Forage Evaluation of Crested Wheatgrass

Kelton C. Adair
Karla H. Wilke
Andrea K. Watson
James C. MacDonald

Summary with Implications

An experiment evaluated the forage value of crested wheatgrass (CWG) harvested throughout the grazing season near Sidney, Nebraska over a two-year period (2019–2020). The purpose of the evaluation was to determine forage quality and rumen undegradable protein (RUP) content to help producers with supplementation decisions for cattle grazing monoculture CWG pastures. In vitro dry matter disappearance quadratically decreased from 54% in May to 37% in September of 2019, with no changes throughout 2020, averaging 43%. In both years, crude protein (CP) decreased throughout the growing season while rumen undegradable protein (RUP) increased (as % CP). Digestible RUP was less than 0.50% of DM for all samples collected. Producers with cattle grazing CWG monoculture pastures could use these data to assist with supplementation decisions.

Introduction

Monoculture pastures of crested wheatgrass (CWG) are commonly grazed by cattle in the panhandle of Nebraska. In the vegetative stage, CWG peaks in CP content, which then decreases as it matures throughout the growing season. Mature CWG plants are low in protein, which may limit forage digestion and body weight gain in stockers; therefore, supplementation may be beneficial for part of the grazing season. Performance improvements have been observed for growing steers supplemented with 2 different protein sources while grazing CWG (*2017 Nebraska Beef Cattle Report*, pp. 36–37).

Although additional protein supplementation may improve the performance of growing cattle, there are limited data available on protein composition of CWG. Crude protein is a combination of rumen degradable protein (RDP) and rumen undegradable protein (RUP). Rumen degradable protein is utilized by microbes in the rumen and not directly available to the animal. The RUP fraction is not degraded by microbes in the rumen and is partially degraded by the animal in the gastrointestinal tract. As forages mature, the ratio of RDP:RUP and digestibility of protein change; therefore, CP alone does not accurately represent the amount of protein actually available to the animal throughout the grazing season. Metabolizable protein (MP) is the true protein digested in the small intestine and absorbed as amino acids and is calculated as Microbial CP + digestible RUP. The objective of this study was to evaluate the protein composition of CWG as it matured. Knowing the amount of RUP available to cattle grazing CWG can help producers calculate MP supply and aid supplementation decisions throughout the grazing period.

Procedure

Sample Collection

Two large pastures, comprised of 95% CWG, were divided into 13 paddocks (85 acres, 3 paddocks and 105 acres, 10 paddocks). Within each pasture, two paddocks were assigned at random for sampling (Pasture 1 = paddocks 2 + 4; Pasture 2 = paddocks 8 + 10). Forage samples were collected twice each month from two random locations within the assigned paddocks by hand clipping forage within a 0.25 m^2 quadrat at ground level. Plant species other than CWG were removed from the sample. For each year, samples were composited by pasture and month. Samples from 2019 (n = 10) were harvested in May, June, July, August, and September while 2020 samples (n = 8) were harvested in May, June, July, and August due to drought conditions. Local precipitation from May 1st to September 30th was 21.8 inches for 2019 and 5.9 inches for 2020 with a 10-yr average precipitation of 13.8 inches. Yearlings were stocked continuously throughout the grazing period at a density of 10.3 acres per steer on all paddocks.

Lab Analysis

Two steers with ruminal and duodenal cannulas were utilized to collect rumen fluid for the *in vitro* and *in situ* lab assays. Steers were fed a diet consisting of 70% smooth bromegrass hay, 23% dried distillers grains plus solubles, 6% dry rolled corn, and 1% supplement (twice daily).

A modified method was used for *in vitro* dry matter disappearance (IVDMD) with the inclusion of 1 g/L of urea to the McDougall's buffer to reduce variation among donor animals and their diets. An *in-situ* procedure was used to determine protein digestibility. Freeze dried CWG samples (2 mm particle size) were composited by month and pasture with 10 composite samples for year 1 and 8 samples for year 2. Samples were incubated in the rumen using Ankom R510 Dacron bags (1.25 g of sample/bag:16 bags/sample). All 18 samples were incubated in each steer with 8 replicates/sample/steer (144 bags/steer). Within each steer, 4 bags from each sample were incubated in the rumen for 20 hours and the remainder for 30 hours (20 hour, 72 bags/steer; 30 hour, 72 bags/steer). Post rumen incubation, half of the samples from each incubation time were assigned to duodenal incubation (20 hour, 36 bags/steer; 30 hour, 36 bags/steer). One bag from each rumen incubation time (and one from each steer) was assigned to each steer for a total of 4 bags/steer for each sample. Duodenal bags were incubated in a pepsin HCL solution (1g pepsin/L and 0.01 N HCl) maintained at 37˚C for 3 hours to simulate abomasum digestion before insertion.

Table 1. Crested wheatgrass through the 2019 grazing season at Sidney, NE

							Orthogonal Contrasts[7]		
Item	May	June	July	August	September	SEM	Linear	Quadratic	Cubic
CP, % DM[1]	9.5	7.7	6.6	6.2	6.3	0.10	<0.01	<0.01	0.35
RUP, % CP[2]	8.8	12.0	13.9	16.2	17.7	1.00	<0.01	<0.01	0.87
RUP, % DM[3]	0.80	0.90	0.93	0.98	1.09	0.06	<0.01	0.33	0.23
RUP dig., %[4]	39.9	43.3	42.3	45.3	46.6	5.72	0.02	0.45	0.21
Dig RUP, % DM[5]	0.40	0.43	0.42	0.45	0.49	0.03	0.02	0.94	0.45
IVDMD, % DM[6]	54.0	52.1	45.6	41.9	37.0	0.01	<0.01	0.02	0.35

