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Determination of Diet Protein and Digestibility of Native Sandhills Upland Range

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Summary

A significant year by grazing level effect was detected on CP content of diet samples collected from 2003 to 2005 at the Gudmundsen Sandhills Laboratory. During drought years (2003 and 2004) cows selected plants which were higher in CP and lower in digestibility. High levels of grazing pressure decreased diet IVOMD compared to diets from ungrazed and moderately grazed pastures. Prediction models generated from these data predict dietary CP and organic matter disappearance (OMD) of cattle grazing native Sandhills range pastures.

Introduction

When grazing native range year-round, diet quality varies throughout the year and with level of grazing pressure (*1997 Nebraska Beef Report*, pp. 3-5; *2001 Nebraska Beef Report*, pp. 23-25). Lower diet quality during dormant months may increase the need for protein or energy supplements during these periods to meet cow requirements (*1997 Nebraska Beef Report*, pp. 3-5). Reports of diet digestibilities collected by grazing cattle are limited. Lardy et al. (*1997 Nebraska Beef Report*, pp. 3-5) demonstrated that diet DM digestibility of Sandhills upland range is the highest in June and July and decreased through the dormant season. However, these digestibility estimates are relative differences and *in vivo* digestibility was not estimated.

Accurate *in vivo* estimates are necessary to formulate supplements and also needed to predict animal performance. Geisert et al. (*2006 Nebraska Beef Report*, pp. 109) reported a 5 percentage unit difference in OMD between *in vitro* and *in vivo* digestibility of forages. *In vivo* digestibility can be estimated by including a calibration set of samples (with known *in vivo* digestibility) within *in vitro* procedures. Therefore, this study was initiated to determine *in vivo* OMD and CP values of Sandhills Range as influenced by month, year(moisture) and grazing pressure.

Procedure

Diet samples were collected at the Gudmundsen Sandhills Laboratory, Whitman, Neb., using six esophageally fistulated cows. Collections began May 2003 and continued through November 2005. Pastures were chosen for sampling based on the stocking rate prior to sampling. Pastures were separated into three grazing groups: non-grazed (None), medium SR (Med, 0.1 to 0.45 AUM) high stocking rate (High, < 0.5 AUM). One pasture was not grazed and was sampled at every collection time while the remaining three pastures varied based on the ranch's grazing rotation. Diet samples were collected every 3 weeks during the growing season and monthly during the dormant season. Diet samples were frozen immediately following collection, freeze-dried, and ground through a Wiley Mill using a 1 mm screen. Samples were composited by pasture and analyzed for CP and IVOMD.

Precipitation data were collected throughout the trial. Moisture at each collection time was cumulative beginning October 1 of the previous year to two days prior to sampling date. Grazing data were recorded to calculate grazing pressure.

In vitro organic matter disappearance (OMD) was based on five forages with known *in vivo* OMD used as standards. Three separate *in vitro* runs were conducted and all diet sample IVOMD values were adjusted to *in vivo* OMD using regression equations generated from the standards. Regression equations were generated from each *in vitro* run and adjusted for run differences using procedures outlined by Geisert et al., (*2006 Nebraska Beef Report*, pp. 109).

Multiple regression analysis was conducted to generate prediction equations to estimate dietary CP and OMD of diets consumed by grazing cattle in the Sandhills. Variables included in this analysis included moisture, day, and grazing pressure (AUM/ton of forage). The day started on April 1 of each year and continued through March 31 of the following year to follow the forage growth patterns. Grazing pressure (GP) was calculated as AUM/ton of forage produced. Clipped sample data from GSL (1998 through 2006) and Barta Brothers Ranch (1999 through 2006) were used to determine annual forage production. Total forage production was estimated using the regression equation; $y = 71.056x + 412.47$ ($R^2 = 0.3575$) where y = forage yield and x = moisture. The total forage yield was adjusted based on forage growth curves for the Sandhills region from the NRCS using the equation $y = 1.953E07x^4 - 1.692\ E05x^3 + 0.0498x^2 - 5.244x + 178.284$ ($R^2 = 0.9948$) where y = forage yield and x = moisture.

Statistical analysis to separate variable differences was conducted using the mixed model in SAS. The regression procedures of SAS were used to analyze prediction equations.

Table 1. Year by grazing effect on CP% values of diets collected from cows grazing upland range pastures.

	Grazing Pressure			
Year	None[2]	Med[3]	High[4]	SEM
2003	8.5[a]	8.0[a]	9.1[a]	0.6
2004	9.4[a]	8.6[a]	8.5[ac]	0.5
2005	9.5[ac]	9.0[ac]	7.1[ab]	0.4

[1]Year x grazing pressure interaction ($P = 0.04$).
[2]Means un-grazed pastures.
[2]Means moderately grazed pastures.
[4]Means heavily grazed pastures.

