Application Note 47: NIR analysis of parameters in Flour Moisture, Water Absorption, Development, Stability, Ash, Starch Damage, Maltose.

Introduction:

NIR spectroscopy measures three chemical bonds, ie, O-H, N-H and C-H. In natural products such as wheat, barley, flour etc, these three bonds can be used to measure Water, Protein and Fat, respectively. Other physical properties and chemical compounds can also be measured in the NIR spectral region, however these measurements still rely on some correlation with one or multiple of these three bonds.

Protein and Moisture in flour are routinely measured using NIR Diffuse Reflectance instruments for at least 30 years. It has recently been demonstrated that NIR Transmission instruments can also measure protein and moisture in flour. However the ability to measure other parameters, such as, Water Absorption, Development, Stability, Ash, Starch Damage and Maltose is not yet established.

This study, although preliminary, shows the feasibility of making such measurements.

Description:

10 Samples of flour were scanned in duplicate using a NIR Technology Australia Cropscan 2000B and Powder Cell. The spectra of the samples are shown in figure 1.

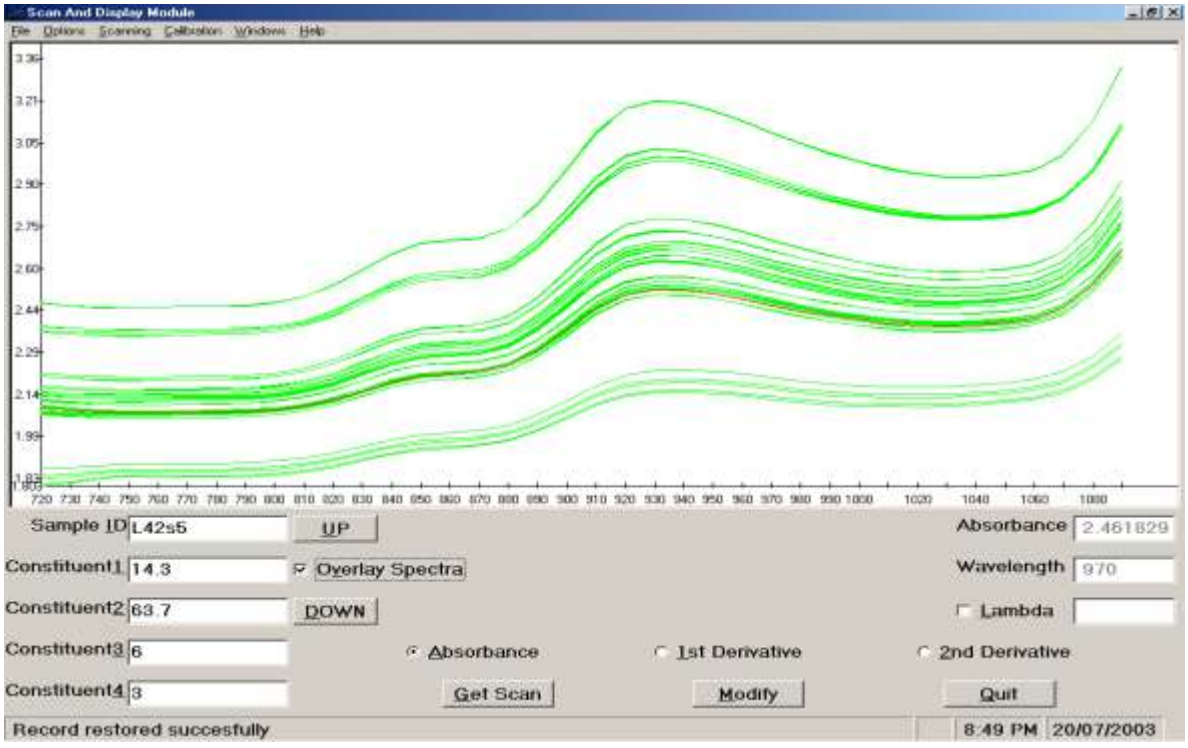

Figure 1. Plot of NIR spectra of Flour

The NIR spectra were regressed against the seven parameters suing NTAS(NIR Technology Australia Software). Partial Least Squares calibrations were developed for each parameter.

