Application Note

Keywords

- Grain products
- Compositional analysis
- Microspectrometer

Techniques

- Shortwave NIR spectroscopy
- Diffuse reflectance

Applications

- Content determination
- Process control

Diffuse Reflectance Analysis of Seeds and Grains

Written by Ruud Niesen and Yvette Mattley, Ph.D.

Near-infrared (NIR) spectroscopy is an important tool for the food industry and is used routinely in agricultural applications. Used initially for the analyses of grains and grain products, NIR spectroscopy techniques more recently have been applied to measurements in the food and beverage, feed, agricultural, pharmaceutical, chemicals and textiles industries.

In this application note, we focus on Shortwave NIR measurements of seeds and grains, although NIR spectroscopy techniques work well for a range of food sample types including fruits, vegetables, oils and dairy products.

Background

NIR spectroscopy is a consistent and reliable technique that's preferred because it is fast and non-destructive. Unique spectral fingerprints in the NIR region provide important information on the composition and quality of the product analyzed. NIR spectroscopy techniques enable quick characterization of samples for moisture, protein, fat, carbohydrates and sugar content, with quantitative results obtained using chemometrics and the appropriate calibration models for the parameters of interest.

NIR spectroscopy for grain analysis is used during grain processing and in storage and provides nutritional content data for product labeling. NIR techniques also play an important role in quality control and the classification of finished goods. The information obtained from NIR measurements is vital for regulatory agencies such as the U.S. Department of Agriculture.

For example, moisture content analysis is important for determining proper product handling during processing to avoid spoilage of the grain by mold or fungi. Moisture analysis also provides identifying information used to determine the types of grains best suited for a particular use or type of grinding. In addition, moisture content is used to determine if processes like freeze-drying should be employed to preserve the grains.

As a process control tool, NIR analysis is accomplished using both manual and automated sampling. By examining the grain samples as they move down conveyors, operators can act on the feedback generated to divert damaged or inferior batches from the main process stream or to exclude product that may be unsafe or contaminated.

Figure 1: A high-power tungsten halogen source and a Shortwave NIR microspectrometer are mounted to an optical fixture to measure grain and other samples.

Measurement Considerations

Shortwave NIR diffuse reflectance spectra were measured for wheat, rice and white pea samples from 650-1100 nm. Spectra were measured using an STS-NIR microspectrometer, the Vivo high-power light source with STAGE-RTL-T reflection and transmission stage and a WS-1-SL diffuse reflection standard (Figure 1). The Vivo has four high powered tungsten halogen bulbs arranged at 45 degrees for diffuse reflection measurements. The illuminated stage employs active cooling that reduces the risk of overheating the samples placed directly on the sample stage.

Figure 2: Diffuse reflectance measurement of white pea samples is effective in identifying spectral differences among samples.

The white pea and grain samples were placed on the stage for diffuse reflection measurements. The peas were held in place using a magnetized outer ring (Figure 2) and the wheat grains were placed directly on the sampling area.

Results

The reflectance spectra measured for the seed and grain samples are shown in Figure 3. While the overall shapes of the spectra are similar, differences are observed in the diffuse reflection intensity with some spectral shape differences observed below 700 nm. These spectral differences enable discrimination of the samples and can be interpreted with the appropriate calibration models to provide quantitative information on the composition of the samples.

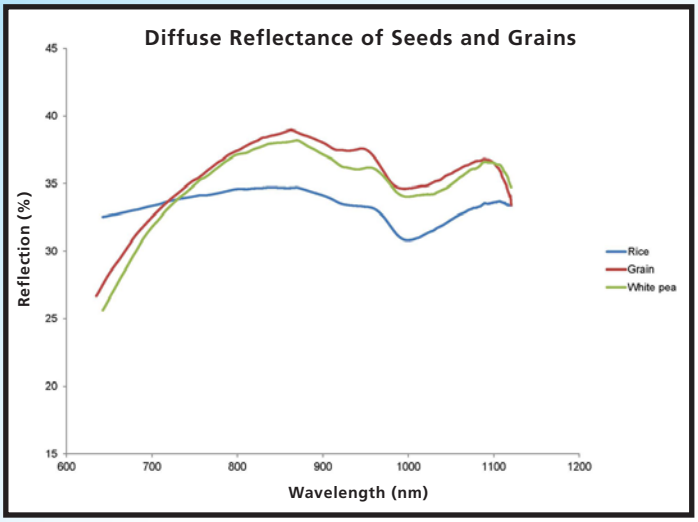

Figure 3: Diffuse reflection spectra of rice, wheat and white pea samples reveal differences in spectral intensity.

Conclusions

As demonstrated in this application note, visible and Shortwave NIR reflection spectroscopy are valuable techniques for the analysis of seed and grain samples. The spectral differences measured for wheat, rice and white pea samples can be analyzed further to provide quantitative information on critical composition parameters such as moisture, protein, fat, carbohydrate and sugar content using chemometrics and the appropriate calibration models. With additional analysis, even the subtlest spectral differences can yield a wealth of quantitative compositional information.

The STS-NIR microspectrometer combined with the Vivo illuminated reflection stage is a great platform for applications from 650-1100 nm. The modular nature and small footprint of this equipment provides flexibility in use, from process lines to field and laboratory settings. The measurements are highly reproducible and support the use of this setup for spectral analysis of grains in this wavelength range.

References

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