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Effect of supplemental carbohydrate type and amount of ruminally degradable protein on utilization of tallgrass-prairie hay by beef steers

Abstract

This experiment determined the impact of type of supplemental carbohydrate and amount of supplemental ruminally degradable protein (RDP) on intake and digestion of prairie hay. Fourteen ruminally fistulated beef steers were supplemented with one of two carbohydrates (corn starch or the simple sugar glucose) at 0.30% of body weight and one of seven levels of ruminally degradable protein (RDP; 0, 0.015, 0.051, 0.087, 0.123, 0.159, or 0.195% of body weight). Two additional steers served as controls (non-supplemented steers, i.e., no carbohydrate or RDP supplementation). Forage intake and digestion were substantially improved by increasing amounts of supplemental RDP. Supplemental carbohydrate with insufficient supplemental RDP depressed fiber digestion although carbohydrate type did not alter the digestion response or forage intake. In conclusion, when supplementing cattle eating low-quality forage, it is important to ensure that the supplement contains adequate RDP. The impact of the supplement on forage use should not differ greatly between starch (e.g., cereal grains) and sugar (e.g., molasses) as the main carbohydrate source.

Keywords

Cattlemen's Day, 2003; Kansas Agricultural Experiment Station contribution; no. 03-272-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 908; Beef; Supplemental carbohydrate; Protein; Tallgrass-prairie; Steers

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EFFECT OF SUPPLEMENTAL CARBOHYDRATE TYPE AND AMOUNT OF RUMINALLY DEGRADABLE PROTEIN ON UTILIZATION OF TALLGRASS-PRAIRIE HAY BY BEEF STEERS

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Summary

This experiment determined the impact of type of supplemental carbohydrate and amount of supplemental ruminally degradable protein (RDP) on intake and digestion of prairie hay. Fourteen ruminally fistulated beef steers were supplemented with one of two carbohydrates (corn starch or the simple sugar glucose) at 0.30% of body weight and one of seven levels of ruminally degradable protein (RDP; 0, 0.015, 0.051, 0.087, 0.123, 0.159, or 0.195% of body weight). Two additional steers served as controls (non-supplemented steers, i.e., no carbohydrate or RDP supplementation). Forage intake and digestion were substantially improved by increasing amounts of supplemental RDP. Supplemental carbohydrate with insufficient supplemental RDP depressed fiber digestion although carbohydrate type did not alter the digestion response or forage intake. In conclusion, when supplementing cattle eating low-quality forage, it is important to ensure that the supplement contains adequate RDP. The impact of the supplement on forage use should not differ greatly between starch (e.g., cereal grains) and sugar (e.g., molasses) as the main carbohydrate source.

Introduction

Supplementing cattle eating low-quality forage with feedstuffs rich in ruminally degradable protein increases forage intake and digestion. However, even in feedstuffs with high concentrations of protein, typically more than half of the feed is something other than

protein. The largest contributor to this remaining portion is usually carbohydrate (e.g., starch, sugar, or fiber). Some research indicates that supplementing cattle eating low-quality forage with feedstuffs rich in starch (such as cereal grains) may negatively impact forage intake and digestion. However, previous research conducted at Kansas State University raised questions about whether the negative effects of supplemental carbohydrate are specific to starch and whether the responses elicited by different carbohydrates might depend on the amount of supplemental ruminally degradable protein fed. In particular, given the widespread use of molasses-based supplements (which contain high concentrations of sugars), we wondered whether sugar would have a different effect than starch on forage utilization and how each of these might respond to different levels of ruminally degradable protein. Therefore, an experiment was conducted to evaluate the influence of both of these factors (i.e., carbohydrate type and level of supplemental ruminally degradable protein) on low-quality forage utilization.