Results:

Figure 2. shows the regression plot for Moisture. As would be expected, this parameter can be easily measured. The range of moisture concentrations for these samples is very narrow and as such, the calibration model would not likely be suitable for other samples with lower and higher moisture content. NIR Technology Australia already has a calibration

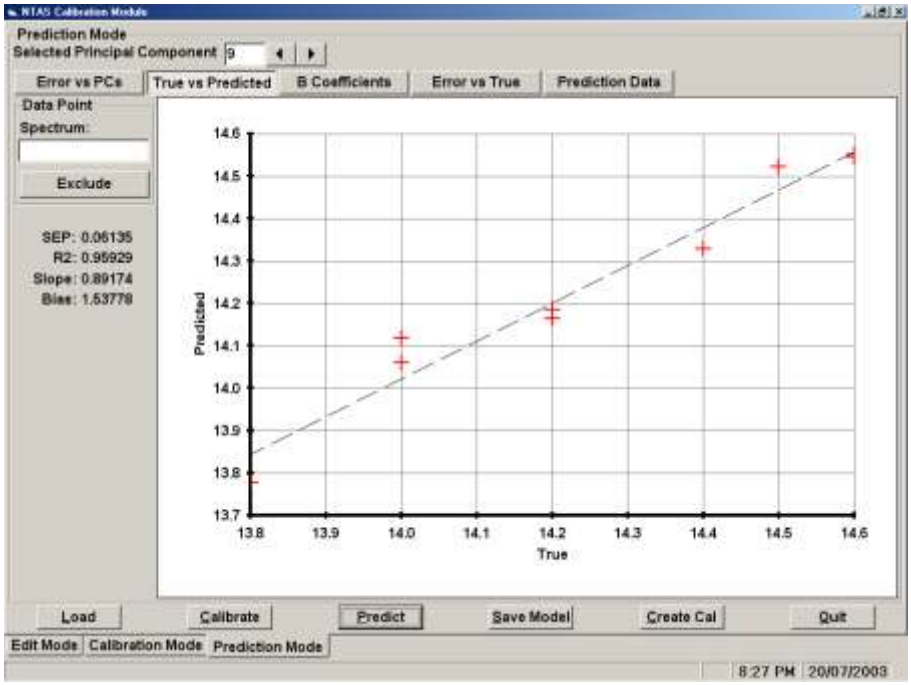

Figure 2. Plot of NIR Moisture vs Ref Moisture

Figure 3. Shows the regression plot for Water Absorption. The range of sample values is good, however there are too few samples. Nonetheless, the correlation is very high, R2 = .98 and the accuracy is good, SEC = .5. It would suggest that this parameter could be measured using the NIR Transmission technique.

