Effects of Supplementing High or Low Quality Forages with Corn or Corn Processing Co-Products Upon Digestibility of Dry Matter and Energy by Steers

A. S. Leaflet R1540

Paul Summer, research assistant, and
Allen Trenkle, professor of animal science

Summary

A digestibility trial, utilizing eight crossbred steers weighing initially 741 lbs. was conducted in an 8 x 8 Latin square design. High-fiber corn by-products were compared with corn as energy sources when fed in mixed diets with either low- or high-quality forage. Ground, dry corn stover and ground alfalfa hay were both fed alone or with corn grain, dried corn gluten feed (CGF), and dried corn distillers grains plus solubles (DDG) in a 1:1 ratio (dry basis). Total tract dry matter digestibility (DMD) was increased for both forages when fed with concentrates. Total tract DMD was similar in stover-based and alfalfa-based diets fed with CGF and DDG. However, stover+corn was lower in DMD than either stover+CGF and stover+DDG. Conversely, alfalfa+corn was higher in DMD than alfalfa+CGF or alfalfa+DDG. Feeding stover with corn tended to decrease digestibility of neutral detergent fiber (NDF), while feeding stover with CGF or DDG increased NDFD. There was no effect upon NDF digestion of alfalfa-based diets when fed with any of the concentrates. Feeding either forage with a concentrate increased digestible energy (DE). Stover+CGF and stover+DDG were similar in DE and were both higher in DE than stover+corn. Alfalfa+DDG tended to be higher than alfalfa+CGF and was similar to alfalfa+corn in DE. Alfalfa+CGF was lower in DE compared with alfalfa+corn. Results are interpreted to indicate that stover is more susceptible to negative feed interactions caused by corn grain than is alfalfa. Additionally, high-fiber corn co-products fed with stover resulted in a positive associative effect but essentially had no associative effect when fed with alfalfa.

Introduction

Previous research has demonstrated that negative associative effects between corn grain and forage are greater when utilizing low-quality forage than high-quality forage. Little research has examined the effects of different roughage quality upon utilization of corn co-products in mixed diets. The objective of this experiment was to examine the effects upon DMD and energy utilization by steers of feeding either high- or low-quality roughage with corn, CGF, or DDG.

Materials and Methods

A digestibility trial was conducted using eight crossbred steers (741 lbs. $\pm$ 163 lbs.) in an 8 x 8 Latin square design. Dietary treatments consisted of either dry corn stover or alfalfa hay fed alone or with one of three energy supplements in a total mixed ration. The forages were harvested in large round bales and ground through a 1-inch screen in a tub grinder immediately prior to the start of the experiment. Forage particle size was not measured, but based upon observation, the particle size of the forages after being ground was 8-10 cm and 5-8 cm for stover and alfalfa, respectively. The concentrates replaced 50% of the forage DM and included cracked corn grain, dry pelleted CGF, or DDG. All diets were balanced to meet crude protein and mineral requirements of the steers (Table 1). Diets were mixed daily and fed at 0600 and 1800 hrs.

Periods lasted for 3 weeks and consisted of 16 days of diet adaptation followed by 5 days of sample collections. Steers were housed individually in pens within an open-front shed at the Iowa State University Beef Nutrition Farm.

Approximately 5% of the total forage and 10% of the total concentrate fed daily was subsampled. The subsamples were mixed thoroughly and subsampled again for lab analysis. Feed refusals were collected and weighed daily during the collection period.

Table 1. Composition of experimental diets fed to steers, % of dry matter.

	Dietary treatments							
Item	Stover	Stover +Corn	Stove +CGF	Stover +DDG	Alfalfa	Alfalfa +Corn	Alfalfa +CGF	Alfalfa +DDG
Alfalfa					96.70	49.08	49.00	49.97
Stover	88.53	46.86	46.42	47.26				
Corn		47.66				49.82		
Corn gluten feed			48.34				50.40	
Distillers grains				47.28				49.49
Molasses	5.84	1.94	2.03	2.11				
Soybean meal	2.92	2.45	2.31	2.40				
Urea	0.94	0.63						
Ammonium phosphate	1.46				1.99	0.79	0.29	0.23
Calcium carbonate		0.12	0.58	0.64				
Sulfur	0.01	0.01						
Vitamin premix	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Salt	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Trace mineral mix	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Nutrient composition								
Crude protein	8.34	8.27	12.29	14.39	17.86	12.2	18.10	20.33
NDF	70.22	42.96	57.05	57.54	55.35	34.5	49.67	50.26
ADF	44.99	25.16	29.06	29.97	37.86	20.8	25.05	26.07
Ash	12.29	7.02	9.40	8.38	13.53	7.24	9.49	8.29

Diet DM digestibility was calculated using an external marker. Chromic oxide was bolused twice daily starting on day 9 of each period (10 g/day) immediately prior to feeding. Fecal grab samples (approximately 60 grams) were collected for 5 days starting on day 17 of each period. The collection schedule represented 2-hour intervals during a 24-hour period.

