Effects of grazing intensity and advancing season on chemical composition and in vitro organic matter disappearance in steers supplemented with dried distillers grains grazing mixed-grass prairie

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The objectives of this study were to evaluate the effects of advancing season and grazing intensity on diet chemical composition and in vitro organic matter disappearance (IVOMD). The results indicate that advancing season does and grazing intensity does not influence chemical composition of the diet. The influence of grazing intensity may have been mitigated by the supplemental feeding of dried distillers grains with solubles.

Summary

A study was conducted to evaluate the influence of advancing season and grazing intensity on dietary chemical composition and in vitro organic matter disappearance (IVOMD) in beef steers grazing mixed-grass prairie in the Missouri Coteau of south-central North Dakota. Five sampling periods were conducted from mid-May to early September 2015. Twelve ruminally cannulated crossbred steers were used to collect diets, while 188 crossbred steers were used to maintain specific grazing intensities on 12 pastures. Treatments were light (LT), moderate (MOD), heavy (HVY) and extreme (EXT) grazing intensities. Each treatment was assigned to three pastures. Grazing treatment × sampling period interactions were not present ($P \geq 0.29$) for all variables measured except IVOMD ($P < 0.01$). We found no main effects of grazing treatment for neutral detergent fiber (NDF), acid detergent fiber (ADF), total nitrogen (N), soluble N (SN), insoluble N (IN), and acid detergent insoluble nitrogen (ADIN). Responses to grazing season were evaluated with linear, quadratic and cubic contrasts. Neutral detergent fiber increased linearly ($P < 0.01$) and cubically ($P = 0.01$), while ADF tended (P = 0.17) to increase linearly with advancing season. Dietary N decreased linearly ($P < 0.01$), quadratically ($P = 0.01$) and cubically ($P = 0.01$). Soluble N and IN expressed a linear ($P < 0.001$) and quadratic ($P = 0.03$) decrease across advancing season, while IN also showed a cubic response ($P < 0.001$). Acid detergent insoluble N did not change as the season advanced ($P > 0.14$). In vitro OM digestibility decreased from May to September ($P < 0.01$) in all sampling periods, but did not show any trends across treatments ($P = 0.82$). However, IVOMD did show a treatment × period interaction ($P < 0.01$). In summary, these data indicate increases ($P < 0.001$) in dietary NDF and decreases ($P < 0.001$) in N, SN, IN and IVOMD with advancing season. These data suggest seasonal factors are a more important driver of grazed masticate forage nutrient composition than the grazing intensities evaluated in this study.

Introduction

The dietary chemical composition of grazed forage, when coupled with forage intake and digestion, are important factors in rangeland-based cattle production systems. We know that as forage maturity increases, dietary crude protein (CP), digestibility and intake often decline, while dietary fiber usually increases (McCollum et al., 1985; Olson et al., 1994; Johnson et al., 1998; Cline et al., 2009).

Bryant et al. (1970) found that if grazing pressure is intense enough to cause a low availability of herbage, the quality of herbage ingested decreases due to the reduced opportunity for selective grazing. Furthermore, as grazing intensity increases, diet quality decreases (Pieper et al., 1959).

Maintaining herds on native grass to reduce input costs of harvested and purchased feeds is common for beef cattle operations. Therefore, modulating cattle stocking rates on pasture is a common management tool used to achieve long-term goals of optimizing forage use, livestock production and agroecosystem sustainability (Biondini et al., 1998).

However, information regarding the impact of grazing intensity on forage intake and digestion by cattle grazing mixed-grass prairie is lacking. Hence, our objectives were to evaluate the effects of advancing season and grazing intensity on diet

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chemical composition and in vitro OM digestibility (IVOMD) by steers grazing mixed-grass prairie in the Missouri Coteau of south central North Dakota.

Experimental Procedures

Protocols described herein were approved by the North Dakota State University Institutional Animal Care and Use Committee. Angus-cross beef steers (n = 188; 706 ± 77.6 pounds initial body weight [BW] were used to establish grazing pressure, and 12 ruminally cannulated steers (600 ± 74.1 pounds) co-grazed with the noncannulated animals.

All steers had free access to water and trace mineral salt blocks (salt 95.5 to 98.5 percent, zinc 3,500 parts per million [ppm], iron 2,000 ppm, manganese 1,800 ppm, copper 280 to 420 ppm, iodine 100 ppm and cobalt 60 ppm; American Stockman Hi-Salt with EDDI; North American Salt Co., Overland Park, Kan.).

Steers were fed dried distillers grains with solubles (DDGS) daily at sunrise at 0.3 percent of their BW. All animals were weighed every 28 days to determine gains as the grazing season progressed, as well as to adjust the DDGS fed. All steers were implanted with Revalor-G (40 milligrams [mg] of trenbolone acetate and 8 mg estradiol; Intervet Inc., Millsboro, Del.) one day before being turned out on pasture.

