2019

Three Year Summary: Comparison of Diets Collected from Esophageally Fistulated Cows to Forage Quality Estimated from Fecal Analysis

Bethany M. Johnston
University of Nebraska-Lincoln, bjohnston3@unl.edu

Jay D. Jenkins
University of Nebraska - Lincoln, jjenkins2@unl.edu

Jacki A. Musgrave Musgrave
University of Nebraska–Lincoln, jacki.musgrave@unl.edu

J. Travis Mulliniks
University of Nebraska - Lincoln, travis.mulliniks@unl.edu

Mitchell B. Stephenson
University of Nebraska - Lincoln, mstephenson@unl.edu

See next page for additional authors

Authors
Bethany M. Johnston, Jay D. Jenkins, Jacki A. Musgrave Musgrave, J. Travis Mulliniks, Mitchell B. Stephenson, James C. MacDonald, and L. Aaron Stalker

Three Year Summary: Comparison of Diets Collected from Esophageally Fistulated Cows to Forage Quality Estimated from Fecal Analysis

Bethany M. Johnston
Jay D. Jenkins
Jacki A. Musgrave
J. Travis Mulliniks
Mitchell B. Stephenson
James MacDonald
L. Aaron Stalker

Summary with Implications

Inconsistency was found in forage quality (crude protein and energy) when esophageally fistulated diets were compared to Nutrition Balance Analyzer (NUTBAL) analysis of fecal samples. On upland range sites, hand-clipping of samples (not a recommended practice to measure forage quality), was closer to fistulated diets than NUTBAL analysis. If cattle managers are solely utilizing NUTBAL for estimates of forage value, incorrect supplemental energy and protein decisions will likely be made resulting in the purchase of unnecessary supplements, thereby reducing the profitability of the operation.

Introduction

Forage quality is difficult for beef cattle producers to measure. Researchers use fistulated animals to collect diets directly from the esophagus or rumen, but most cattlemen do not have access to fistulated animals and hand-clipped forage samples do not always reflect the selectivity of grazing animals. The Nutrition Balance Analyzer (NUTBAL) forage quality analysis method claims to measure forage crude protein and energy through the analysis of fecal samples from grazing animals collected by producers. Near Infrared Reflectance Spectroscopy (NIRS) is conducted on fecal samples and combined with client information and research/technology developed by the Grazing Animal Nutrition Lab (GAN Lab) in Temple, TX.

The objective of this study was to compare the quality estimations from forage samples collected with fistulated grazing animals, hand-clipping, and fecal samples collected for NUTBAL analysis on Nebraska Sandhills rangelands.

Procedure

Comparisons were made between forage diets collected from esophageally fistulated cows, fecal samples from cows grazing the same pasture, and from hand-clipped quadrats. The esophageal diets (forage the cow bit off, chewed, and expelled into a collection bag when swallowed) and the hand-clipped samples were evaluated for CP. Energy (TDN) was determined from ADF analysis in a commercial laboratory (Ward Labs, Kearney NE) for clipped samples, while the esophageal samples were analyzed using in vitro digestibility techniques to determine TDN. The fecal samples were evaluated for crude protein and energy (in the form of digestible organic matter [DOM]) through the NUTBAL program utilizing NIRS. Two locations were evaluated; upland pastures (warm-season grass dominated) and subirrigated wet meadows (cool-season grass dominated) at the Gudmundsen Sandhills Lab near Whitman, NE in 2016 and 2017. Hand-clipped forage samples were only collected within the upland pastures. Diet, fecal and clipped samples were collected in July, September, and November. Fecal samples were dried at 50 degree C for 72 hours prior to shipping for NUTBAL analysis.

