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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 $y = 1.953E07x^1 - 1.692 E05x^2 + 0.0498x^3 - 5.244x + 178.284$ ($R^2 = 0.9948$) 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. |
|---|---|---|---|---|
| Year | None | Med | High | SEM |
| 2003 | 8.5$^a$ | 8.9$^b$ | 9.1$^a$ | 0.6 |
| 2004 | 9.4$^a$ | 8.6$^a$ | 8.5$^c$ | 0.5 |
| 2005 | 9.5$^{bc}$ | 9.0$^{bc}$ | 7.1$^{ab}$ | 0.4 |

$^a$Year x grazing pressure interaction ($P = 0.04$).
$^b$Means non-grazed pastures.
$^c$Means moderately grazed pastures.
$^d$Means un-grazed pastures.
Late Growing

Early Growing

OMD

CP 0.27*D

Variable

Equation

R²

Model P-value

CP 0.27*D

0.630

<0.001

OMD

Early Growing

0.273*D² - 4.56E-10*D³ - 8.01E-01*D⁴ - 8.345E-01*D⁵ + 7.88

0.4590

0.0120

Late Growing

-0.4268*GP - 0.7664*M - 0.06015*D + 0.00271*GP² + 126.1528

0.3371

0.0025

Dormant

-0.14294*GP - 0.192*M - 0.01070*GP² + 7.98686

0.5490

<0.001

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 grasses.

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

<table>
<thead>
<tr>
<th>Variable</th>
<th>Equation</th>
<th>R²</th>
<th>Model P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP</td>
<td>0.273<em>D² - 4.56E-10</em>D³ - 8.01E-01<em>D⁴ - 8.345E-01</em>D⁵ + 7.88</td>
<td>0.630</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>OMD</td>
<td>3.8285<em>M² - 5.7359E-14</em>D² - 2.0368E+10<em>M² - 1.67E-03</em>GP² + 5.447846</td>
<td>0.4590</td>
<td>0.0120</td>
</tr>
<tr>
<td>Early Growing</td>
<td>-0.4268<em>GP - 0.7664</em>M - 0.06015<em>D + 0.00271</em>GP² + 126.1528</td>
<td>0.3371</td>
<td>0.0025</td>
</tr>
<tr>
<td>Late Growing</td>
<td>-0.14294<em>GP - 0.192</em>M - 0.01070*GP² + 7.98686</td>
<td>0.5490</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Dormant</td>
<td>-0.14294<em>GP - 0.192</em>M - 0.01070*GP² + 7.98686</td>
<td>0.5490</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Means day.

Means day*day.

Means day*day*day.

Means day*day*day*day.

Means growing season beginning April 1 (day 1) through June 15 (day 76).

Means growing season beginning June 16 (day 77) through Sept. 30 (day 183).

Means dormant season beginning Oct. 1 (day 184) through March 31 (day 365).

Means cumulative moisture.

Means cumulative moisture*cumulative moisture.

Means grazing pressure*cumulative moisture.

Means grazing pressure.
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 produced), compared (Figure 2) to no grazing pressure, diet OMD was lower at any time point throughout the year when grazing pressure was considered high.

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 individual situations. 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.

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.