

Effect of Supplementation Program on Intake and Utilization of Low Quality Prairie Hay by Steers

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Story in Brief

Sixteen 943 lb Hereford steers were used in four replications of a 4 x 4 latin square design to determine the effect of different supplementation programs on intake and digestibility of low to medium quality prairie hay (5.45 percent CP, dry matter basis). Prairie hay was given free choice. The four treatments were: 1) Control hay only, plus minerals-vitamin; 2) High protein (HP), 40 percent CP; 3) 20 percent CP, formulated to be low in starch (LS) and 4) 20 percent CP, formulated to be high in starch (HS). Daily DM intakes of the supplements were .24 lb, 2.1 lb, 4.0 lb and 4.0 lb, respectively, to provide equal levels of supplemental protein on the HP, LS and HS treatments.

All three protein supplementation programs significantly ($P < .01$) increased daily prairie hay intake, dry matter digestibility, apparent crude protein digestibility and ruminal ammonia compared with the control. No significant differences were observed, however, among the three different protein supplementation programs for forage intake, dry matter digestibility or apparent crude protein digestibility. Total daily digestible dry matter intake was highest on the 20 percent CP-LS and HS treatments. Rumen NH_3 concentration was very low ($P < .01$) on the control diet compared to the three protein supplement treatments, with ruminal NH_3 levels also being lower on the LS vs HS treatments.

Introduction

A positive effect of protein supplementation on low quality forage intake and utilization has been widely recognized. Protein supplements often vary greatly in protein content and can be formulated from a wide variety of feeds. Supplements containing from 20 percent to 40 percent all natural crude protein are often fed to beef cattle (stockers, replacement heifers and cows, dry or lactating) grazing or being fed low quality roughages. This is especially true during the wintertime when protein supplementation is common. Low quality forages commonly used include winter range pasture, marginal quality grass hays or cereal straws. While protein supplementation has been shown to be beneficial in improving forage intake and utilization of low quality forages, limited data has been reported about the effects of different types of protein supplementation programs (e.g. high vs low protein supplements fed at equal daily supplemental protein intakes; high vs low starch levels in the supplements; etc.). In addition to the effects of protein, starch content of the supplement might effect the rumen environment, altering activity of the ruminal microbial

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population. Forage intake, forage utilization and/or animal performance may be altered. Some feeds, which can be used to formulate low protein cubes (e.g. 20 percent CP) may be high in starch, such as grains, or low in starch, such as by-product feeds.

The objective of this study was to investigate the effects of high protein (40 percent) or low protein (20 percent) supplements, fed at equal supplemental protein intakes, on forage intake, digestibility, rumen ammonia and rumen pH using low to medium quality prairie hay with the low protein supplements being formulated to be either low or high in starch. Prairie hay, plus supplemental minerals and vitamins, was used as a control.

Materials and Methods

Sixteen mature Hereford steers (934 lb) were randomly allocated to metabolism stalls. A 4 x 4 latin square design was used with four replications (periods) and four treatments. There were four simultaneous replications of the latin square. The treatments were: Prairie hay, plus 1) minerals and Vitamin A (Control); 2) 40 percent CP, high protein supplement (HP); 3) 20 percent CP, low starch (LS) and 4) 20 percent CP, high starch (HS).

The ingredient composition of the supplements is shown in Table 1 and nutrient composition of the hay and supplements in Table 2. Low to medium quality prairie hay was fed "ad libitum" daily in all treatments. The HP, LS and HS supplements were fed twice daily to provide 2.1, 4.0 and 4.0 lb per day (DM basis), supplying equal levels of supplemental protein. Prairie hay, with only supplemental minerals and vitamin A, served as a control.

Each period in the Latin square was 17 days with days 1-7 being an adaptation period. Prairie hay, fed and rejected, was weighed on days 3-14, with total feces being collected on days 10-16. The rumen was sampled on day 17 within 4-8 hours after supplement was fed. Body weight was recorded at the end of each period.