Experimental Procedures

Sixteen ruminally fistulated beef steers (body weight = 485 lb), each given free-choice access to tallgrass-prairie hay (Table 1), were used in a two-period crossover experiment. Fourteen steers were supplemented with either corn starch or a simple sugar (dextrose, a form of the simple sugar glucose) at 0.30% of body weight and one of seven levels of ruminally degradable protein (RDP; 0, 0.015, 0.051, 0.087, 0.123, 0.159, or 0.195% of

body weight). Two additional steers served as controls (non-supplemented steers, i.e. no carbohydrate or RDP supplementation). Each experimental period lasted 24 days (14 days of adaptation) and included periods for measuring intake and fecal output and for monitoring ruminal fermentation. Offered and refused hay was weighed to measure feed intake, and intake was used in conjunction with fecal measurements to calculate organic matter and fiber (i.e., neutral detergent fiber) digestibilities.

Results and Discussion

Forage intake increased (Figure 1; linear, $P < 0.01$) as increasing amounts of supplemental RDP were fed. Similarly, the total amount of digestible feed consumed (digestible organic matter intake, which includes that from both forage and supplement) responded positively to increasing supplemental RDP, although the rate of increase in intake slowed somewhat at the highest levels of RDP supplementation (quadratic, $P < 0.05$). The type of supplemental carbohydrate did not affect forage ($P = 0.37$) or digestible organic matter ($P = 0.44$) intake.

Forage fiber and organic matter (i.e., forage plus supplement) digestion were substantially improved (Figure 2; linear, $P < 0.05$) by providing increasing amounts of supplemental RDP. Although the rate of improvement in fiber digestion tended (quadratic, $P = 0.08$) to

decrease at the highest levels of RDP supplementation. When compared with the non-supplemented cattle, fiber digestion was depressed by about 23% when supplemental carbohydrate was fed without any supplemental RDP. However, when adequate supplemental RDP was fed, fiber digestion was similar to or slightly higher than that observed in the non-supplemented cattle. Supplemental carbohydrate type did not significantly alter the effect on digestion. Ruminal pH averaged between 6.1 to 6.8 (data not shown) across treatments, suggesting that differences in fiber digestion are unlikely to be adequately explained by changes in pH alone. The positive effect of supplemental ruminally degradable protein appears to be primarily due to the provision of nutrients that are commonly deficient in low-quality forages, particularly RDP (nitrogen). Protein supplementation also increases the concentration of branched chain volatile fatty acids, which serve as growth factors for some fiber-digesting microbes and, as a result, may stimulate ruminal fiber digestion.

In conclusion, when supplementing low-quality forages, it is important to ensure that supplements provide an adequate quantity of RDP. However, results from this study suggest that little difference in forage utilization would be likely for supplements that differ solely on the basis of the presence of starch (as would be found in cereal grains) versus glucose (as would be found in molasses) as the dominant carbohydrate source.

Table 1. Chemical Composition of Forage and Supplements

Item	Organic Matter	Neutral Detergent Fiber	Acid Detergent Fiber	Crude Protein	Ruminally Degradable Protein
	-----% of Dry Matter -----				% of Crude Protein
Prairie hay	94.5	76.2	40.4	5.1	56.9
Supplement component					
Casein	97.1	-	-	94.2	100
Starch	100	-	-	-	-
Dextrose	100	-	-	-	-