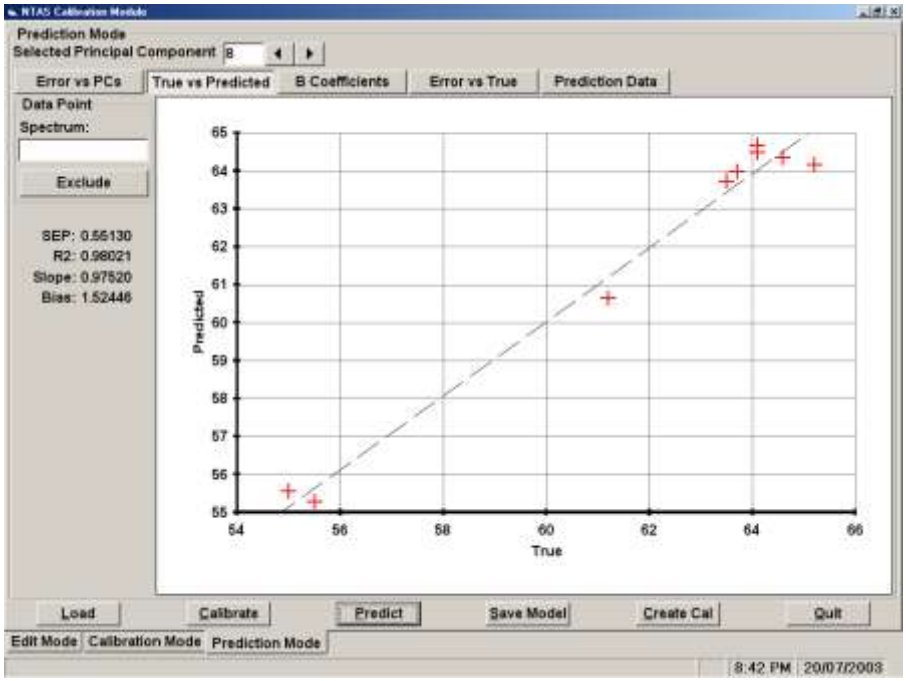

Figure 3. Plot NIR Water Absorption vs Ref Water Absorption

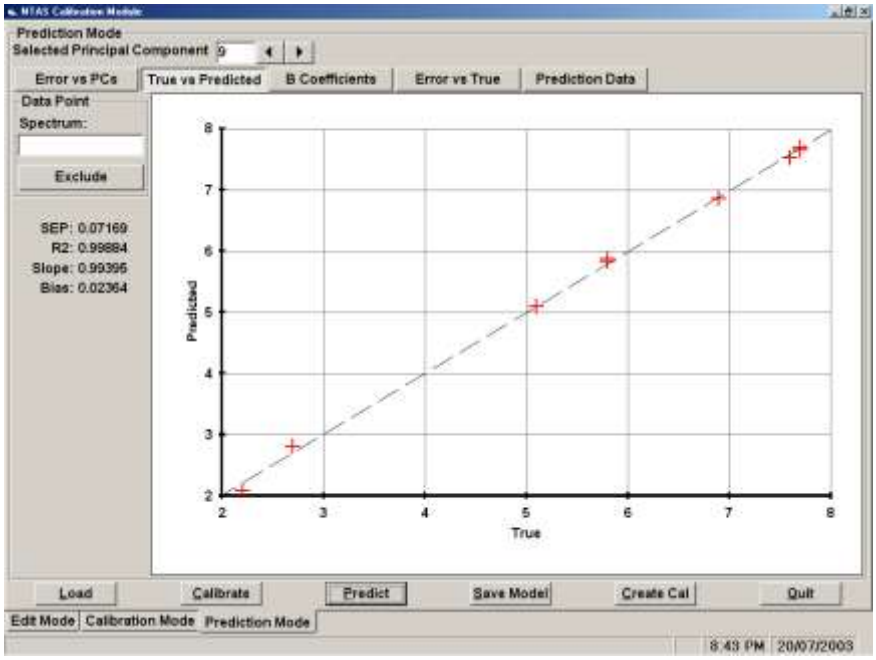

Figure 4. Plot NIR Development vs Ref Development

Figure 4. show the regression plot for Development. The correlation and accuracy for this parameter are excellent, ie, R2 = .999 SEC = .07. Although we do not know what in the NIR spectra is correlating to Development, it is obviously very strong.

Figure 5. shows the regression plot for Stability. It is noted that Water Absorption and Stability are high correlated and as such, it is not surprising that since development shows strong correlation, that Stability does also. The R2 = .989 and SEC = .17 are not as good as Development, however it is considered that both Development and Stability parameters should be measurable with the NIR Transmission technique.