Collections for upland pasture

Fecal samples were directly collected from 12 cows early in the months of July, September, and November 2015, 2016 and 2017. Cows were grazing upland rangeland at moderate stocking rates. Cows were in the same pasture from June to November. The cows ranged in age from 3 to 9 years old. Three esophageally fistulated cows grazed the upland pasture and diet samples were collected, at the same time the fecal samples were collected from the cows. The esophageal samples were dried, ground, and evaluated for in vitro organic matter digestibility using a 48-hour in vitro fermentation. Five standards with known in vivo digestibilities were included in the in vitro runs to correct the in vitro organic matter digestibility to in vivo digestibility. The organic matter digestibility was multiplied by organic matter content to determine digestible organic matter. Digestible organic matter was assumed to be equal to TDN for the in vitro diet sample analysis. Two in vitro runs were conducted for all samples and the in TDN estimates from the two runs were averaged. Forage was also clipped by hand in an effort to collect a sample representative of plants and plant parts consumed by cattle. This collection was subjective of the person clipping, and an attempt to estimate and collect the cows' grazing habits. The hand-clipped samples were sent to a commercial laboratory and TDN was estimated using equations from ADF content.

Collections for subirrigated meadow

Fecal samples were directly collected from 12 cows in early in the months of July, September, and November of 2015, 2016, and 2017 grazing subirrigated meadow. Three esophageally fistulated cows grazed the meadow pasture and diets were collected, the same time the fecal samples were collected from the cows. The meadows were broken into 4 pastures. The rotation allowed each pasture to be grazed twice in the growing season. Esophageal samples were analyzed using in vitro digestibility techniques and TDN was estimated in the same manner as the upland pasture samples.

Assumptions

Several assumptions were made, including: 1) the models used in the NUTBAL program represented similar forage quality and values as native Sandhills grassland in Nebraska. 2) fistulated animals were selecting the same diets as the grazing cows.

Other considerations included: 1) To minimize the loss of nitrogen from the manure (cow patty on the ground), fecal samples were taken directly from the cow's rectum while restrained in a cattle handling facility. 2) Total digestible nutrients reported for fecal samples were calculated from the NUTBAL energy DOM. NUTBAL DOM was converted to TDN by multiplying the DOM value reported by the GAN lab by 1.06., as suggested by NRCS Enhancement Activity 65 in 2015. 3) Precipitation received during growing season could have influenced protein and TDN in the grazed forage.

Table 1. Crude protein (CP) and total digestible nutrient (TDN) content of diets collected from *upland range* by esophageally fistulated cattle compared with NUTBAL analysis of fecal samples and clipped forage

Item	Diet[1]	NUTBAL[2]	Clipped[3]	SE	*P*-value
CP					
Jul	8.0	8.0	8.0	0.3	0.99
Sep	7.1[a]	5.2[c]	6.1[b]	0.3	< 0.01
Nov	5.4	5.2	5.2	0.3	0.92
TDN					
Jul	56.6[b]	65.8[a]	55.6[b]	1.0	< 0.01
Sep	46.2[c]	64.4[a]	54.7[b]	1.0	< 0.01
Nov	44.3[c]	62.4[a]	50.2[b]	1.0	< 0.01

[1]TDN equal to digestible organic matter using in vitro organic matter digestibility.

[2]Digestible organic matter (DOM) was converted to TDN by multiplying DOM by 1.06.

[3]TDN estimated from ADF in a commercial laboratory.

Statistical Analysis

Data were analyzed using the Mixed Procedure in SAS with sample collection method, month, and the interaction of collection method and month as the fixed effects. Year was also included in the model as a random effect. Differences were considered significant when $P < 0.05$ were observed. Upland and subirrigated meadows samples were analyzed separately. Differences were considered significant when $P < 0.05$ were observed.

Results & Discussion

The CP values reported herein were from the 2015, 2016, and 2017 sampling dates while the TDN values were from the 2016 and 2017 sampling dates only. The samples collected from esophageally fistulated steers compared to NUTBAL analyzed and hand-clipped samples resulted in significantly different measures in forage quality. The in vitro TDN values reported herein are for comparison to NUTBAL analyses. Another Beef Cattle Report (*2019 Nebraska Beef Cattle Report*, pp. 50–52), has more extensive diet sample collection and analysis. That analysis includes monthly samples for range over a three-year period with 36 diet samples for each month. While the esophageally fistulated diets' TDN estimates generally agree for both reports, the data reported in the companion article provide a more robust estimate of changes in forage quality through the growing season.

