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EFFECTS OF SUPPLEMENTING PRAIRIE HAY WITH TWO LEVELS OF CORN AND FOUR LEVELS OF DEGRADABLE INTAKE PROTEIN. I. INTAKE AND DIGESTION BY STEERS

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Story in Brief

When forage is not adequate to maintain a desired level of animal performance, supplementation is needed to overcome nutrient deficiencies. Supplementation of cattle with 20% cubes is a common practice, with byproduct feeds often used. However, corn is one of the cheapest energy sources available on a cost per unit of energy basis. Based on previous research, it appears that insufficient ruminally degradable protein limits the usefulness of corn-based supplements for cattle consuming low-quality grass hay. Ruminally cannulated steers were used to determine the effects of feeding supplemental corn with varied levels of degradable protein from soybean meal on intake and digestion of prairie hay. Steers had ad libitum access to prairie hay and were supplemented with two levels of corn (0 or .75% BW dry matter) and four increasing levels of degradable protein. Intake of hay and total diet organic matter increased quadratically as protein increased for supplements with and without corn. Forage organic matter digestibility increased linearly for corn diets while no change was noted in diets without corn. Total diet digestibility increased linearly in response to protein addition for treatments with or without corn. Total digestible organic matter intake was increased for corn-supplemented cattle, while additional protein resulted in increased digestible intake regardless of corn level. Inadequate degradable protein in grain-based supplements decreased forage intake and digestibility and total diet energy intake of cattle fed low-quality prairie hay.

Key Words: Grain, Degradable Intake Protein, Intake, Digestion

Introduction

Efforts to increase forage intake, digestion and subsequent conversion of forage into beef by supplementing cattle are of major importance to the beef industry. This is especially true in Oklahoma because forage quality typically limits cattle performance before forage quantity does. Supplements for grazing cattle are usually composed of high-protein (from oilseed meals) or high-energy (byproduct fiber or grain starch) feedstuffs. Effects of both energy (Horn and McCollum, 1987; Caton and Dhuyvetter, 1997) and protein (McCollum and Horn, 1991) supplementation have been documented. Improvements in rate of gain, efficiency of gain, cost of gain, carrying capacity of rangeland, or to improve or maintain body condition due to supplementation depends on many factors. Previous research with low-quality prairie hay supplemented with large amounts of grain (Chase and Hibberd, 1985) has indicated the existence of negative associative effects including a substitution effect of supplement for forage and reduced forage digestion. Utilization of grain-based supplements by forage-fed cattle in previous research (Chase and Hibberd, 1985) has been reduced by deficiencies in ruminally degradable intake protein (DIP). Recent research (Cochran et al., 1998) has focused on DIP supply in relation to energy supply from digestible organic matter (DOM). This relationship is represented as total diet DIP:DOM. Previous research (Bodine et al., 1999) using low-quality forages suggested the possibility of minimizing negative associative effects of grain supplementation by balancing DIP:DOM. The current trial was designed to determine the effects on intake and digestion of supplementing cattle fed low-quality prairie hay with two levels of corn and four increasing DIP levels.

Materials and Methods

Animals, Diets and Samples. Eight ruminally cannulated steers (Angus and Angus x Hereford; 699 ± 55 lb) were weighed at the start and end of each 14-d period and housed in individual indoor pens with ad libitum access to fresh water and trace mineral salt. Steers were moved to individual metabolism stalls for a 3-d adaptation prior to a 4-d collection period. Feed ingredients and nutrient composition are shown in Table 1. Experimental diets were formulated (NRC, 1996) using average intake and digestibility of hay measured in a preliminary trial, corn intake, 11.5% microbial efficiency and balanced for DIP (CORN100) with SBM. Grams of supplemental DIP in CORN100 were multiplied by 0, 33 and 66% (CORN0, CORN33 and CORN66) and similar grams of supplemental DIP per kg of BW were fed for supplements without corn (NOCORN0, NOCORN33, NOCORN66 and NOCORN100). Dry matter intake from supplement was equalized within level of corn by the addition of cottonseed hulls (CSH). Supplements were fed daily prior to hay. During each period, feeds and total fecal collections were weighed daily and subsamples collected.

