RUMINAL FERMENTATION AND INTESTINAL NUTRIENT FLOWS IN STEERS GRAZING RANGELAND IN THE SUMMER

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Story in Brief

Fistulated beef steers grazing tallgrass rangeland were used to monitor intake, ruminal fermentation and nutrient flows to the small intestine during four trials in both the 1986 and 1987 grazing seasons (May-September). Intakes in 1986 remained around 2.1% of body weight throughout the first three trials and decreased to 1.9% in late September, whereas 1987 intakes declined throughout the season, from 1.8% body weight in mid-May to 1.4% in late September. Nitrogen intake declined with advancing season both years. Duodenal flow of nitrogen exceeded nitrogen intake in all 1986 trials and in two 1987 trials. True ruminal digestion of organic matter remained fairly stable throughout the 1986 season, and ruminal ammonia nitrogen (mg/100ml) ranged from 7.1 in May to 2.6 in late September. In 1987, true ruminal digestion declined the latter half of the summer, and ruminal ammonia levels ranged from 3.8 in May to 1.4 in August. Microbial efficiency (g microbial nitrogen/kg organic matter truly fermented) did not change across trials in either year. Although no significant differences occurred, microbial efficiency tended to be lower in mid-season of both years suggesting an imbalance of ruminal substrates for microbial synthesis.

(Key Words: Ruminal Fermentation, Duodenal Flow, Rangeland, Microbial Efficiency, Intake.)

Introduction

The influence of advancing season on growth and nutritive value of range plants in relation to daily requirements of grazing animals is well noted. However, information concerning the relationship between diet quality, ruminal environment and nutrient utilization in grazing cattle is quite limited. A more complete understanding of these relationships will aid the

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development of nutrition and grazing management programs that will improve the efficiency of livestock production from forages.

Studies were conducted in 1986 and 1987 to investigate the seasonal changes in diet quality, forage intake and nutrient utilization that occur on tallgrass prairie rangeland in central Oklahoma. Portions of these studies are discussed in this report.

Materials and Methods

Cattle were grazed on moderately stocked tallgrass prairie rangeland located 12 miles southwest of Stillwater. Range condition on the area was high fair-low excellent and the vegetation was dominated by big bluestem, little bluestem and switchgrass.

Four 10-day trials were conducted both years: mid May, late June, mid August and late September. Diet samples were collected from esophageally fistulated steers during each trial. The procedures are reported in another article in this publication (Campbell and McCollum, 1989). Six ruminally and duodenally cannulated beef steers (Angus x Hereford and Limousin x Hereford) were used to estimate intake and monitor ruminal fermentation in 1986. Eight ruminally and duodenally cannulated beef steers (Angus x Hereford, Limousin x Hereford and Hereford) were used in 1987. Chromic oxide powder was used as an external marker to estimate fecal output and duodenal flow. Purine content of digesta was utilized to estimate microbial contribution to duodenal flow. Intakes were calculated by fecal output/(1-in vitro organic matter digestibility). Fecal samples began after five days continuous dosage of chromic oxide and consisted of five samples over a three day period. Samples were composited within steer, dried in a forced air oven at 50°C and ground through a 1 mm screen. Duodenal digesta was collected at 1600 hours on day 7, 0200, 1200 and 2000 hours on day 8 and 0800 hours on day 9 of each trial. Digesta was composited across sampling times for each steer and lypholized. Fecal and duodenal samples were analyzed for ash, kjeldahl nitrogen, purines and chromium. Ruminal fluid was collected at 0800, 1400 and 2000 hours on day 9, and 0200 and 0800 hours on day 10 of each trial. Fluid was strained through cheesecloth, acidified and immediately frozen in plastic whirlpaks until analyzed for ammonia nitrogen. Addition fluid was collected and composited across steers for bacterial pellet isolation. The fluid was preserved with formaldehyde, centrifuged, and the resulting bacterial pellet washed and lypholized. Analysis included kjeldahl nitrogen and purine concentration.

