Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 1 *Cattleman's Day (1993-2014)*

Article 883

1989

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Recommended Citation

DelCurto, T.; Cochran, R.C.; Corah, L.R.; Beharka, A.A.; and Vanzant, E.S. (1989) "Influence of supplemental protein concentration on intake, utilization, and quality of diet selected by steers grazing dormant tallgrass-prairie," *Kansas Agricultural Experiment Station Research Reports*: Vol. 0: Iss. 1. https://doi.org/10.4148/2378-5977.2286

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Abstract

Fifteen ruminally and 12 esophageally cannulated steers were randomly assigned to receive low (LP), moderate (MP), and high (HP) crude protein (CP) supplements in a 23-day winter grazing trial designed to evaluate dormant tallgrass forage intake and utilization. Supplemental CP levels were 13, 26, or 39%, respectively. Forage organic matter (OM) intake was greatest (P<.05) for the MP steers. Likewise, fiber (NDF) digestibility and ruminal fill were largest (P<.10) for the MP treatment. Furthermore, the quality of diet selected tended to improve with increasing supplemental protein concentration. Increasing CP concentration in supplements dramatically improves the intake and utilization of dormant forage. In this study, intake and digestibility were optimized with the MP supplement.

Keywords

Cattlemen's Day, 1989; Kansas Agricultural Experiment Station contribution; no. 89-567-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 567; Beef; Protein concentrations; Intake; Utilization; Quality; Steers; Dormant tallgrass-prairie

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INFLUENCE OF SUPPLEMENTAL PROTEIN CONCENTRATION ON INTAKE, UTILIZATION, AND QUALITY OF DIET SELECTED BY STEERS GRAZING DORMANT TALLGRASS-PRAIRIE

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Summary

Fifteen ruminally and 12 esophageally cannulated steers were randomly assigned to receive low (LP), moderate (MP), and high (HP) crude protein (CP) supplements in a 23-day winter grazing trial designed to evaluate dormant tallgrass forage intake and utilization. Supplemental CP levels were 13, 26, or 39%, respectively. Forage organic matter (OM) intake was greatest (P<.05) for the MP steers. Likewise, fiber (NDF) digestibility and ruminal fill were largest (P<.10) for the MP treatment. Furthermore, the quality of diet selected tended to improve with increasing supplemental protein concentration. Increasing CP concentration in supplements dramatically improves the intake and utilization of dormant forage. In this study, intake and digestibility were optimized with the MP supplement.

Introduction

Previous research at Kansas State University indicates that moderate to high levels of supplemental crude protein (CP) stimulates forage intake and utilization. Those studies were conducted in confinement with harvested dormant forage. With controlled studies simulating winter grazing conditions, however, protein supplementation often yields variable responses. Responses to supplemental protein are most likely to be observed when the CP content of forages are less than 6 to 8%. As the digestibility of forage declines, however, the availability of the CP to the microbial population and host animal also declines. Therefore, forage digestibility as well as CP content must be considered when predicting intake responses to supplemental protein.

The objective of this study was to evaluate the effect of increasing CP concentrations in supplements fed to beef steers grazing dormant, tallgrass-prairie forage.

Experimental Procedures

Fifteen ruminally and 12 esophageally cannulated Angus x Hereford steers averaging 703 and 783 lbs, respectively, were used in a randomized complete block design. Steers were blocked by weight and assigned to: 1) low protein, 13% CP supplement; 2) moderate protein, 26% CP supplement; or 3) high protein, 39% CP supplement. Low, moderate and high protein supplements were individually fed at .5% body weight and corresponded to 39.7%, 79.3%, or 119.8%, respectively, of the CP required by 700 lb yearling steers gaining .5 lb per head daily.

The forage utilization study simulated normal winter grazing conditions typical of the tallgrass prairie region. Two adjacent 10-acre pastures were used during the 23-day study.

The vegetation consisted of big bluestem (*Andropogon gerardii*), little bluestem (*Andropogon scoparius*), indiangrass (*Sorghastrum nutans*), Kentucky bluegrass (*Poa pratensis*), sedges (*Carex spp.*), and numerous other grasses and forbs. The ruminally and esophageally cannulated steers were maintained separately, but groups were rotated between pastures daily to decrease the potential for variation from differences between pastures. The 23-day trial began in mid-December and consisted of a 16-day adaptation period, 6-day fecal collection period, and complete ruminal evacuations on day 23. Esophageal collections were taken on days 17 through days 20 at 7 A.M., 10 A.M., 1 P.M., and 4 P.M.

Results and Discussion

The percentage of organic matter (OM) in forage was unaffected (P>.10) by supplement treatment (Table 16.1). Low percentage OM (83.5%) in esophageal samples reflect salivary contamination and reinforces the need to express other nutrients on an OM basis. The CP content in the forage OM selected tended to increase in direct proportion (P=.14) to increasing supplemental protein concentration. The selected diet was 8.7% CP when averaged across treatments. Similar forage harvested during winter months and fed to confined steers was less than 3% CP. Under normal grazing conditions, therefore, steers appear to select a diet substantially higher in CP than the average quality of forage available. Steers in this study may have preferentially selected Kentucky bluegrass and sedges, which are cool-season species and would have higher CP contents than the warm-season forage component. If ash contribution and acid detergent insoluble nitrogen (ADIN) are factored in, however, the CP in the forage DM falls to 5 to 6%. In addition, contamination from salivary nitrogen would be expected to elevate CP levels. Acid detergent insoluble nitrogen tended (P=.10) to decrease linearly with increasing supplemental protein and represented over 30% of the total forage nitrogen for all supplement treatments. Acid detergent lignin concentrations in forage OM were relatively unaffected (P>.10) by supplemental protein treatments. In contrast, the fiber (NDF) content in the forage OM decreased (P<.10) in direct proportion to increasing supplemental protein. Acid detergent fiber (ADF) in the grazed forage was lowest (P<.10) for the MP steers.