Laboratory and Statistical Analysis. Concentrations of DM, OM, CP, DIP, starch, NDF and ADF in feed samples and DM and OM in fecal samples were determined by methods in accordance with AOAC (1990). Variables were analyzed as a 2 x 4 factorial (2 levels of corn and 4 levels of DIP) using MIXED procedures of SAS (1996). Effects modeled included level of corn, level of DIP, steer, period and all appropriate interactions. Orthogonal contrasts were performed to test for linear and quadratic trends.

Results and Discussion

Intake and digestibility of hay and total diet OM are reported along with DOM in Table 2. Interactions (P<.03) were noted between level of corn and level of DIP in all variables measured except DOM (P>.41). Linear or quadratic trends are compared across levels of degradable protein and reported separately for CORN and NOCORN treatments for all variables.

Intake. Intake of prairie hay OM (HOMI; Table 2) was similar (P>.96) between CORN and NOCORN supplements at the lowest level of DIP. While substitution has been found in previous work (Chase and Hibberd, 1985) with corn supplementation of prairie hay, similar HOMI indicated no substitution of corn for forage existed at this level of DIP in the current trial. Forage OMI and total OMI (TOMI; Table 2) increased quadratically (P<.02) as DIP increased for both NOCORN and CORN supplements.

Digestibility. Total tract apparent hay organic matter digestibility (HOMD; Table 2) was not affected (P>.43) by increasing DIP for NOCORN treatments. However, HOMD improved quadratically (P<.03) as supplemental DIP was increased in CORN supplements. Apparent HOMD was reduced (P<.04) for CORN at all levels of DIP vs NOCORN supplements. The largest numeric increase occurred from the first increment of supplemental DIP from SBM. The low HOMD for prairie hay fed with corn and no supplemental DIP agrees with previous research (Chase and Hibberd, 1985). However, the addition of DIP from SBM at the highest level increased HOMD of low-quality prairie hay to a similar TDN value as those suggested by NRC (1996). This indicates no negative associative effect on HOMD from high levels of corn when balanced for DIP. Linear increases (P<.01) in total OMD (TOMD; Table 2) were found for NOCORN and CORN supplements. Increasing DIP improved TOMD twice as many percentage units for CORN than NOCORN supplements. This points to the need for balanced total diet DIP:DOM ratios when grain-based supplements are formulated for forage-fed cattle. Feeding prairie hay with the highest level of DIP resulted in greater (P<.01) TOMD for the corn-based supplement.

Energy Status. Intake of digestible organic matter (DOM) is a function of intake and digestibility. Supply of DOM to an animal can be used as a predictor of expected animal performance and DOM is often used interchangeably with TDN to approximate dietary energy supply. Therefore, changes in DOM should be more closely related to changes in animal performance than either intake or digestibility alone. While previous work (Chase and Hibberd, 1985) has shown a reduction in DOM with increasing levels of corn supplementation, the current trial found feeding CORN supplements increased ($P<.01$) DOM compared with NOCORN supplements (Table 2). Increasing levels of DIP from SBM resulted in quadratic ($P<.01$) improvements in DOM averaged across both levels of corn. While our study only had two levels of corn, increased DOM for diets containing corn observed in the current trial indicates an improvement in energy intake for steers fed corn with supplemental DIP. Trends for increases in DOM as DIP increased indicate a uniform positive associative effect regardless of level of grain inclusion. This once again points to the importance of DIP:DOM ratio in regard to supplement formulation.

Total Diet DIP:DOM Ratio. While experimental diets were formulated on the basis of DIP supply in relation to DOM supply, recent research (Cochran et al., 1998) has shown a possible breakpoint (10%) in this ratio. It is thought that increasing DIP beyond 10% results in increases in intake and digestibility occurring at a decreasing rate. The ratio between DIP and DOM in the total diet can be used to evaluate potential effects of supplements on forage-fed cattle. Greater responses in forage intake and utilization would be expected as DIP:DOM is increased up to 10% than would be seen for increases above 10%. Cumulative effects on intake and digestibility are represented in DOM and appear to suggest the importance of DIP:DOM ratio in balancing and formulating supplements for forage fed cattle, especially when grain is utilized.

With increasing knowledge of the interaction between DIP and DOM, actual requirements for DIP will become better defined as the understanding of differences in forages, sources of DIP and DOM aid in improving the overall efficiency of supplementation. In the current study, it appeared that we may have overestimated the microbial efficiency of DOM use, thereby actually overfeeding DIP at the highest levels. This is somewhat apparent in the graphical presentation of the data, as it appears the greatest increase in intake or digestion was found with the first increment of supplemental DIP from SBM (0 to 33). Smaller improvements were noted between increases of DIP from SBM at higher levels (33, 66 and 100) and were not always consistent. Our results allow us to conclude that increasing DIP was beneficial to intake and digestion of hay and total diet organic matter in steers consuming prairie hay and individually fed supplements containing either level of corn.