The grazing trial was conducted at the Central Grasslands Research Extension Center (CGREC) on the Missouri Coteau in south-central North Dakota. The study site had been divided into 12 pastures of approximately 31.9 acres each in 1989. Cattle grazed from May 15 to Sept. 11, 2015. Patton and Nyren (2014) reported the botanical composition of the plant communities at the study site the year before this study.

The most common grasses in 2014 were Kentucky bluegrass *(Poa pratensis L.)*, western wheatgrass *(Pascopyrum smithii A.)*, sun sedge *(Carex inops)*, green needlegrass *(Nassella viridula)*, obtuse sedge *(Carex obtusata Lilj.)* and blue grama *(Bouteloua gracilis)*. Common forbs were heath aster *(Symphyotrichum ericoides)*, common dandelion *(Taraxacum officinale)* and western yarrow *(Achillea millefolium L.)*. Buckbrush *(Symphoricarpos occidentalis)* was the only common shrub.

Steers were stocked at densities so that at the end of the grazing season, 65 (LT), 50 (MOD), 35 (HVY) and 20 percent (EXT) of an average annual above-ground biomass remained at the end of the grazing season. Each of the cannulated steers was assigned to a pasture at random, with each treatment having three pastures. Animals were removed at the end of the grazing season when forage utilization on half of the pastures had reached desired grazing intensity.

Five 10-day collection periods were conducted for May, June, July, August and September. Sampling periods began with collection of diet samples.

At sunrise, cannulated steers were restrained and subjected to total ruminal evacuation. Ruminal digesta was removed physically from each cannulated steer and the rumen then was double-rinsed with water to assure complete removal of contents.

Steers then were allowed to graze on their assigned pastures for 30 to 45 minutes. Then ruminal masticate samples were removed, labeled and immediately placed on ice. Previously collected ruminal contents were placed back in the animal. All samples then were frozen at minus 20 C for later analysis.

Masticate samples were lyophilized (Genesis 25LL, Virtis, Gardiner, N.Y.). Dry matter, ash and CP were determined using AOAC (1990). Neutral detergent fiber and ADF of diet samples were determined using ANKOM procedures (ANKOM, Macedon, N.Y.). Acid detergent insoluble N was calculated as N remaining in the ADF residue.

Soluble N was extracted with 0.15 M NaCl according to the procedure of Waldo and Goering (1979). In vitro OM digestibilities (Tilley and Terry, 1963) were conducted to determine IVOMD. Masticate forage and ruminal fluid collected from each animal was used for in vitro determinations.

Chemical composition and IVOMD were analyzed as a repeated measures design using a mixed model approach in SAS (SAS Inst. Inc., Cary, N.Y.). Effects for sampling period, grazing treatment and period × treatment interactions were included in the model. In the absence of interactions, orthogonal contrasts were used to determine linear, quadratic and cubic, responses across the grazing season (sampling period).

Sampling period × grazing treatment interactions ($P \leq 0.05$) were detected for IVOMD; therefore, the simple effect means were separated using the LSMEANS statement in SAS. The procedures of SAS were used for all statistical analysis and P-values ≤ 0.05 were considered different.

Results and Discussion

No treatment × period interactions ($P > 0.05$) were observed for diet analyses, with the exception of interactions of IVOMD, which will be discussed later in this section. Therefore, main effect means are reported for grazing intensity treatment and grazing period (Table 1).

Organic matter, NDF and ADF of cattle diets were not affected ($P > 0.05$) by grazing intensity. Crude protein, total N, soluble N (SN), insoluble N (IN) and ADIN also did not differ among grazing intensity treatments ($P > 0.05$).

Table 1 shows the effects of

grazing intensity and advancing season on the chemical composition of the diet as well as IVOMD. Neutral detergent fiber and ADF changed with advancing season ($P < 0.01$). These results coincided with Olson et al. (1994) for south-central North Dakota, Johnson et al. (1998) for western North Dakota and McCollum et al. (1985) for south-central New Mexico.

Neutral detergent fiber increased with advancing season ($P < 0.01$ and $P = 0.01$, respectively for a linear and cubic response) and ADF tended ($P = 0.17$; linear) to increase as the season advanced. These responses are supported by previous data from south-central North Dakota (Olson et al., 1994) and western North Dakota (Johnson et al., 1998), as well as south-central New Mexico (McCollum et al., 1985); these researchers observed similar responses.