Forage and total OM intake increased (P<.05) with protein supplementation, with the MP steers having the highest intakes (Table 16.2). On a percent body weight basis, MP steers consumed 50% and 32% more forage than LP and HP steers, respectively. The depression in forage intake associated with the HP supplement was unexpected. In a similar study in which dormant tallgrass forage was harvested and fed to confined steers, MP steers also consumed slightly more forage than HP steers. However, both supplements supported higher intakes than the LP supplement.

Total OM digestibility tended (P=.15) to exhibit the same pattern as intake, with MP steers having the highest digestibilities. Fiber (NDF) digestibility was affected similarly (P<.10); MP steers had 37% and 29% higher NDF digestibilities than LP and HP steers, respectively. Once again, the trend toward lower digestibility in HP vs. MP supplementation was unexpected and may have been due to the trend toward higher diet quality selected by MP steers.

Total OM fill (from ruminal evacuations) followed the same trend (P<.10) as that observed for forage intake (Table 16.3). Steers fed MP supplements had 19% and 26% more fill than LP and HP steers, respectively. In contrast, indigestible fiber (APL) fill and passage were unaffected (P>.10) by supplemental protein concentration. Ruminal liquid volume tended (P=.11) to increase in direct proportion to increasing supplemental protein concentration, but rate of liquid passage was not influenced (P>.10).

In conclusion, increasing supplemental protein concentration dramatically improved the intake and utilization of dormant, tallgrass prairie forage. In this study, the steers supplemented with moderate levels of CP (26%) displayed the highest forage intake levels and fiber digestibilities.

Table 16.1. Effect of Supplemental Protein Concentration on Quality of Diet Selected by Esophageally Cannulated Steers

Item	Low Protein	Moderate Protein	High Protein	SE[a]	Contrasts[b] Linear	Quadratic
Organic Matter, %	83.1	83.6	84.0	.6	.344	.915
ADIN[c]	34.5	31.0	29.6	1.8	.102	.643
	- - % of Forage Organic Matter - -					
Crude Protein	8.26	8.76	8.94	.28	.139	.658
NDF[d]	80.7	78.5	78.9	.6	.087	.149
ADF[e]	63.6	61.3	62.3	.6	.197	.064
ADL[f]	10.5	10.2	9.6	.4	.185	.829

[a]Standard error of the means (n=4).
[b]Probability of observing a greater F-value.
[c]ADIN = acid detergent insoluble nitrogen expressed as percent of total N.
[d]NDF = neutral detergent fiber.
[e]ADF = acid detergent fiber.
[f]ADL = acid detergent lignin.

Table 16.2. Effect of Supplemental Protein Concentration on OM Intake and Digestibility in Ruminally Cannulated Steers

Item	Supplemental Protein: Low Protein	Moderate Protein	High Protein	SE[a]	Contrasts[b]: Linear	Quadratic
OM Intake, lb						
Forage	6.19	9.28	7.14	.84	.430	.016
Supplement	3.26	3.22	3.17			
Total	9.46	12.50	10.32	.84	.467	.016
OM Intake, % body wt:						
Forage	.87	1.31	.99	.10	.449	.033
Supplement	.47	.46	.46			
Total	1.34	1.77	1.45	.10	.487	.033
Total OMD, %[c]	43.3	48.9	44.5	2.6	.725	.152
Fiber Digestibility,%[d]	32.2	44.0	34.2	4.6	.771	.094

[a]Standard error of the means (n=5).
[b]Probability of observing a greater F-value.
[c]OMD = organic matter digestibility.
[d]Neutral detergent fiber digestibility.

Table 16.3. Effect of Supplemental Protein Concentration on Fill, Flow and Passage Rates in Ruminally Cannulated Steers

Item	Low Protein	Moderate Protein	High Protein	SE[a]	Contrasts[b]: Linear	Quadratic
Total OM Fill, lb	8.2	9.7	7.7	.7	.738	.096
Indigestible Fiber (APL) Fill, lbs[c]	.44	.53	.44	.07	.847	.291
Indigestible Fiber (APL) passage, %/h[c]	3.1	3.4	3.4	.4	.557	.785
Indigestible Fiber (APL) Flow, g/h[c]	4.7	6.1	5.4	.8	.564	.308
Liquid Volume, liter	29.1	46.8	47.0	7.1	.112	.343
Dilution Rate, %/h	10.7	11.3	11.3	.6	.529	.668
Liquid Flow, liter/h	3.2	5.5	4.7	1.0	.305	.227

[a]Standard error of the means (n = 5).
[b]Probability of observing a greater F-value.
[c]Alkaline peroxide lignin (APL) was used to describe an indigestible fiber component of the diet.