Years were analyzed separately due to a significant year x trial interaction. Data from 1986 were analyzed by least squares procedures with

a model containing trial and steer. In 1987, steers were blocked according to weight, resulting in a model containing trial, block and steer within block.

Results and Discussion

Intakes when expressed as percent of body weight, remained fairly stable throughout the first three trials of 1986 and then declined ($P<.05$) in late September (Table 1). Intakes in the last two trials of 1987 were lower ($P<.05$) compared to May and June trials (Table 1). Intake is influenced by advancing maturity of forage and the accompanied increase in fiber content. In 1986, diet ADF tended to increase as the summer progressed, changing from 42.9% in May to 44.9% in August and 47.6% in September (Campbell and McCollum, 1988). Intakes reflected this change. Intakes in 1987 also reflected the ADF content of the diets, which increased from mid-May through mid-August and stabilized through late September (Campbell and McCollum, 1989).

In 1987, a significant block effect occurred for intake expressed as percent of body weight. Forage intake by steers in the heavy block (average wt. 1400 lb), averaged over the summer, were 21.1% lower than the smaller steers (average wt 1005 lb). When the heavier steers were excluded, intakes

Table 1. Organic matter intake and flow to the small intestine.

		Trial			
Component	Year	Mid May	Late June	Mid August	Late September
Steer wt, lb	86	603	708	777	840
	87	1122	1166	1241	1274
Intake, g/d	86	5620^{a}	6784^{b}	7394^{c}	7146^{bc}
	87	8910^{a}	8914^{a}	8505^{a}	7894^{b}
Intake, % of body wt	86	2.05^{ab}	2.11^{a}	2.09^{a}	1.88^{b}
	87	1.80^{a}	1.73^{a}	1.53^{b}	1.38^{b}
Passage, g/d					
Duodenal	86	3002^{a}	3578^{ab}	4217^{bc}	4449^{c}
	87	5273	5313	5620	5488
Forage	86	2364^{a}	2778^{ab}	3421^{bc}	3627^{c}
	87	4248^{a}	4485^{ab}	4927^{c}	4670^{bc}
Microbial	86	638^{a}	800^{b}	796^{b}	822^{b}
	87	1025^{a}	828^{b}	693^{c}	818^{b}
Digestion, % of intake					
Ruminal, apparent	86	46.1	47.2	43.0	37.7
	87	40.5^{a}	40.4^{a}	33.6^{b}	30.3^{b}
Ruminal, true	86	57.6	59.0	53.8	49.2
	87	52.1^{a}	49.7^{a}	41.9^{b}	40.7^{b}

^{a,b,c}Row means with different superscripts are different ($P<.05$).

were 2.1, 1.9, 1.7 and 1.5% body weight in mid May, late June, mid August and late September, respectively. Steers in the heavy block were obese Herefords. Therefore, lack of productive function and high body fat levels resulted in lower intake as a function of body weight.

Nitrogen intake declined with advancing season both years (Table 2). In 1986, nitrogen intake declined 28.6%, from 119.9 g/day in mid May to 85.6 g/day in late September. A decrease of 51.6% in nitrogen intake was noted in 1987, declining from 191 g/day in mid May to 92.5 g/day in mid August. Differences in total nitrogen intake (g/day) between years is not only due to differences in nitrogen concentration in the diet, but also to differences in total organic matter intake (g/day). In 1986, total organic matter intake increased as the season advanced as a result of weight gain by the steers. Also, steers used in 1987 were larger than steers utilized in 1986, therefore total intake was higher in 1987.

Nitrogen reaching the small intestine exceeded nitrogen intake in all 1986 trials, and during the last two trials of 1987. Forages containing less than 2 to 2.5% nitrogen are normally associated with a net gain of nitrogen reaching the duodenum relative to ingested nitrogen. This gain is the result of nitrogen recycling into the rumen. Microbial growth is dependent on the amount of fermentable organic matter and nitrogen available in the rumen. Previous research has suggested that ruminal microbes require between 2

Table 2. Nitrogen intake and flow to the small intestine.