Literature Cited

AOAC. 1990. Official Methods of Analysis (15th Ed.). Association of Official Analytical Chemists, Arlington, VA.

Bodine, T.N. et al. 1999. Okla. Agr. Exp. Sta. Res. Rep. P-973:

Caton, J.S. and D.V. Dhuyvetter. 1997. J. Anim. Sci. 75:533.

Chase, C.C. and C.A. Hibberd. 1985. Okla. Agr. Exp. Sta. Res. Rep. MP-117:207.

Cochran, R.C. et al. 1998. Proc. 9th Annual Florida Rum. Nutr. Symp. Gainseville. p 123.

Horn, G.W. and F.T. McCollum III. 1987. Proc. Graz. Livest. Conf. Jackson, WY. p 125.

McCollum, F.T. III and G.W. Horn. 1991. The Professional Animal Scientist. 6(2):1.

NRC. 1996. Nutrient Requirements of Beef Cattle (7th Ed.). National Academy Press, Washington, DC.

SAS. 1996. SAS System for Mixed Models. SAS Inst. Inc., Cary, NC.

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Table 1. Supplement DM ingredient (lb) and nutrient composition (%).

	Level of	Level of DIP			
Ingredient (lb)	corn	0	33	66	100
Corn	CORN	5.11	5.11	5.11	5.11
	NOCORN	-	-	-	-
Soybean meal	CORN	-	.64	1.28	1.92
	NOCORN	-	1.29	1.90	2.62
Cottonseed hulls	CORN	1.88	1.27	.64	0
	NOCORN	2.54	1.27	.64	0
Total	CORN	7.11	7.11	7.11	7.11
	NOCORN	2.68	2.68	2.68	2.68
Composition (%)					
DM[a]	CORN	88.20	88.13	88.06	87.98
	NOCORN	90.16	89.74	89.55	89.33
OM[a]	CORN	96.16	95.72	95.30	94.91
	NOCORN	92.26	90.13	88.98	87.99
CP[a]	CORN	7.62	12.10	16.43	20.87
	NOCORN	4.01	27.26	38.64	50.36
DIP[b]	CORN	3.52	6.41	9.28	12.22
	NOCORN	2.01	17.42	24.97	32.74
NDF[a]	CORN	38.51	31.81	25.08	18.20
	NOCORN	85.29	48.83	30.85	12.54
ADF[a]	CORN	22.67	17.31	11.92	6.39
	NOCORN	65.34	36.07	21.64	6.94
Starch[a]	CORN	51.10	51.08	51.11	51.17
	NOCORN	.35	1.06	1.40	1.76
DIP g/kg BW	CORN	.39	.69	.99	1.30

	NOCORN	.09	.69	.99	1.30
DIP:DOM[c] (%)	CORN	4.73	8.05	11.11	13.95
	NOCORN	5.06	28.30	34.63	39.45

[a]Proximate analysis.

[b]Calculated from values obtained from NRC (1996).

[c]Calculated from observed values for DOM and NRC (1996) values for DIP.

Table 2. Organic matter intake (lb) and digestibility (% of intake) of selected dietary components.

Level of DIP	0	33	66	100	Effect[1]
Hay OMI					
CORN	8.51	11.09	11.71	11.58	Q
NOCORN	8.49	13.82	14.43	14.89	Q
Total OMI					
CORN	15.34	17.91	18.50	18.53	Q
NOCORN	10.91	16.24	16.81	17.30	Q
ADF intake					
CORN	5.73	6.59	6.50	6.06	L
NOCORN	5.84	7.62	7.52	7.36	L
Hay OMD					
CORN	29.91	45.89	41.99	49.39	Q
NOCORN	57.60	54.79	56.18	55.22	Q
Total OMD					
CORN	51.99	60.34	58.89	65.59	L
NOCORN	54.13	56.79	59.75	60.72	L
Total DOMI					
CORN	7.94	10.78	10.87	12.15	L
NOCORN	5.90	9.17	10.03	10.50	L

[1]L = linear increases ($P<.03$) with increasing level of DIP; Q = quadratic increases ($P<.10$) with increasing level of DIP.

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