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Effect of source of carbohydrate and degradable intake protein in supplements on low-quality forage utilization by steers

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EFFECT OF SOURCE OF CARBOHYDRATE AND DEGRADABLE INTAKE PROTEIN IN SUPPLEMENTS ON LOW-QUALITY FORAGE UTILIZATION BY STEERS

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Summary

Twelve ruminally fistulated steers were used in an experiment to study the impact of the source of carbohydrate (CHO) and degradable intake protein (DIP) in supplements on low-quality forage utilization. Treatments consisted of two different CHO types (fed at 0.16% of initial BW) each offered with an equal amount of DIP (0.087% of initial BW) but with six different proportions of non-protein nitrogen (NPN) and true protein as sources of DIP. The CHO types were starch and dextrose (a simple sugar). The different proportions of the two sources of N contributing to the DIP were 100:0, 80:20, 60:40, 40:60, 20:80 and 0:100 % of supplemental N as casein (true protein source) vs urea (NPN source), respectively. Interactions were not evident for the traits presented. Forage OM, total OM, and total digestible OM intake increased in response to an increase in the proportion of supplemental true protein. Although CHO type did not affect intake, digestibility of OM and NDF was greater when the simple sugar rather than starch served as the CHO source.

(Key Words: Forage, Starch, Sugar, Protein, Urea, DIP, Steers)

Introduction

Degradable intake protein (DIP) supplementation improves low-quality forage utilization by cattle. Some supplemental DIP can come from a non-protein nitrogen (NPN) source, such as urea, without harming forage utilization. However, very high concentrations of urea in supplements have been associated with reduced forage utilization, compared with supplements that contain little NPN. A common practice to improve the acceptability of and response to supplements that contain urea is to incorporate a significant quantity of carbohydrate (CHO; typically nonstructural CHO such as starch or sugars) into the supplements. There is some evidence that when sufficient supplemental DIP is provided to maximize forage utilization, the negative effect associated with CHO supplementation is less if the CHO is sugar rather than starch. However, the consistency with which such responses are observed, and potential effects of source of DIP on the response has not been verified. Therefore, this experiment was conducted to study the impact of source of CHO and DIP on low-quality forage utilization in beef steers.

Experimental Procedures

Twelve ruminally fistulated beef steers (BW = 1100 lb) given ad libitum access to tallgrass-prairie hay (5.3%CP, 74.8%NDF) were randomly assigned at the beginning of the experiment to one of 12 treatments. Steers were subjected to two 20-day periods (11 days of adaptation), which included periods for intake and fecal collection, ruminal evacuation, and monitoring ruminal fermentation. Treatments were arranged as a 2 × 6 factorial and consisted of two different CHO types (fed at 0.16% of initial BW), each offered with an equal amount of

DIP (0.087% of initial BW) but with six different proportions of NPN and true protein. The CHO types were starch and dextrose. The different proportions of the two sources of N contributing to the DIP were 100:0, 80:20, 60:40, 40:60, 20:80 and 0:100 % of supplemental N as sodium caseinate (true protein source) vs urea (NPN source), respectively. Treatments were ruminally dosed once daily. Offered and refused hay was weighed to estimate feed intake, and in conjunction with fecal measurements, was used to calculate organic matter (OM) and neutral detergent fiber (NDF) digestibilities.

Results and Discussion

Interactions among CHO and DIP sources were not observed for the reported traits. Forage OM, total OM, and total digestible OM intake increased in response to an increase in the proportion of supplemental true protein (linear, $P<0.05$; Table 1). However, CHO type did not significantly affect intake. Digestibility of OM and NDF was greater when the simple sugar dextrose served as the CHO source compared with starch ($P<0.05$; Table 2). Treatments did not affect ruminal total VFA and pH ($P>0.20$; data not shown). However, ruminal ammonia increased in proportion to the increase in supplemental NPN (linear, $P<0.01$). Ruminal ammonia was also significantly lower for the dextrose than starch treatment ($P<0.01$). In conclusion, while the CHO types evaluated did not interact with source of supplemental DIP with regard to effects on intake and digestion, both factors exerted independent effects on these characteristics. Forage digestibility was affected by the provision of sugar vs starch, whereas the relative proportion of true protein vs NPN in the supplemental nutrients affected forage intake.

Table 1. Intake of Low-Quality Forage by Beef Steers Supplemented with Two Carbohydrate (CHO) and Two Degradable Intake Protein (DIP) Sources

	Intake, g/kg BW.75					
	Forage OM		Total OM		Total DOM[a]	
CHO Source[b]	Starch	Dextrose	Starch	Dextrose	Starch	Dextrose
DIP Source, %[c]						
0:100	47.2	50.9	56.5	59.8	30.2	33.3
20:80	59.5	52.8	68.6	63.0	34.3	38.9
40:60	52.2	50.1	62.2	60.4	31.4	34.5
60:40	54.8	52.9	65.7	63.3	37.5	37.4
80:20	56.7	58.8	68.2	70.1	34.8	42.6
100:0	79.9	62.3	91.8	73.7	44.2	41.0
Average	58.4	54.6	68.8	65.1	35.4	38.0
SEM[d]	6.5		6.5		3.9	

[a]Digestible organic matter.
[b]Carbohydrate sources supplied at 0.16% BW daily (DM basis).
[c]Proportion of DIP supplied from casein vs urea; provided at 0.087% BW daily (DM basis).
[d]Standard error of the mean (n=2).

Table 2: Total Tract Digestion and Ruminal Ammonia of Low-Quality Forage by Beef Steers Supplemented with Two Carbohydrate (CHO) and Two Degradable Intake Protein (DIP) Sources

	Digestibility, %				Ammonia	
	OM		NDF		mM	
CHO Source[a]	Starch	Dextrose	Starch	Dextrose	Starch	Dextrose
DIP Source, %[b]						
0:100	52.9	55.7	47.7	51.3	18.07	13.10
20:80	50.0	63.0	44.9	60.1	10.34	8.18
40:60	51.4	57.5	44.4	51.3	12.85	9.15
60:40	57.0	58.8	51.8	53.1	7.94	8.11
80:20	50.8	61.0	44.5	56.5	5.49	3.65
100:0	48.3	55.6	42.1	49.0	4.97	5.20
Average	51.7	58.6	45.9	53.6	9.94	7.90
SEM[c]	5.2		5.7		1.52	

[a]Carbohydrate sources supplied at 0.16% BW daily (DM basis).
[b]Proportion of DIP supplied from casein vs urea; provided at 0.087% BW daily (DM basis).
[c]Standard error of the mean (n=2).