Upland pasture results

Crude protein and TDN values of diet samples, NUTBAL analyzed fecal samples, and hand-clipped forage from upland range are reported in Table 1. In September, diet samples contained more ($P \leq 0.01$) CP than NUTBAL samples, but in July and November, the CP content of both diet and NUTBAL samples were similar ($P > 0.90$). In all three months, TDN were inflated ($P < 0.05$) by the NUTBAL analysis. In July, the NUTBAL estimate of TDN was 9.2 percentage units greater than the fistulated cow samples, but in November the value was elevated by 18.1 percentage units. A TDN estimate off by 18 percentage units has dramatic impact on nutritional status of an animal and would result in erroneous supplementation recommendations.

Hand-clipped samples were lower in TDN than diet samples in all instances except for the July TDN estimate. However, clipped samples were closer to diet samples more often than were NUTBAL estimates. The clipped samples had a CP estimate that was 1 unit lesser than the diet samples in September, but were otherwise similar to the diet samples.

Subirrigated meadow results

Crude protein and TDN values of diet samples and NUTBAL analyzed fecal samples from meadows are reported in Table 2. In all July and November, the NUTBAL method underestimated ($P \leq 0.05$) the amount of CP in the diet. The NUTBAL method generally overestimated forage TDN. Forage TDN estimates were greater ($P < 0.01$) for NUBAL in September and November, but were not different in July ($P = 0.17$). No hand-clipped samples were taken on the wet meadows.

Overall NUTBAL slightly under estimated the amount of CP being consumed by grazing cattle and consistently overestimated the amount of TDN cattle were consuming on Nebraska Sandhills rangeland and meadows. Additionally, the NUTBAL estimates failed to capture the decline in forage quality as the grazing season progressed. The lack of consistency between NUTBAL and the diet samples precludes the possibility of developing an adjustment factor that can be applied to GAN lab reports in making useful cattle management decisions.

After NUTBAL analysis of this study's fecal samples were received by the GAN lab, the animal performance reports generated recommended feeding supplemental nutrients to prevent substantial body weight and body condition score loss. Supplemental nutrients were not fed and the animals did not lose the body weight and body condition score projected by the NUTBAL report (Table 3).

Conclusions

NUTBAL analysis of crude protein and energy numbers (from fecal sampling) differed from wet chemistry analysis of esophageally fistulated and hand-clipped forage samples. If cattle producers are solely utilizing NUTBAL for estimates of forage value, miscalculations for supplemental energy and protein requirements are likely,

Table 2. Crude protein (CP) and total digestible nutrient (TDN) content of diets collected from *subirrigated meadows* by esophageally fistulated cattle compared with NUTBAL analysis of fecal samples

Item	Diet[1]	NUTBAL[2]	SE	*P*-value
CP				
Jul	10.2	9.4	0.3	0.05
Sep	9.3	9.3	0.3	0.99
Nov	8.1	5.0	0.3	< 0.01
TDN				
Jul	58.9	60.6	1.2	0.17
Sep	51.2	60.3	1.2	< 0.01
Nov	43.9	55.8	1.2	<0.01

[1]TDN equal to digestible organic matter using in vitro organic matter digestibility.

[2]Digestible organic matter (DOM) was converted to TDN by multiplying DOM by 1.06.

Table 3. Actual body weight and body condition score of cows grazing upland range or meadow (no supplementation of adding nutrients).

Item	Jun	Jul	Sep	Nov
Upland range				
Body Weight, lbs.	954	909	968	1006
Body Condition Score	5.1	5.2	5.4	5.2
Meadow				
Body Weight, lbs.	1020	975	1022	1086
Body Condition Score	5.1	5.2	5.3	5.5

and may result in the purchase of unnecessary supplements, thereby reducing the profitability of the operation. Overall, crude protein was slightly underestimated and TDN was consistently overestimated in forage diets, and the decline in forage quality (summer to winter) was not captured through NUTBAL analysis.

Bethany Johnston, extension educator, Thedford

Jay Jenkins, extension educator, Valentine

Jacki Musgrave, research technician, Gudmundsen Sandhills Lab

Travis Mulliniks, assistant professor, Animal Science, North Platte

Mitchell Stephenson, assistant professor, Agronomy, Scottsbluff

James MacDonald, associate professor, Animal Science, Lincoln

Aaron Stalker, faculty, Animal Science, Rexburg, ID