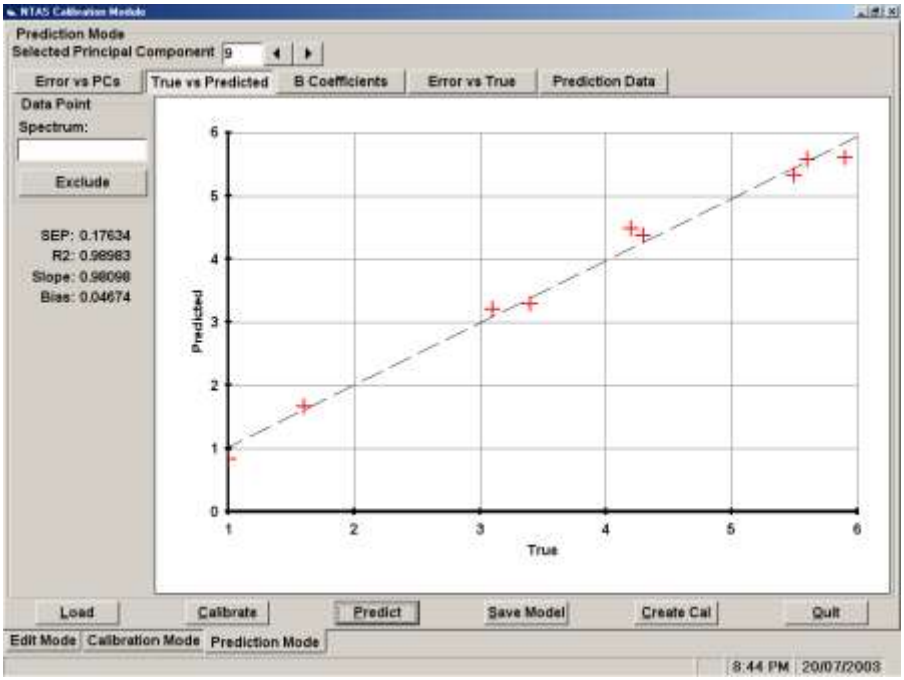

Figure 5. Plot NIR Stability vs Ref Stability

Figure 6. shows the regression plot for Ash. Ash has been measured in flour using the NIR region. The explanation for measuring Ash is that the Ash is what is left when the protein, starch, water and fiber are burnt off. Since the NIR measures protein, water, starch and fiber, then it should be able to measure the remaining material. The correlation is good, but not perfect but the accuracy is very good, ie, R2 = .95, SEC = .01. To improve the calibration, more samples with values across the entire range should be scanned.

Figure 7. shows the regression plot for Starch Damage. The correlation and accuracy for Starch Damage are extremely good, ie, R2 = .996, SEC = .06. AS can be seen from the plot the linearity is very good and it indicated that the NIR Transmission technique should provide a very good means of measuring Starch Damage.

