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Using near-infrared reflectance spectroscopy for rapid nutrient evaluation of sorghum silage

Abstract

This research was designed to develop a set of prediction equations to measure nutrient composition of Kansas sorghum silages by near-infrared reflectance spectroscopy (NIRS). Because sorghum silages are highly variable in grain content, we included a large number of cultivars to develop a robust set of equations for dry matter, crude protein, neutral detergent fiber, and acid detergent fiber. The results indicate that NIRS analysis of sorghum silages is feasible.

Keywords

Cattlemen's Day, 1996; Kansas Agricultural Experiment Station contribution; no. 96-334-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 756; Beef; Sorghum silage; Nutrient evaluation; Near-infrared reflectance spectroscopy

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**USING NEAR-INFRARED REFLECTANCE
SPECTROSCOPY FOR RAPID NUTRIENT
EVALUATION OF SORGHUM SILAGE**

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Summary

This research was designed to develop a set of prediction equations to measure nutrient composition of Kansas sorghum silages by near-infrared reflectance spectroscopy (NIRS). Because sorghum silages are highly variable in grain content, we included a large number of cultivars to develop a robust set of equations for dry matter, crude protein, neutral detergent fiber, and acid detergent fiber. The results indicate that NIRS analysis of sorghum silages is feasible.

(Key Words: Sorghum Silage, Nutrient Evaluation, Near-Infrared Reflectance Spectroscopy.)

Introduction

The near-infrared reflectance spectrometer (NIRS) is designed to rapidly determine the nutrient content of feeds and foods. The instrument scans a feed using reflected wavelengths just above those we can see, sends the information to a computer programmed with equations for various nutrients, and returns nutrient value in less than 1 minute. The reliability of the instrument is based on equations that compare NIRS outputs to traditional chemical analyses. Such equations exclusively for sorghum silages are generally not available.

Experimental Procedures

Two hundred eighty eight sorghum silage samples were dried using a forced air-oven

(55°C), then ground to 1 mm using a UDY impact mill. Samples were scanned using an NIRS Systems scanning monochrometer unit and immediately placed in a vacuum oven to obtain total dry matter data. A computer program selected 108 scans that differed enough to be useful in developing equations. Those samples were analyzed in duplicate for crude protein, neutral detergent fiber, and acid detergent fiber.

Sixty-eight samples were selected by the instrument's computer to be used for development of calibration equations. The remaining 40 samples were used for validation.

Results and Discussion

Statistical summaries of the calibrations and validations are shown in Table 1 and the "best fit" equations and corresponding wavelengths in Table 2.

Of the original 68 samples selected for calibration, several were omitted because the chemical values were outside the expected norm relative to the respective spectra. Neutral detergent fiber had the highest standard error because of the variation in samples; however, the R² indicated acceptable correlations between the spectra and chemical analyses. Acid detergent fiber and crude protein had lower SEC values. Moisture, as expected, did not correlate well with laboratory data. Perhaps that problem can perhaps be resolved by using Karl Fischer titration instead of oven drying for laboratory water measurement.

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Regression equations (Table 2) indicate that either four or five wavelengths were needed for prediction.

In summary, these data indicate that the development of robust equations by NIRS for sorghum silage is feasible, but additional work is needed on moisture measurement.

Table 1. Selected Means, Standard Errors, and Coefficients for Nutrient Components of Sorghum Silages

| Variable | N | Mean | SEC ^a | R ² | SEV ^b | R ² |
|-------------------------|----|-------|------------------|----------------|------------------|----------------|
| Dry matter | 64 | 93.51 | .71 | .78 | .73 | .76 |
| Crude protein | 65 | 7.81 | .36 | .92 | .39 | .91 |
| Neutral detergent fiber | 65 | 48.22 | 1.41 | .92 | 1.50 | .91 |
| Acid detergent fiber | 65 | 30.54 | .87 | .96 | .92 | .95 |

^aSEC - standard error of calibration.

^bSEV - standard error of validation.

Table 2. NIRS Equation Constants for Nutrient Analysis of Sorghum Silages

| Variable | Component | Coefficient | F | Wavelengths (mm) |
|-------------------------|----------------|-------------|--------|------------------|
| Dry matter | B ₀ | 82.50 | | |
| | B ₁ | 66.31 | 10.11 | 1636 |
| | B ₂ | 4.80 | 35.24 | 688 |
| | B ₃ | 64.04 | 18.07 | 2212 |
| | B ₄ | 100.99 | 55.19 | 2476 |
| | B ₅ | 102.84 | 99.89 | 1444 |
| | B ₆ | 205.84 | 20.65 | 1292 |
| Crude protein | B ₀ | 24.08 | | |
| | B ₁ | 34.10 | 12.86 | 1700 |
| | B ₂ | 60.76 | 30.34 | 1228 |
| | B ₃ | 40.71 | 37.46 | 2180 |
| | B ₄ | 22.66 | 104.16 | 2228 |
| Neutral detergent fiber | B ₀ | 141.93 | | |
| | B ₁ | 40.26 | 21.23 | 440 |
| | B ₂ | 588.20 | 265.62 | 1220 |
| | B ₃ | 561.70 | 153.40 | 2340 |
| | B ₄ | 47.40 | 11.98 | 632 |
| Acid detergent fiber | B ₀ | 33.32 | | |
| | B ₁ | 89.15 | 16.37 | 2260 |
| | B ₂ | 266.85 | 34.58 | 2148 |
| | B ₃ | 346.58 | 107.85 | 1436 |
| | B ₄ | 330.28 | 353.94 | 2276 |