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Abstract

Thirteen ruminally fistulated steers were used to determine the effect of carbohydrate (CHO) source and degradable intake protein (DIP) on intake and digestion of tallgrass-prairie hay. In general, DIP supplementation had positive effects on intake and digestion, although response varied somewhat with CHO source. Increasing the amount of supplemental CHO generally decreased hay intake, but effects on digestion were dependent on CHO source.

Keywords

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EVALUATION OF THE EFFECTS OF CARBOHYDRATE SOURCE AND LEVEL OF DEGRADABLE INTAKE PROTEIN ON THE INTAKE AND DIGESTION OF TALLGRASS-PRAIRIE HAY BY BEEF STEERS

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Summary

Thirteen ruminally fistulated steers were used to determine the effect of carbohydrate (CHO) source and degradable intake protein (DIP) on intake and digestion of tallgrass-prairie hay. In general, DIP supplementation had positive effects on intake and digestion, although response varied somewhat with CHO source. Increasing the amount of supplemental CHO generally decreased hay intake, but effects on digestion were dependent on CHO source.

(Key Words: Steers, Intake, Digestion, Carbohydrate, Protein.)

Introduction

Feeding supplements with a high concentration of protein has been shown to increase intake and digestion of low-quality forages. In contrast, feeding supplemental carbohydrate (CHO) in the form of starch has been shown to decrease intake and digestion of low-quality forages . The use of byproduct feedstuffs in supplementation programs has increased the use of nonstarch CHO sources, which may have different effects on low-quality forage utilization compared to starch. Recent research at KSU demonstrated that the main dietary constituent limiting the use of low-quality tallgrass prairie is degradable intake protein (DIP) and subsequently defined the amount of DIP required to maximize intake and digestion of such forage. However, it is unclear how different amounts and types of supplemental CHO might affect DIP use and (or) "requirement". Therefore, this study was designed to evaluate the effects of various CHO sources and DIP level on intake and digestion of tallgrass-prairie hay.

Experimental Procedures

Thirteen ruminally fistulated Angus x Hereford steers (average BW = 580 lb) were used in a 4-period, 13-treatment, incomplete Latin square. The treatments were arranged in a 2x3x2 factorial plus negative control (no supplement). Supplement treatments consisted of two levels of DIP (sodium caseinate; .031 and .122% BW) and three CHO sources (starch, sugar, and digestible fiber) at two levels (.15 and .30% BW). Supplements were placed directly into the rumen once daily prior to feeding prairie hay (5.7% CP, 74.9% NDF) at 130% of the previous 5-day average intake. The sugar fed was a monosaccharide (dextrose), and the fiber was a commercially prepared oat fiber (treated with alkaline hydrogen peroxide) that was highly digestible. The experimental period consisted of an 11-day adaptation followed by a 7-day intake and total fecal collection period. Feed offered, feed refused, and fecal output measured during that period were used to calculate organic matter (OM) and neutral detergent fiber (NDF) digestibilities.

Results and Discussion

Results are shown in Table 1. In general, DIP supplementation increased forage and total diet intakes and digestion, although response varied somewhat with CHO source. Forage and total diet OM intakes were not affected by increasing level of DIP when starch was the CHO source. However, OM and NDF digestion and total digestible OM intake (TDOMI; a measure of overall energy intake) were enhanced by increasing level of DIP for steers fed supplemental starch. Increasing DIP when dextrose or fiber was

Table 1. Influence of Supplemental Carbohydrate and Degradable Intake Protein on Intake and Digestion