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Table 2. **Monthly average IVOMD and CP (% DM) values of diet samples from native Sandhills upland range pastures.**

	IVOMD				
Sample Date	Ave[1]	High[2]	Med[3]	None[4]	CP[5]
January	54.2	52.2	56.5	53.0	6.9
February	54.6	53.0	55.9	55.0	6.2
March	52.6	53.5	52.7	52.0	7.4
April	59.5	60.5	60.9	62.8	8.0
May	65.8	62.5	67.5	67.2	12.4
June	62.6	62.6	61.8	63.4	10.8
July	55.9	50.7	57.0	60.0	11.5
August	55.5	50.9	57.9	57.6	8.9
September	51.4	51.6	47.3	55.2	8.8
October	53.0	50.1	51.7	56.4	7.9
November	51.4	49.4	50.5	54.3	7.6
December	53.9	51.6	51.3	58.7	7.0
Average	55.8	49.3	55.9	58.0	8.6

[1]IVOMD average for all pastures.
[2]IVOMD values for high grazing level.
[3]IVOMD values for moderate grazing levels.
[4]IVOMD values for un-grazed pastures.
[5]CP (% DM) average for all pastures.

Results

Annual precipitation was 13, 15, and 19 inches for 2003, 2004, and 2005, respectively. The average precipitation for this area is between 18 and 20 inches annually. A year by grazing pressure interaction ($P = 0.04$) occurred for CP of diet samples (Table 1). There was no difference in CP among GP in 2003 and 2004 and among Med and un-grazed pastures in 2005. In 2005 High GP decreased CP compared to Med and non-grazing. This could be explained by drought conditions in 2003 and recovering drought conditions in 2004. Cows may have selected plants such as forbs which were generally higher in CP, but lower in digestibility than grasses.

There was a year effect ($P < 0.001$) on IVOMD where 2003 was higher than 2005 with 2004 as intermediate; however year did not interact with GP. The average IVOMD was 59.1%, 55.4% and 53.0% for 2003, 2004, and 2005, respectively. This could be explained by decreased precipitation in 2003 and 2004 delaying plant maturity thus increasing digestibility.

Grazing pressure significantly affected ($P < 0.01$) IVOMD of diet samples where High GP decreased digestibility compared to None with Med intermediate (54.1%, 55.9%, and 58% for High, Med, and None, respectively). Grazing cattle naturally select plants and plant components which are higher in digestibility than what is generally available. As more grazing pressure is applied to a pasture, the availability of highly digestible plants and plant parts decreases, forcing cattle to consume diets with lower digestibility.

Diet IVOMD was ($P < 0.001$) effected by month (Table 2), with diets collected May through July being more digestible than diets collected during the dormant season. Diets collected during the dormant season remained relatively constant in IVOMD and values gradually increased to peak growing season. Lardy et al. (*1997 Nebraska Beef Report*, pp. 3-5) showed similar results where digestibility was the greatest in the growing season and lowest throughout the dormant season.

Regression equations formulated from each *in vitro* run were used to adjust the IVOMD values. These adjustments allow for comparison of samples analyzed in different runs. The average adjustment for all IVOMD runs for the current trial was 3 percentage units. There was a 2 percentage unit difference in digestibility comparing the data set from Lardy et al. *(1997 Nebraska Beef Report*, pp. 3-5), who did not adjust to *in vivo* values, to the data generated from this trial. When comparing IVOMD data from Patterson et al., (*2000 Nebraska Beef Report*, pp 5-6) to IVOMD data from this trial, the average difference is 5.4 percentage units. This is similar to the difference seen by Geisert et al. (*2006 Nebraska Beef Report*, pp. 109).

(Continued on next page)

Table 3. **Organic matter digestibility and CP prediction equations for diets consumed by cattle grazing native Sandhills range pastures**

Variable	Equation	R^2	Model *P*-value
CP	$0.273*D^{a} - 4.56E^{-3}*D2^{b} + 2.86E^{-5}*D3^{c} - 8.01E^{-8}*D4^{d} + 8.345E^{-11}*D5^{e} + 7.88$	0.630	<0.001
OMD			
Early Growing[f]	$3.2825*M^{i} - 5.7359E^{-4}*D2 - 2.0086E^{-1}*M2^{j} - 1.67E^{-3}*GP2^{k} + 5\ 4.47846$	0.4590	0.0120
Late Growing[g]	$-0.4268*GP^{l} - 0.76643*M - 0.06015*D + 0.01070*GP2 + 73.98686$	0.3371	0.0025
Dormant[h]	$-0.14294*GP - 7.77112*M + 0.1923*M2 + 0.00271*GP2 + 126.15238$	0.5490	<0.001

[a]Means day.
[b]Means day*day.
[c]Means day*day*day.
[d] Means day*day*day*day.
[e]Means day*day*day*day*day.
[f]Means growing season beginning April 1 (day 1) through June 15 (day 76).
[g]Means growing season beginning June 16 (day 77) through Sept. 30 (day 183).
[h]Means dormant season beginning Oct. 1 (day 184) through March 31 (day 365).
[i]Means cumulative moisture.
[j]Means cumulative moisture*cumulative moisture.
[k]Means grazing pressure*grazing pressure.
[l]Means grazing pressure.

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However, due to variability among *in vitro* runs, one cannot simply assume a constant adjustment percentage. The regression equation from samples with known digestibility must be generated for each *in vitro* run to appropriately adjust the data, one equation for all runs will not accurately adjust each individual run.