Prairie hay (fed and rejected), supplements and feces were weighed and sampled for moisture and nitrogen determinations. All samples were also analyzed for acid detergent fiber, cellulose, lignin, starch and ash, although these

Table 1. Ingredient composition of the supplements (DM basis).

Ingredient	Control %	40% High Protein %	20% CP- Low Starch %	20% CP- High Starch %
Ground wheat	--	--	--	69.28
Wheat midds	--	--	84.16	--
Cottonseed meal	--	92.00	9.91	23.60
Molasses	--	2.60	5.00	5.00
KC1	37.81	1.60	--	.34
Dicalcium phosphate	54.02	2.80	--	1.28
CaCO ₃	--	--	.43	--
TM Salt	7.57	.93	.46	.46
Vitamin A (30,000 IU/g)	.60	.07	.04	.04

Table 2. Dry matter and crude protein content of prairie hay and supplements.

Item	Control ^b %	Treatment		
		40% High Protein %	20% CP- Low Starch %	20% CP- High Starch %
Dry matter, %	87.5	90.0	88.8	87.3
Crude protein, % ^a	5.54	40.5	20.2	22.1

^aDM basis^bComposition of hay

are not to be reported herein. The pH of the rumen fluid was determined immediately after sampling and the ruminal liquor was strained and frozen for ammonia determination.

Results and Discussion

Daily intake of prairie hay was significantly higher ($P < .01$) on all three protein supplementation treatments (40 percent HP, 20 percent CP-LS, 20 percent CP-HS) compared to the control (Table 3). There were no significant differences, however, in forage intake among the three protein supplementation programs with all values being very similar. Dry matter digestibility was increased ($P < .01$) from 45.9 percent on the control treatment to 54.2, 56.7 and 56.1 percent on the HP, LS and HS treatments, respectively. Moreover, intake of total digestible dry matter was increased substantially on the three supplementation programs, with digestible dry matter intakes being 3.7, 6.6, 7.9 and 7.9 lb per day on the control, HP, LS and HS treatments, respectively. Apparent digestibilities of the crude protein were very low ($P < .01$) on the control diet, with little difference among the three protein supplementation treatments. Corrections for metabolic fecal nitrogen would yield higher protein digestion coefficients. Ruminal NH_3 concentrations were generally low on all treatments, and were very low ($P < .01$) on the control diet. A lower ruminal NH_3 concentration on the LS treatment compared to the HP and HS treatments ($P < .01$ for HS) may be related to source of protein in the supplements since the LS supplement contained the least CSM. No significant differences existed in the pH of the rumen fluid among any of the treatments, averaging 6.74, 6.68, 6.69 and 6.63 on the control, HP, LS and HS treatments, respectively.

In general, feeding a lower protein supplement (20 percent CP) in a larger quantity to provide equal supplemental protein intakes did not appear to have any detrimental effects upon either forage intake or ration digestibility in this trial compared to feeding a 40 percent supplement. Moreover, starch level in the 20 percent CP supplements did not appear to have any effect on forage intake or dry matter digestibility. Possibly, different results may have been observed with different types or qualities of forages, supplement levels or management procedures. Further studies are needed to determine the importance of such variables. The lower protein supplements fed in larger quantities, were effective in increasing total energy intake compared to the 40 percent CP treatment.

Table 3. Daily dry matter intake of prairie hay and supplement, apparent digestibility of dry matter and protein and rumen ammonia concentration.

Item	Treatment				SE
	Control	40% High Protein	20% CP-Low Starch	20% CP-High Starch	
Hay intake, lb ^a	7.8	10.1	9.9	10.1	.35
Supplement intake, lb	.24	2.1	4.00	4.00	0
Dry matter dig, % ^a	45.9	54.2	56.7	56.1	2.04
Digestible dry matter intake, lb	3.7	6.6	7.9	7.9	--
Apparent crude protein dig, % ^a	7.2	54.9	54.6	52.0	3.10
Ruminal [NH ₃], mg/100 ml ^{a,b}	.35	3.56	2.64	4.44	.37

^aControl vs all supplement treatments (P < .01)

^bLS vs HS (P < .01)