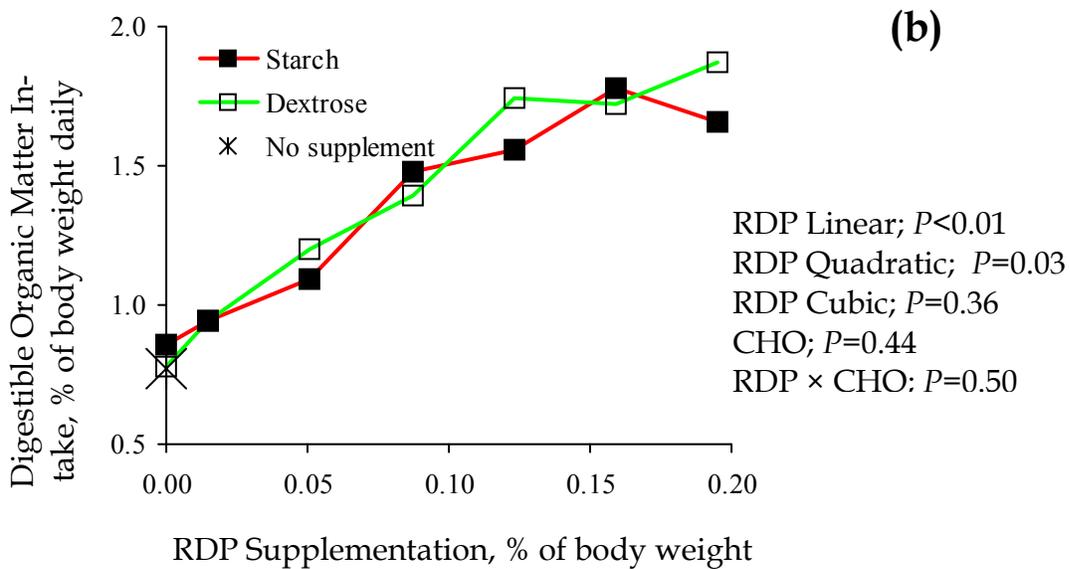
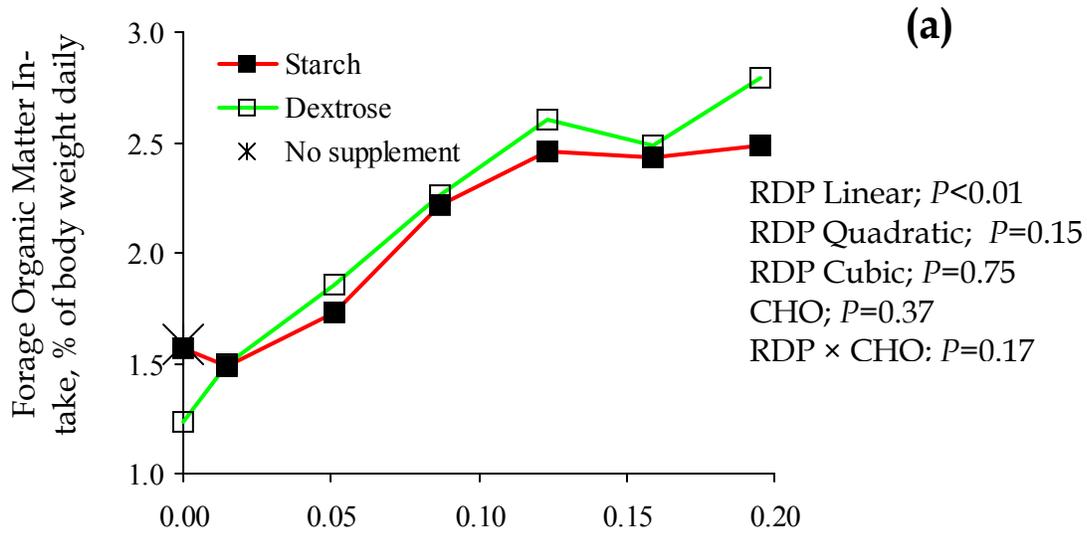


Figure 1. Intake of Forage Organic Matter (a) and Total Digestible Organic matter (b) by Beef Steers Supplemented with Increasing Levels of Rumen Degradable Protein (RDP) and Two Carbohydrate Types (CHO).