Table 2. Intake and digestibility of experimental diets fed to steers.

	Dietary treatments								
Item	Stover	Stover +Corn	Stover +CGF	Stover +DDG	Alfalfa	Alfalfa +Corn	Alfalfa +CGF	Alfalfa +DDG	SEM
Intake, kg/d									
DM	2.92[a]	6.47[bc]	6.88[c]	6.17[b]	6.47[bc]	9.27[d]	9.36[d]	9.35[d]	0.22
OM	2.59[a]	6.07[bc]	6.31[c]	5.73[bc]	5.71[b]	8.63[d]	8.48[d]	8.58[d]	0.21
NDF	2.23[a]	2.87[b]	4.20[e]	3.77[d]	3.91[de]	3.39[c]	4.93[f]	4.97[f]	0.15
ADF	1.42[a]	1.67[a]	2.11[b]	1.94[b]	2.69[c]	2.04[b]	2.49[c]	2.59[c]	0.09
Forage	2.57[a]	3.03[ab]	3.16[b]	2.90[ab]	6.26[d]	4.54[c]	4.59[c]	4.67[c]	0.19
DMI, %BW	0.75	1.58	1.67	1.40	1.66	2.08	2.15	2.06	
Digestibility, %									
DM	39.1[a]	53.7[b]	58.9[c]	59.4[c]	55.8[b]	66.1[d]	60.1[c]	61.8[c]	1.01
OM	43.6[a]	56.4[b]	62.8[c]	63.1[c]	56.3[b]	67.3[d]	62.4[c]	63.1[c]	0.88
NDF	45.4[a]	42.8[a]	57.4[bc]	58.2[bc]	55.8[bc]	55.1[c]	57.2[bc]	59.2[b]	1.37
ADF	44.0[a]	40.0[b]	50.6[acde]	52.1[de]	50.7[cde]	47.9[acd]	46.8[ac]	51.5[de]	1.58
Energy	39.4[a]	54.7[b]	60.4[c]	62.4[ce]	50.2[d]	64.2[e]	59.8[c]	62.1[ce]	1.03
DE, Mcal /kg	1.65	2.34	2.57	2.86	2.02	2.76	2.57	2.89	

[abcdef] Means within a row without a common superscript differ. ($P < .05$).

Results and Discussion

Feeding concentrates with stover increased intake of stover compared with feeding stover alone, whereas feeding concentrates with alfalfa decreased intake of alfalfa compared with alfalfa alone (Table 2). Feeding stover with either CGF or DDG resulted in a higher dry matter digestibility compared with stover+corn. Alfalfa+corn had a higher dry matter digestibility compared with alfalfa+CGF or alfalfa+DDG. Neutral detergent fiber digestibility of the stover–based diets was higher with the inclusion of CGF or DDG compared with stover alone; inclusion of corn with stover tended to decrease NDF digestibility compared with stover alone, but the difference was not significant. The NDF digestibility of alfalfa fed alone did not differ from that of feeding alfalfa plus concentrates. Gross energy digestion of stover–based diets with either CGF or DDG was higher than with stover+corn. Gross energy digestion of alfalfa+corn was higher than with alfalfa+CGF and similar to alfalfa+DDG.

The increase in dry matter digestibility of stover diets fed with corn co-products compared with corn is not considered to be due to a protein deficiency in the stover+corn diet. Intake of crude protein by steers consuming stover+corn was 535 g/day. The 1996 NRC recommends 418 g/day for a 900-lb. steer gaining 2.2 lbs./day. Furthermore, intake of stover and of total diet dry matter was not increased by feeding high-protein corn by-products compared with corn, indicating that protein was not limiting digestion.

