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

K. J. Budiongo, L. H. Harbers, B. W. Seabourn [1], K. K. Bolsen, and B. E. Brent

Summary

This research was designed to develop a set of prediction equations to measure nutrient composition of Kansas sorghum si lages 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 corre sponding 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 R^2 indicated acceptable cor relations between the spectra and chemical analyses. Acid detergent fiber and crude protein had lower SEC values. Moisture, as e xpected, 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.

---

[1]Graduate student, Department of Grain Science.

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

[a]SEC - standard error of calibration.
[b]SEV - 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