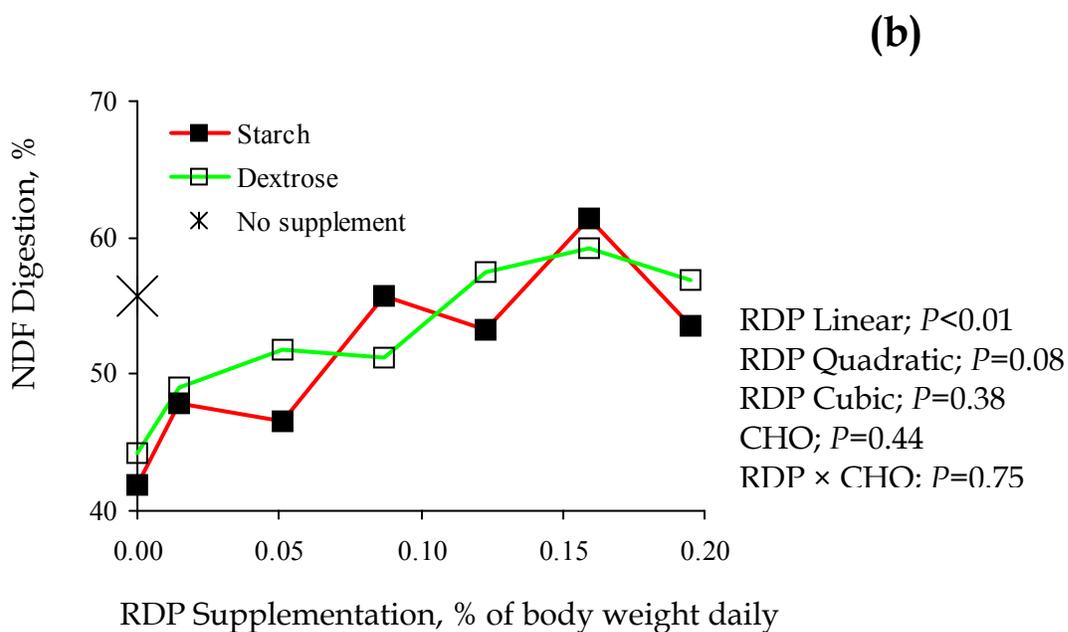
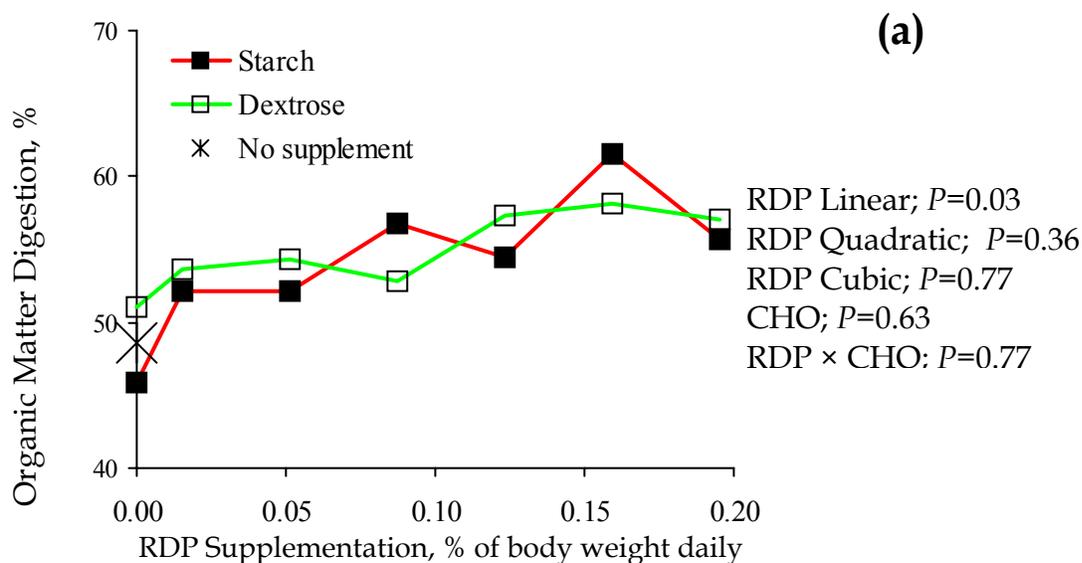


Figure 2. Digestion of Organic Matter (a) and Neutral Detergent Fiber (NDF) (b) by Beef Steers Supplemented with Increasing Levels of Rumen Degradable Protein (RDP) and Two Carbohydrate Types (CHO).