APPLICATION NOTE

FT-NIR Spectroscopy

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Analysis of Properties of Soymeal Using FT 9700 FT-NIR Analyzer

Introduction

Soybean production has been increasing rapidly over the last few decades and, as such, soy and soy-related end products have become ever more pervasive in day to day life. In 2018, 347 million metric tons of soybeans were produced worldwide, with 67 % of these being used to create soymeal.[1, 2]

In turn, 97 % of all globally produced soymeal is used in animal feedstock.[3] Soymeal is a key component used in poultry and livestock feed due to its high protein content and useful composition of amino acids.[4] As the commercial livestock and poultry market continues to grow, it is predicted that the demand for high quality soymeal will increase accordingly.

Major nutritional components of soymeal, such as moisture, protein, and fat, can have a key influence on the animals' growth and, ultimately, the overall profits of farmers. Therefore, accurate analysis of these nutritional parameters of soymeal is highly important to allow producers to ensure that they are meeting the end-users specific needs.

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Traditional methods of analyzing the quality of soymeal are often time-consuming and may produce hazardous chemical waste. Near-infrared (NIR) spectroscopy, on the other hand, can rapidly quantify these parameters without the need for solvents or lengthy sample preparation. When combined with chemometric techniques, such as partial least squares (PLS), NIR spectroscopy can provide a fast and accurate method to quantifying these key nutritional parameters in soymeal at any stage of the production process. FT 9700™ is a new PerkinElmer FT-NIR analyzer and its' performance analysing soymeal was evaluated.

Experimental

Over 530 soymeal samples were collected from a variety of countries of origin, including China, Spain, US, Brazil and Canada, therefore maximizing the natural variation present within the samples. Reference values for the moisture, protein, and fat for each sample were obtained using the standard method used to analyze each parameter.

The samples were ground using a LM 3310 disc mill in order to minimize moisture loss within the milling process. The ground soymeal samples were then scanned in replicate using multiple FT 9700 analyzers, using the settings shown in Table 1.

Table 1. Scanning parameters for soymeal samples.

Scanning Parameters	
Spectral Range	10,600 – 4,000 cm^{-1}
Resolution	16 cm^{-1}
Number of Scans	32

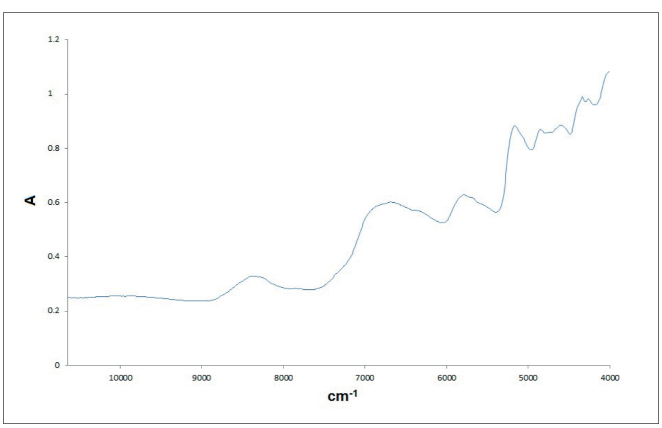

Figure 1. Example NIR spectrum of soymeal.

Table 2 indicates the number of calibration and validation samples used in each of the parameter models. The calibrations were stabilized for natural temperature variations that may be present in the samples.

Table 2. Number of samples used in soymeal parameter models.

Parameter	Number of Calibration Samples	Number of Validation Samples
Moisture (%)	332	87
Protein (%)	536	154
Fat (%)	333	125

Results

The calibration plots for each analyzed parameter can be seen in Figures 2-4. The calibration (blue) and validation (red) data points are evenly distributed about the unity line, indicating a high level of agreement between the predicted and reference values for each of these parameters.