		Trial			
Component	Year	Mid May	Late June	Mid August	Late September
Intake	86	119.9^{a}	99.8^{b}	90.2^{bc}	85.6^{c}
	87	191.0^{a}	151.4^{b}	92.5^{c}	101.3^{c}
Passage, g/d					
Duodenal	86	155.2	154.0	168.7	142.3
	87	215.1^{a}	198.5^{a}	165.1^{b}	161.5^{b}
Forage	86	92.3^{ab}	87.1^{ab}	99.7^{a}	80.3^{b}
	87	190.2^{a}	175.8^{a}	149.9^{b}	144.0^{b}
Bacterial	86	58.4	62.6	63.5	57.1
	87	99.3^{a}	80.6^{b}	63.0^{c}	72.2^{bc}
Digestion, % of intake					
Ruminal, apparent	86	-31.2^{a}	-54.8^{ab}	-86.8^{c}	-65.2^{bc}
	87	-13.2^{a}	-31.6^{b}	-79.2^{d}	-59.7^{c}
Ruminal, true	86	22.0^{a}	12.6^{ab}	-10.4^{c}	6.5^{b}
	87	42.1^{a}	25.7^{b}	- 6.0^{c}	17.4^{b}
Microbial Eff., g microbial N/kg OM truly fermented	86	18.4	15.8	16.0	19.1
	87	21.6	18.3	18.4	23.0

^{a,b,c,d}Row means with different superscripts are different (P<.05).

and 5 mg NH_3-N/100 ml rumen fluid. True ruminal organic matter digestion did not change significantly throughout the 1986 season (Table 1), and ruminal ammonia-N levels remained above 2 mg/100 ml (Figure 1). Microbial efficiency values did not change (P>.05) across the 1986 season (Table 2). In 1987, true ruminal digestion of organic matter declined the last two trials. However, differences in microbial efficiency were only noted in mid August, during the same trial in which ammonia-N levels dropped below 2 mg/100 ml.

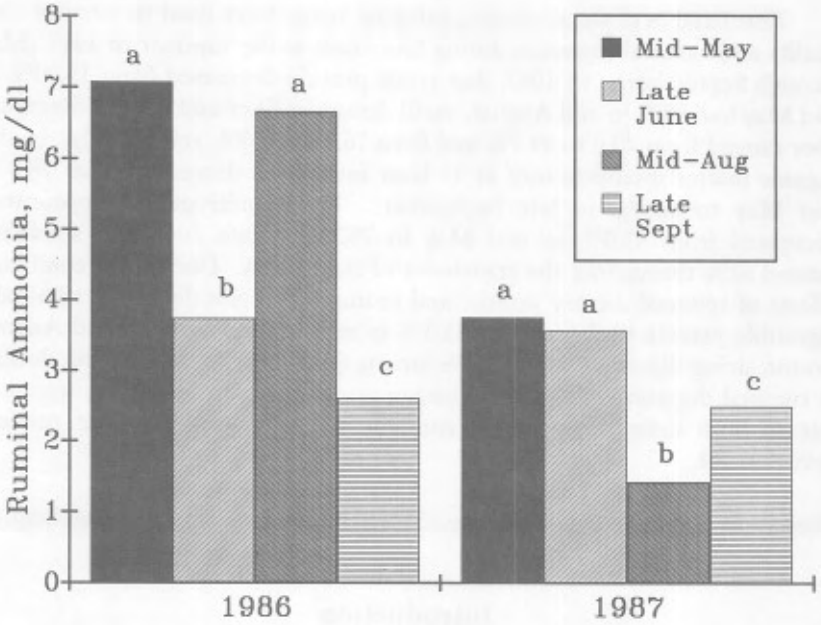

Figure 1. Ruminal ammonia-N concentration, mg/100 ml. ^{a,b,c,d}Means within a year with different superscripts are different (P<.05).

Literature Cited

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