		Low DIP (.031% BW)						High DIP (> 122% BW)							
		Starch (% BW)		Dextrose (% BW)		Fiber (% BW)		Starch (% BW)		Dextrose (% BW)		Fiber (% BW)			
Item	NC	.15	.30	.15	.30	.15	.30	.15	.30	.15	.30	.15	.30	SEM	Contrasts[b]
Forage OMI[c] g/kg $BW^{.75}$	57.72	66.11	57.86	57.25	53.58	62.94	55.43	66.26	55.89	71.73	64.52	68.65	66.43	3.10	1,3,4,5,6,7,8
Forage OMI kg/d	3.77	4.30	3.76	3.75	3.49	4.10	3.58	4.31	3.65	4.66	4.20	4.46	4.31	.20	1,3,4,5,6,7,8
Forage OMI % BW	1.43	1.64	1.44	1.42	1.33	1.57	1.38	1.65	1.39	1.79	1.60	1.71	1.65	.08	1,3,4,5,6,7,8
Total OMI g/kg $BW^{.75}$	57.74	74.13	72.69	65.15	68.19	70.31	68.82	78.06	74.48	83.52	82.89	77.70	83.47	3.09	1,3,4
Total OMI kg/d	3.77	4.82	4.73	4.26	4.44	4.58	4.46	5.08	4.87	5.43	5.41	5.17	5.43	.20	1,3,4
Total OMI % BW	1.43	1.84	1.81	1.62	1.70	1.75	1.71	1.94	1.85	2.07	2.06	1.99	2.08	.08	1,3,4
TDOMI[d] g/kg $BW^{.75}$	28.47	42.29	39.78	35.87	39.64	38.18	35.51	48.93	43.93	51.48	52.68	45.03	51.84	2.10	1,2,3,4,6
TDOMI kg/d	1.87	2.75	2.59	2.35	2.58	2.49	2.29	3.19	2.87	3.35	3.44	2.92	3.38	.14	1,2,3,4,6
TDOMI % BW	.71	1.05	.99	.89	.99	.95	.88	1.21	1.09	1.28	1.31	1.12	1.29	.05	1,2,3,4,6
OMD[e] %	50.00	57.44	54.31	55.37	59.20	54.30	51.38	62.61	59.23	62.03	63.46	56.74	62.19	1.94	1,2,3,4,6
NDFD[f] %	48.65	52.61	41.60	49.44	47.22	56.05	53.31	58.82	50.11	58.65	56.21	56.48	63.18	2.31	1,2,3,4,5,6

[a]NC = negative control (no supplement).

[b]Statistically significant ($P \leq .12$) contrasts were 1 = low vs high DIP, 2 = low vs high DIP for starch treatments, 3 = low vs high DIP for dextrose treatments, 4 = low vs high DIP for fiber treatments, 5 = low vs high CHO, 6 = low vs high CHO for starch treatments, 7 = low vs high CHO for dextrose treatments, 8 = low vs high CHO for fiber treatments.

[c]OMI = organic matter intake.

[d]TDOMI = total digestible organic matter intake.

[e]OMD = organic matter digestion.

[f]NDFD = neutral detergent fiber digestion.

infused increased hay and total diet OM intakes, as well as OM and NDF digestion and TDOMI. The highest level of DIP supplementation was designed to provide sufficient total dietary DIP to maximize forage intake and digestion in the absence of supplemental CHO . Our results indicated that increasing the amount of supplemental DIP up to this approximate "requirement" (about 11% of TDOMI) resulted in increased TDOMI regardless of the type of supplemental CHO fed. However, TDOMI differed among CHO sources at the highest level of DIP supplementation, suggesting that the amount and type of supplemental CHO are important factors to consider when planning an approach for delivering supplemental DIP.

Increasing the amount of supplemental starch within both DIP levels decreased forage intake , as well as OM and NDF digestion. Increasing the amount of a highly digestible CHO like starch typically results in conditions in the rumen that are unfavorable for forage digestion. This decrease in digestion coupled with decreased forage intake resulted in less TDOMI (i.e., less energy intake). Increasing the amount of supplemental dextrose or fiber within a DIP level decreased forage intake, but neither OM and NDF digestion nor TDOMI were greatly affected. Increasing the amount of supplemental digestible fiber had minimal effects on digestion, possibly because this CHO source is similar to the forage and, therefore, is unlikely to result in ruminal conditions adverse to forage digestion. Similarly, the fundamental source of microbial energy from digested forage (glucose) is the same as that provided by the dextrose (d-glucose). This may have circumvented some of the negative effects of starch on fiber digestion by avoiding use of a substrate that is preferentially used by amylolytic (starch-digesting) bacteria. Amylolytic bacteria are highly competitive with fibrolytic (fiber-digesting) bacteria and, with adequate starch availability, can reduce ruminal ammonia available for fiber digestion.

Our results suggest that supplemental DIP will improve low-quality forage utilization. All three sources of supplemental CHO decreased forage intake; however, the effects on OM and NDF digestion were dependent on the CHO source and the amount of supplemental DIP provided.