Expected dry matter digestibility for each of the mixed diets can be calculated by using the digestibility coefficients for the forages in this trial combined with previously found values for the concentrates from the literature. Dry matter digestibilities for the concentrates were assumed as follows: CGF 70.6% (Firkins et al.1985 and Green et al. 1987), DDG 67.9% (Firkins et al. 1985), and corn 81.7% (Green et al. 1987). Figure 1 compares the expected values with the observed values.

Figure 1. Expected and Observed Dry Matter Digestibility's of Mixed Diets Fed to Steers.

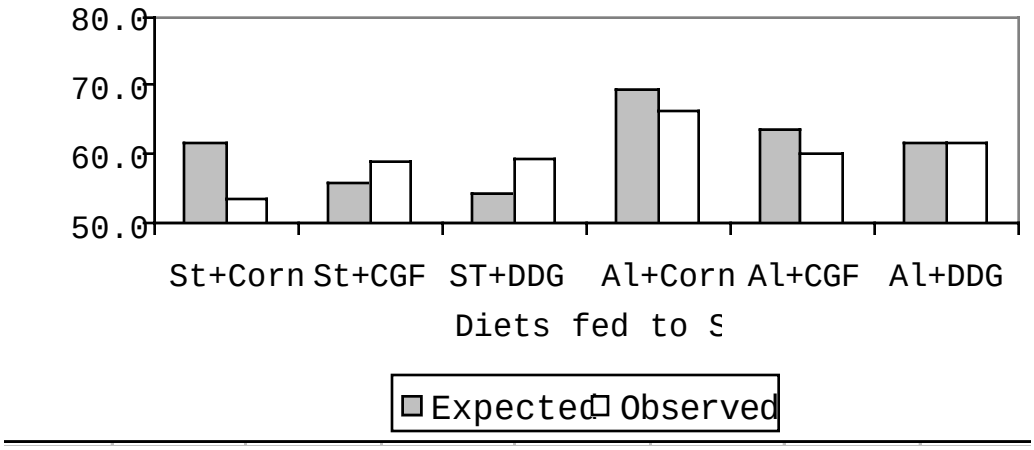

Figure 1 shows that feeding corn with either stover or alfalfa caused a decrease in dry matter digestion compared with expected values (negative associative effects). The negative associative effect of corn with stover was greater than with alfalfa+corn. Corn gluten feed and DDG fed with stover increased dry matter digestion compared with expected values (positive associative effect). Corn gluten feed fed with alfalfa decreased dry matter digestion compared with the expected value, whereas DDG fed with alfalfa resulted in no associative effects.

In addition to the value of higher digestible energy which CGF and DDG have when fed with stover compared with corn, they also provide CP supplementation for low-quality, forage-based diets. The added CP of CGF or DDG is not as valuable when these feeds are fed with high-quality, high-protein forages such as alfalfa. When considering the value of either CGF or DDG, their crude protein content along with their apparent energy content should be considered. The forage:concentrate ratio in this experiment was 1:1; the magnitude of associative effects at different forage:concentrate ratios are unknown. In general, as the level of concentrate decreases, negative associative effects also decrease. However, it is not known what effect a higher forage:concentrate ratio would have on the positive associative effects between stover and corn co-products observed in this experiment.

Implications

When energy supplementation of low-quality forage is required, CGF and DDG provide more digestible energy and increased digestible dry matter than does corn. When energy supplementation of high-quality forage is required, corn provides more digestible energy than CGF, while DDG is intermediate. High-quality forage diets supplemented with corn are higher in digestible dry matter than diets supplemented with CGF or DDG.

References

Green, D. A., R. A. Stock, F. K. Goedeken, and T. J. Klopfenstein. 1987. Energy value of corn wet milling by-product feed for finishing ruminants. J. Anim. Sci. 65:1655.

Firkins, J. L., L. L. Berger, and G. C. Fahey, Jr. 1985. Evaluation of wet and dry distillers grains and wet and dry corn gluten feeds for ruminants. J. Anim. Sci. 60:847.

Acknowledgments

This study was supported in part by USDA grant 94-41888-0039. Materials were supplied as follows: trace mineral premix, Calcium Carbonate Division of J.M. Huber Corporation, Quincy, Ill.; and vitamin A, Hoffmann-LaRoche, Inc., Nutley, N.J. The assistance of Rod Berryman, research farm superintendent; Julie Roberts, secretary; Andrea Cerrillo, Chris Iiams, and Leanne Dietrich, Ruminant Nutrition students; and the animal caretakers at the ISU Beef Nutrition Research Farm is appreciated.