Monthly CP values (Table 2) followed a similar pattern to IVOMD values ($P < 0.001$). These patterns agree with previous data from Lardy et al. (*1997 Nebraska Beef Report*, pp. 3-5) where CP is highest in the growing season and lowest during the dormant months.

Organic matter disappearance prediction equations (Table 3) were separated into three segments; early growing (days 1-76), late growing season (days 77-183) and dormant season (days 184-365). Day 1 was April 1 and day 365 was March 31 of the following year in order to follow the plant growing cycle. Significant variables in the prediction models varied among the three different seasons. Predicted OMD values were not different ($P = 0.9999$) from the observed values in all seasons. When evaluating the prediction of the control pasture (no grazing pressure) the model predicted similar results as seen in the observed OMD results (Figure 1). In 2003, lower moisture increased diet OMD, and increasing moisture in 2004 and 2005 decreased predicted OMD. In order to evaluate the model's ability to predict OMD based on grazing pressure we used 2005 moisture data. When grazing pressure was assumed to be high (32 Animal Unit Days/ton of forage in a deferred grazing system), compared (Figure 2) to no grazing pressure, diet OMD was lower at any time point throughout the year when grazing pressure was considered high.

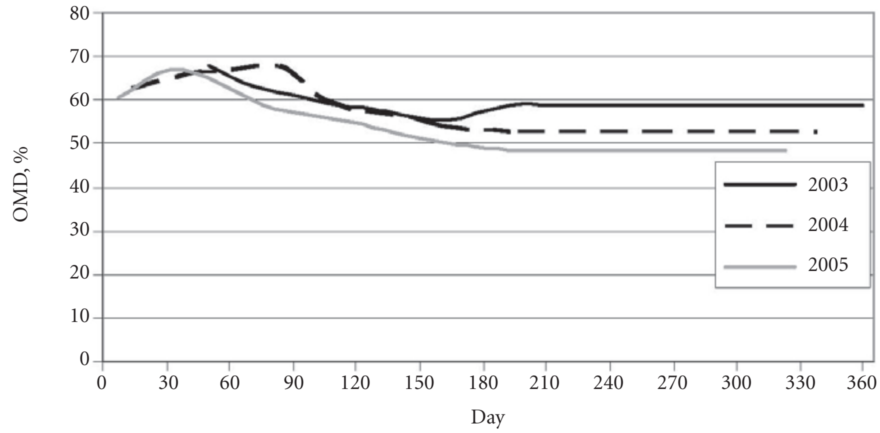

Figure 1. **Seasonal predicted dietary OMD for the control pasture (none-grazed) during three consecutive years.**

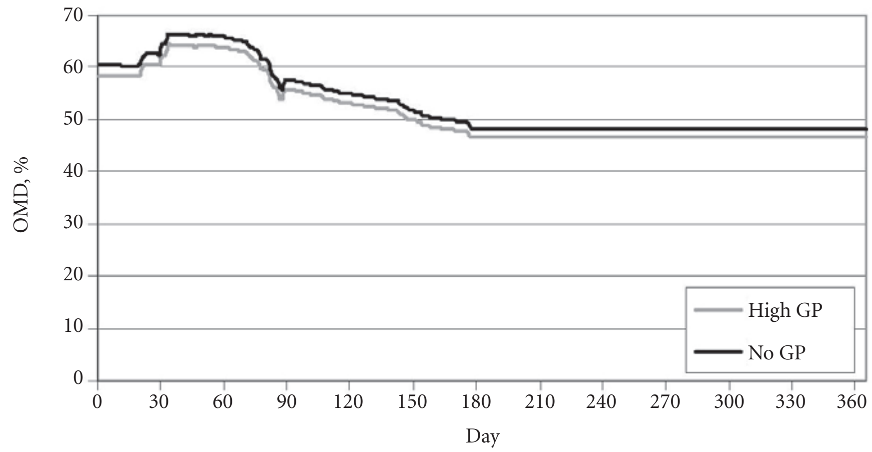

Figure 2. **Grazing pressure effect on predicted dietary OMD values. High grazing pressure assumed at 32 AUD/ton of forage produced.**

Conclusions and Implications

For producers, nutritionists or others to accurately predict cattle performance of cattle on pasture using the 1996 NRC Model, it is essential to have appropriate protein and energy values for the grazed forage. By adjusting *in vitro* data to *in vivo*, as was done in this experiment, we believe accurate energy (OMD) values were obtained. By collecting diet samples with fistulated cattle, the samples reflect what cattle in a production setting would eat. Collecting samples over three years differing in rainfall allowed us to estimate the effect of moisture on diet quality. Finally, by collecting samples after known amounts of grazing pressure, the effect of grazing pressure on diet quality was determined.

When all of the data were used in the computer model, three complex equations were developed for the three phases of the growing season. The equations account for advancing plant maturity (day), moisture and grazing pressure. This allows the user to predict forage OMD in a variety of individulized situtions. Model output is illustrated in Figures 1 and 2 where one or more of the variables was held constant. This model has potential for widespread use in Nebraska native pastures.

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