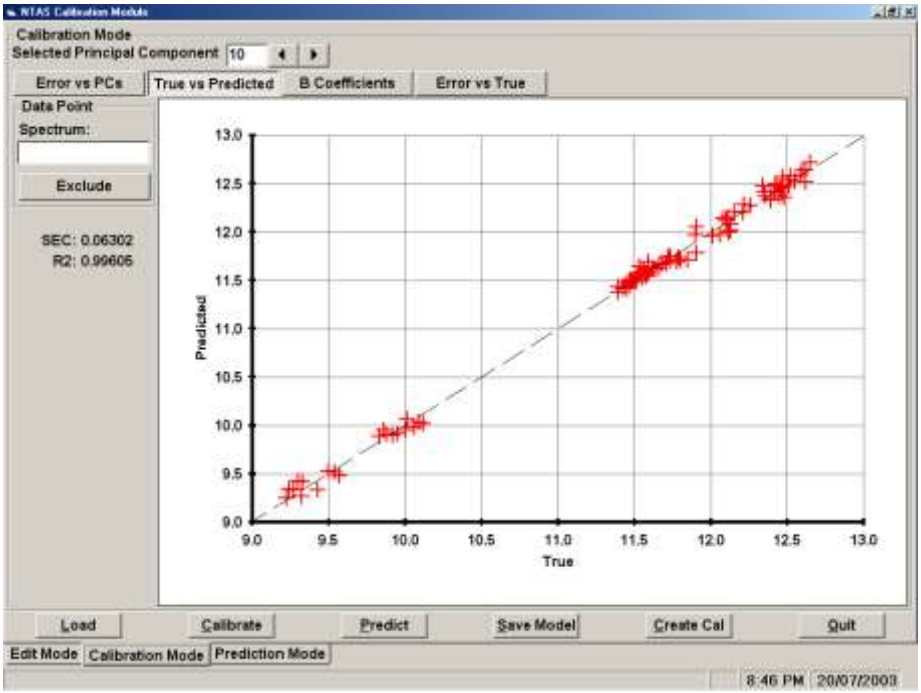

Figure 6. Plot NIR Ash vs Ref Ash

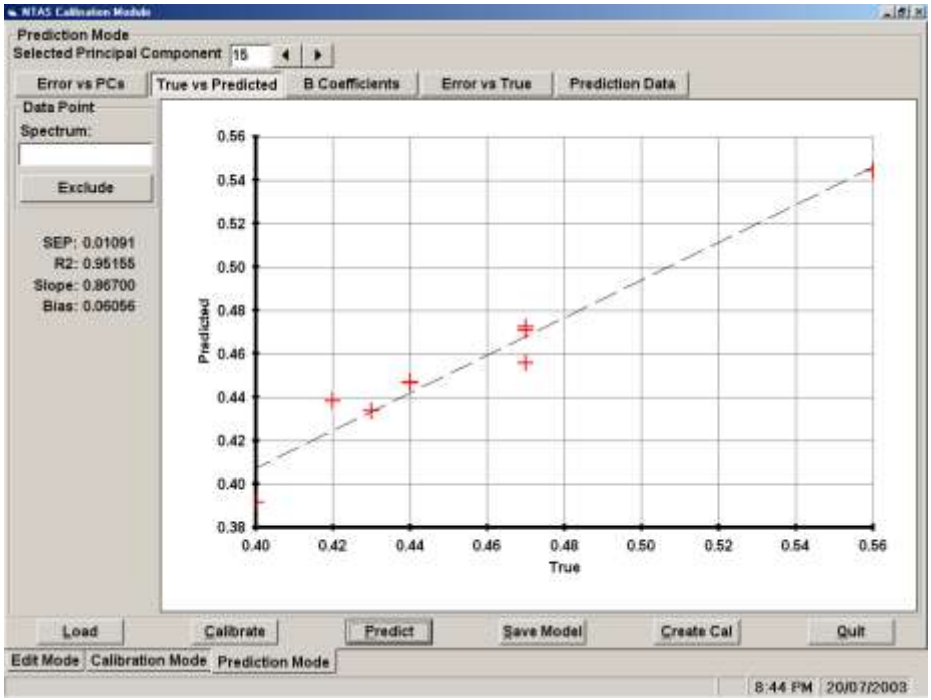

Figure 7. Plot NIR Starch Damage vs Ref Starch Damage

Figure 8. shows the regression plot for Maltose. Sugars are measured in the NIR region due to the presence of OH and CH bonds. However it is difficult to measure individual sugars since the saccharide ring structure is common to all sugars. However the plot shows an excellent correlation and accuracy, ie, R2 = .99, SEC = .01. This data suggests that Maltose is the major sugar in the flour and as such shows an excellent correlation. This parameter should also be measurable using this technique.

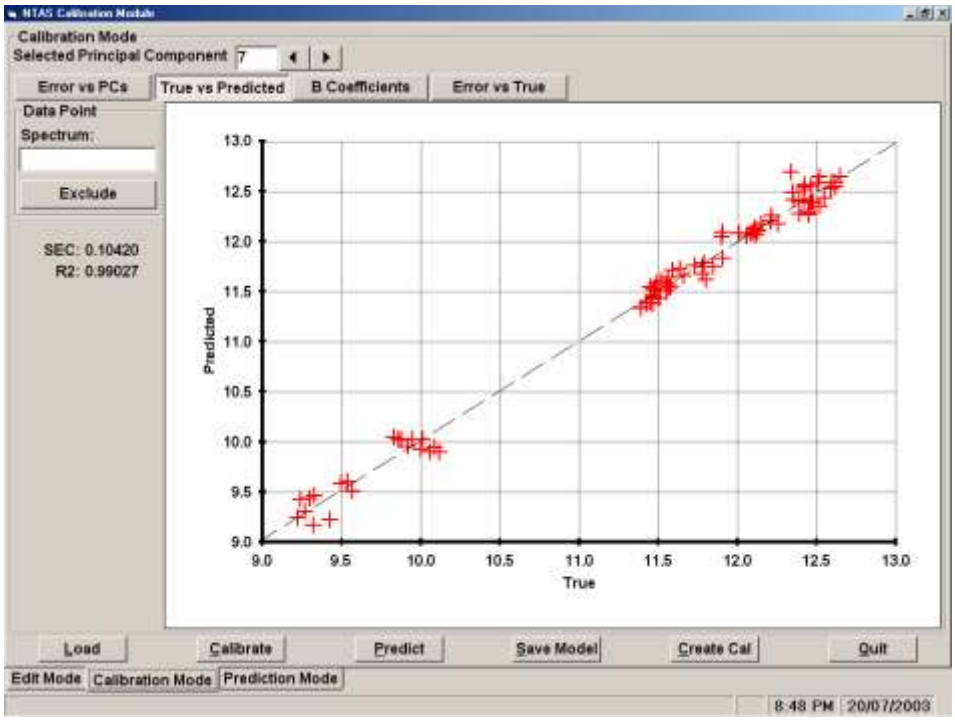

Figure 8. Plot NIR Maltose vs Ref Maltose

Conclusion:

It would appear that all seven parameters are measurable using the Cropscan 2000B. It must be noted that the number of samples usually required to develop NIR calibrations is 50 –100. As such, the data may be improved or may show poorer correlation's using more samples. However considering the high levels of correlation and the fact that samples were scanned in duplicate indicates that the correlations are not coincidental but will allow usable calibrations to be developed.

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