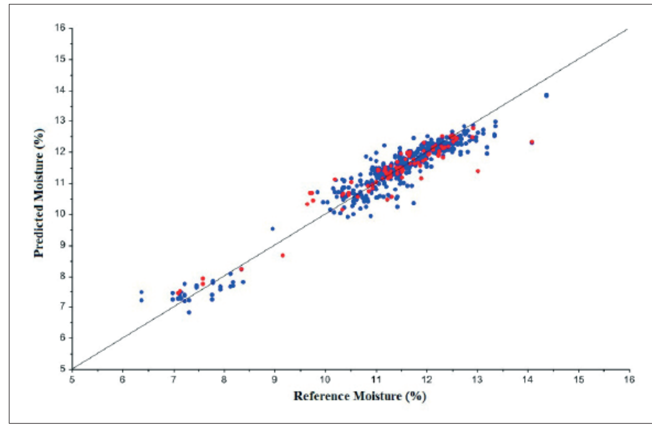

Figure 2. Correlation plot for moisture analysis of soymeal.

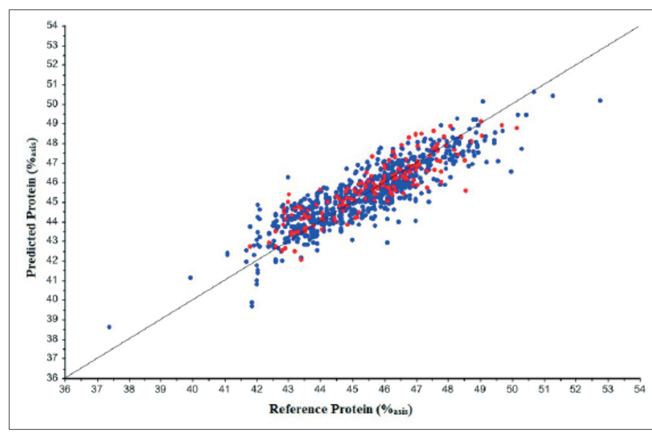

Figure 3. Correlation plot for protein analysis of soymeal.

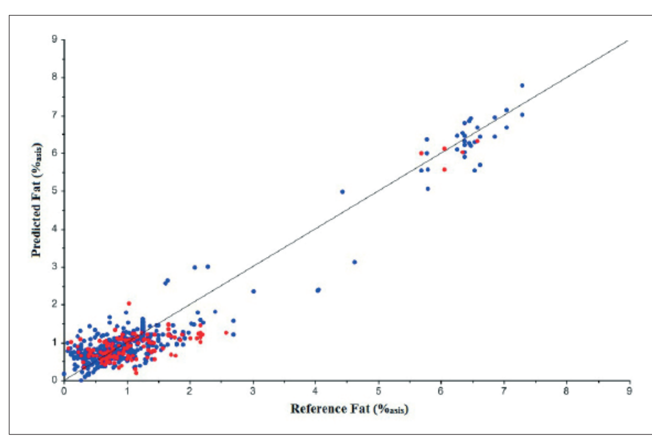

Figure 4. Correlation plot for fat analysis of soymeal.

Table 3 illustrates the overall regression data for each of the calibration models. The standard error of prediction (SEP) is relatively low for each model, indicating that the models have good prediction capabilities when quantifying the parameters in an unknown soymeal sample.

Table 3. Regression summary for soymeal parameter models (where SEC is standard error of calibration and SEP is standard error of prediction).

Parameter	Range	R^2	SEC	SEP
Moisture (%)	6.38 – 14.37	0.91	0.33	0.40
Protein (%)	37.40 – 52.75	0.91	0.90	0.83
Fat (%)	0 – 7.30	0.93	0.36	0.46

Conclusion

The results show that the FT 9700 NIR analyzer is capable of accurately quantifying multiple parameters of soymeal samples. The relatively low SEP values indicate that each of the models has good predictive capabilities. Furthermore, the results are transferable as the spectra were collected on multiple instruments.

Overall, the FT 9700 NIR analyzer is suitable for accurately and rapidly determining a variety of quality and nutritional parameters of soymeal samples. This technique could be utilized to allow routine checks of soymeal to be performed at any stage of the production process.

References

1. *World Soybean Production,* Soybean Meal Info Center, 2018.
2. *Soy Agriculture,* Yale University, 2019.
3. *Uses of Soybeans,* North Carolina Soybean Production Association, 2014.
4. R. Brister, *Measuring Beyond the Bushel,* United Soybean Board, 2017.

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