[1] CP, % DM—Crude protein as a percent of total dry matter

[2] RUP, %CP—rumen undegradable protein as a percent of crude protein

[3] RUP, % DM—rumen undegradable protein as a percent of total dry matter

[4] RUP dig, %—rumen undegradable protein digestibility

[5] Dig RUP, % DM—digestible rumen undegradable protein as a percent of total dry matter (RUP as % of DM that is digested by cattle)

[6] IVDMD, % DM—In vitro dry matter disappearance as a percent of total dry matter

[7] Orthogonal Contrasts—*P*-values describing changes over time

Table 2. Crested wheatgrass through the 2020 grazing season at Sidney, Ne

						Orthogonal Contrasts[7]		
Item	May	June	July	August	SEM	Linear	Quadratic	Cubic
CP, % DM[1]	12.1	9.6	6.8	5.3	0.10	<0.01	0.02	0.05
RUP, % CP[2]	8.7	11.9	17.8	20.7	0.90	<0.01	0.92	0.19
RUP, % DM[3]	1.03	1.14	1.21	1.06	0.06	0.58	0.06	0.50
RUP dig, % CP[4]	35.4	36.1	38.0	39.8	5.42	0.25	0.85	0.90
Dig RUP, % DM[5]	0.37	0.36	0.38	0.40	0.04	0.49	0.73	0.86
IVDMD, % DM[6]	41.8	46.2	41.7	42.8	0.02	0.91	0.54	0.26

[1] CP, % DM—Crude protein as a percent of total dry matter

[2] RUP, %CP—rumen undegradable protein as a percent of crude protein

[3] RUP, % DM—rumen undegradable protein as a percent of total dry matter

[4] RUP dig, %—rumen undegradable protein digestibility

[5] Dig RUP, % DM—digestible rumen undegradable protein as a percent of total dry matter (RUP as % of DM that is digested by cattle)

[6] IVDMD, % DM—In vitro dry matter disappearance as a percent of total dry matter

[7] Orthogonal Contrasts—*P*-values describing changes over time

Bags were then placed in the duodenal cannula one at a time every 5 minutes, with a maximum of 18 samples per animal daily. Bags were recovered in the feces within 24 hours after duodenal insertion and placed in a freezer. At the end of the collection period, bags were thawed, rinsed, refluxed for 1 hour in neutral detergent solution, dried in a 60˚C forced air oven for 24 hours, and weighed to measure RUP digestibility. Samples that were only rumen incubated were also refluxed in neutral detergent solution to remove any microbial attachment and used to measure RUP content: RUP, % DM = [(Residue N * Residue weight) * 6.25]/original sample DM. All incubated samples were analyzed by Ward Laboratories for nitrogen content to calculate RUP (N remaining in bags after rumen incubation) and total tract indigestible protein (TTIDP; N remaining in bags recovered from feces).

Statistical Analysis

The mixed procedure of SAS 9.4 was used to analyze all data. Individual observations calculated from 4 bags (2 after rumen incubation and 2 after duodenal incubation) for each composite sample were considered an experimental unit. Orthogonal contrasts were used to analyze changes in forage quality over time. Due to very different precipitation amounts in the 2 years, data were analyzed by year with month and pasture as fixed effects for IVDMD and CP data. Steer was included as a random effect for RUP and RUP digestibility data with pasture, month, and rumen incubation time as fixed effects. A *P*-value of less than 0.05 was considered significant.

Results

There were no significant interactions between month and incubation time ($P \geq 0.28$) and no significant biological effects of 20-hour and 30-hour incubation times ($P \geq 0.07$). Therefore, main effects of month are shown in Tables 1 and 2 for 2019 and 2020, respectively. Forage quality quadratically decreased throughout the growing season in 2019 (IVDMD, $P = 0.02$) but stayed relatively stable in 2020 ($P \geq 0.26$). This was primarily due to low IVDMD early in 2020 which likely resulted from minimal new growth during the drought and dead

mature plant matter from the previous year being included in the sample. In both years, CP decreased throughout the grazing season ($P \leq 0.02$) while RUP as a percent of CP increased ($P < 0.01$). In 2019, RUP (% DM) and RUP digestibility increased linearly throughout the growing season ($P \leq 0.02$) resulting in greater digestible RUP (% DM) later in the growing season. In 2020, RUP (% DM), RUP digestibility, and digestible RUP (% DM) did not significantly change throughout the grazing season ($P \geq 0.06$). These data suggest that CWG may increase in digestible RUP throughout the growing season in years with above average precipitation while forage quality, including digestible RUP, remains relatively constant throughout the growing season in years with below average precipitation. Research reported in the *2023 Nebraska Beef Cattle Report* (pp. 26–28) suggests a positive economic impact from supplementing additional RUP to yearlings grazing crested wheatgrass during the grazing season.

Conclusion

In a monoculture CWG pasture being continuously grazed, CP decreased throughout the grazing season as RUP (% CP) increased. Digestible RUP of CWG ranged from 0.36 to 0.49 (% DM) throughout the grazing season for two consecutive years with varying precipitation. Nutritionists that have clients grazing yearlings on CWG monoculture pastures should assume that less than 0.5% of all DM consumed is digestible RUP.

Kelton C. Adair, Graduate Student, University of Nebraska-Lincoln

Karla H. Wilke, Professor, Animal Science, Panhandle Research and Extension Center, Scottsbluff

Andrea K. Watson, Research Associate Professor, Animal Science, University of Nebraska–Lincoln

James C. MacDonald, Professor, Animal Science, University of Nebraska–Lincoln