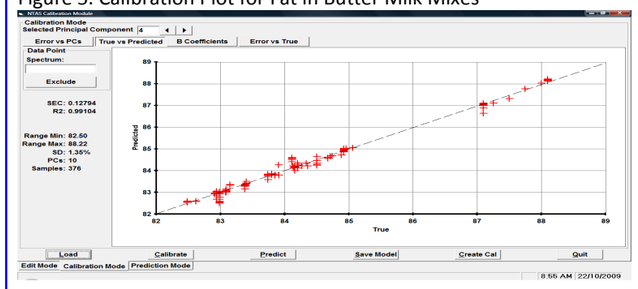

Figure 6. Calibration Plot for Water in Butter Milk Mixes

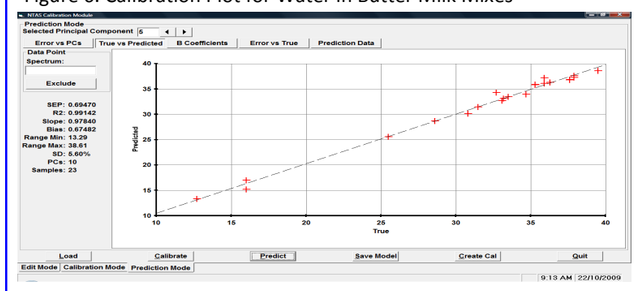

Figure 7. Calibration Plot for Fat in Processed Meats

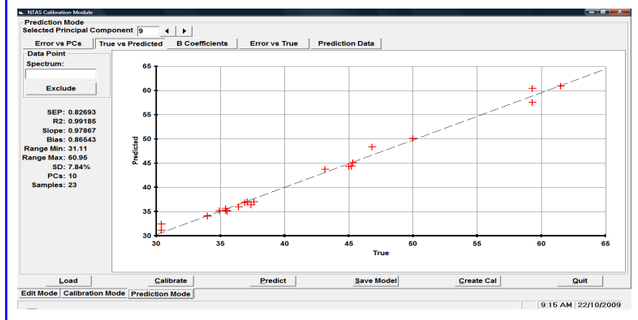

Figure 8. Calibration Plot for Moisture in Processed Meats

Discussion:

Near Infrared Transmission spectroscopy offers an excellent means of measuring high fat /high moisture content foods. Where as diffuse reflectance spectra of high moisture content materials saturate, i.e., all the energy is absorbed above 1900nm, transflectance spectra provide strong absorbance bands for moisture and fat. As well, transflectance spectra represent the whole sample not just surface layer. Excellent linearity over a wide concentration range can be achieved with transflectance spectra and the pathlength can be varied to optimise the measurement.