Nitrogen (percent of OM) decreased linearly ($P < 0.01$), quadratically ($P < 0.01$) and cubically ($P < 0.01$) as the season advanced. Typically, forage masticate N concentration declines with increasing forage maturity associated with advancing season. Such was the case in our study and the work of others within the region (Olson, et al., 1994; Johnson, et al., 1998; Cline et al., 2009). Soluble N decreased ($P < 0.01$) in a linear fashion, whereas IN data were represented by declining linear, quadratic and cubic responses ($P < 0.01$).

McCollum et al. (1985) also found that N, SN and IN decreased with advancing grazing season. In the present study, ADIN was not impacted by advancing season. However, Cline et al. (2009) observed an increase in ADIN from late June to mid-November.

We found a sampling period × by grazing intensity interaction ($P = 0.01$; Table 1) for in vitro organic matter disappearance (IVOMD); therefore, interactive means are discussed (data not shown). In vitro OM digestibility decreased from May to September ($P < 0.05$) in all grazing intensities. In May, IVOMD was similar across all grazing intensities ($P > 0.05$). In June, LT and MOD had greater ($P < 0.05$) IVOMD, compared with HVY, while EXT was similar to all grazing intensities (75.7, 73.4, 62.9 and 69.1 ± 2.8 percent, respectively).

In July, LT had the lowest and HVY the greatest IVOMD ($P < 0.05$). In August, LT had similar ($P > 0.05$) IVOMD, compared with all other grazing intensities, while MOD was lower ($P < 0.05$) than HVY. In September, IVOMD was 52.5, 44.9, 50.3, and 42.8 ± 5.1 percent; $P > 0.05$) for LT, MOD, HVY and EXT grazing intensities.

Table 1. Effects of grazing intensity and advancing season on dietary chemical composition and in vitro OM digestibility (IVOMD) in steers grazing mixed-grass prairie.

	Grazing Intensity (TRT)[1]					Grazing Period (PD)[2]						*P*-value[3]					
Item	LT	MOD	HVY	EXT	SEM[4]	May	Jun	Jul	Aug	Sep	SEM[5]	TRT	PD	TRT × PD	L	Q	C
No. of Observations	15	15	15	15	-	12	12	12	12	12	–	–	–	–	–	–	-
OM, %	81.3	82.2	80.6	82.3	1.49	74.6	82.4	83.9	83.7	83.2	3.08	0.83	0.05	0.44	0.02	0.02	0.16
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NDF	67.5	69.6	70.7	65.6	2.05	58.4	69.9	67.5	70.7	75.2	3.81	0.34	<0.01	0.89	<0.01	0.32	0.01
ADF	38.5	40.2	41.5	36.1	1.85	37.2	38.5	37.1	39.5	43.1	4.05	0.25	<0.01	0.87	0.17	0.33	0.44
CP	18.7	17.7	17.8	19.6	0.63	29.9	18.3	16.9	14.9	12.3	0.86	0.18	<0.01	0.63	<0.01	<0.01	<0.01
N	2.99	2.84	2.85	3.14	0.10	4.78	2.92	2.70	2.38	1.97	0.14	0.18	<0.01	0.63	<0.01	<0.01	<0.01
Soluble N	0.70	0.73	0.69	0.82	0.06	1.08	0.81	0.66	0.57	0.55	0.09	0.36	<0.01	0.29	<0.01	0.03	0.73
Insoluble N	2.28	2.11	2.16	2.32	0.08	3.70	2.11	2.05	1.81	1.42	0.12	0.22	<0.01	0.59	<0.01	<0.01	<0.01
ADIN	0.48	0.42	0.44	0.47	0.04	0.52	0.37	0.47	0.44	0.45	0.06	0.77	0.26	0.93	0.70	0.31	0.15
IVOMD	60.4	62.6	63.4	60.6	2.62	75.9	70.3	62.1	52.8	47.6	3.35	0.82	<0.01	0.01	0.97	0.97	0.14

[1]LT = light, MOD = moderate, HVY = heavy and EXT = extreme grazing intensities.

[2]Grazing period collections were May (May 11 to 22), Jun (June 10 to 19), Jul (July 8 to 17), Aug (Aug. 5 to 14), and Sep (Sept. 2 to 11).

[3]Significance level of the F-test for treatment (TRT), period (PD), treatment by period (TRT × PD), linear (L), quadratic (Q) and cubic (C) effects for items.

[4]Standard error of mean for grazing intensity, n = 15. Most conservative standard error mean values were used.

[5]Standard error of mean for grazing period, n = 12. Most conservative standard error mean values were used.

The results of this study demonstrate that grazed forage by beef cattle in the Missouri Coteau increase in fiber and decrease in N as season advances. Grazing intensity had little impact on grazed forage nutrient composition. Consequently, previously observed differences in livestock production due to grazing intensity in the Missouri Coteau must be driven by changes in dietary intake or in vivo digestion. Additional research accessing changes in intake and rates of digestion are needed.

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