A Leader in Nutrition Solutions

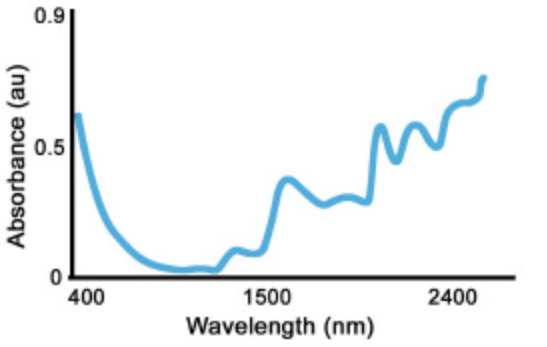
SWINE NEWSLETTER

December 2003

Determining the Nutritive Value of Feedstuffs: Near-Infrared (NIR) Technology

Rapid and accurate information about the nutritive value of feedstuffs allows the feed industry to utilize ingredients at their optimum value. Currently, Akey is using NIR technology to predict protein, moisture, fat, fiber, and amino acid levels in feedstuffs. NIR predicts the composition of an ingredient based on reflection or absorption of light at various frequencies. Based on light that is reflected, the composition of a feedstuff can be predicted, assuming enough samples have been analyzed to develop a prediction equation.

Figure 1. Example NIR Spectrum

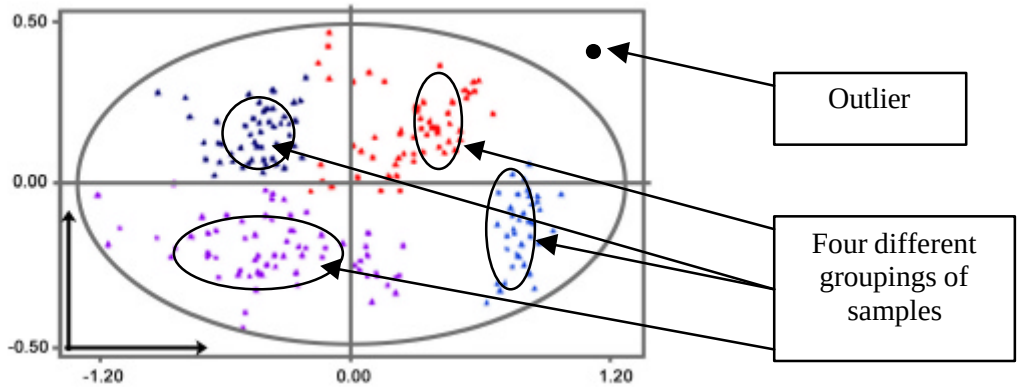


Feedstuffs are made up mostly of organic material. The molecular bonds most common in an ingredient occur between hydrogen, carbon, oxygen, sulfur, phosphorus, and nitrogen. Vibration frequency between these molecules causes the bonds to absorb light in the near-infrared region, or the region that extends just beyond red (not visible for humans) in the rainbow spectrum. To obtain information about the number and type of organic bonds in an ingredient, NIR spectrometry uses the fact that different molecular bonds absorb specific frequencies of light. Thus, nutrient composition is predicted based on the feedstuff's color in the near-infrared region. An NIR machine illuminates an ingredient with light of a specific and known frequency (or wavelength) in the near-infrared region. The absorption of the light by the feedstuff is then measured as the difference between the amount of light emitted by the NIR machine and the amount of light reflected by the sample. An NIR spectrum (Figure 1) depicts the relationship between the wavelength of light tested and the amount of light absorbed.

Although the principles behind NIR are simple, translating a spectrum into the composition of a feedstuff is complicated. Different organic bonds are visible at different wavelengths, and each peak or valley on the spectrum must be considered before the composition of a feedstuff can be predicted with confidence. Samples of a feedstuff are chemically analyzed to determine the actual composition. These analytical data are compared and correlated to the spectra to develop a prediction equation for determining the composition of a feedstuff. Depending on the feedstuff and the nutrient, the number of samples needed to develop a dependable equation to predict its composition range from 50 to 500.

The NIR machine is designed to evaluate the accuracy of a spectrum relative to the prediction equation for a feedstuff. When the predicted composition of an ingredient is outside the normal

Figure 2. Example Confidence Area for Estimating the Composition of a Feedstuff



range for the feedstuff (outlier), the user is informed and the results are considered questionable. When an outlier is identified, the sample should be sent for chemical analysis to determine the actual composition and compare it to the NIR results.

A confidence area for estimating or predicting the composition of a feedstuff is shown in Figure 2. The more spectra used to develop an equation, the more confidence a user has in that equation. If the predicted composition of a sample falls outside of the confidence circle, such as the sample in the top right corner of Figure 2, the NIR would consider that sample an outlier. The confidence area in Figure 2 also illustrates the impact of different factors on grouping of samples. Within the confidence area, there appears to be at least four different groups of samples. This could be due to time of year, the laboratory that completed the chemical analyses, sample source, or the composition of the ingredient. Although the sample groups are different, using all of the samples to generate a prediction equation results in a more robust equation that can predict the nutrient composition of the ingredient over a broader range of conditions.

NIR technology is an excellent tool for predicting the organic composition of feedstuffs. However, there are challenges that impact its usefulness. NIR is not designed to estimate the mineral composition of feedstuffs (e.g., ash, Ca, P, Zn, etc). Also, dramatic changes in ingredient composition result in recalibration of equipment and the need for more samples within a prediction equation. NIR may be used to estimate the composition of finished products (complete feeds) if the composition does not change significantly. If the formula for the finished product changes, the accuracy of the information from the equation may be compromised.

Akey uses NIR technology as a tool to verify that a material meets specifications, to adjust ingredient matrices, and to determine which loads or batches are out of tolerance. For loads out of tolerance, chemical analyses are completed to quantify value and composition of affected feedstuffs. By incorporating NIR technology in its continuous improvement processes, Akey can manufacture higher quality, more consistent products to meet the demands of its customers.

Copyright © 2003 by Akey. All rights reserved.