EFFECT OF CORN ENDOSPERM TYPE AND CORN CONTAINING THE CRY1F PROTEIN ON PERFORMANCE OF BEEF HEIFERS FED FINISHING DIETS BASED ON STEAM-FLAKED CORN

J. J. Sindt, J. S. Drouillard, E. R. Loe, T. J. Kessen, M. J. Sulpizio, S. P. Montgomery, and F. N. Owens

Summary

Eighty beef heifers (initial body weight = 795 ± 18 lb) were individually fed finishing diets based on steam-flaked corn for 118 days. Dietary treatments consisted of corn hybrids containing vitreous (HARD), opaque (SOFT), or intermediate (INT) types of corn endosperm. Within the HARD endosperm type, a transgenic hybrid (HARD-GMO) containing the Herculex I Cry1F protein was compared with its nontransgenic, conventional (HARD-CONV) counterpart. Dry matter intake, average daily gain, and gain efficiencies were similar among treatments. Likewise, hot carcass weight, dressing percentage, and ribeye area were unaffected by dietary treatment. Heifers fed HARD-CONV were fatter than heifers fed HARD-GMO, having fewer ($P<0.01$) USDA Yield Grade 1 and 2 carcasses. In this experiment, feeding flaked corn finishing diets that contained different endosperm types did not alter performance or carcass characteristics. Feeding heifers HARD-GMO compared with HARD-CONV corn resulted in similar performance, although heifers fed HARD-CONV had higher USDA Yield Grades, perhaps because of greater starch availability of HARD-CONV flaked corn than HARD-GMO corn.

Introduction

Physical characteristics of corn kernels can differ depending on how the starch is embedded in the protein-starch matrix. Corn having a very densely packed endosperm is vitreous or glassy in appearance, whereas starch that is less tightly bound with endosperm protein is present in a more floury or opaque form. Hardness of endosperm starch may contribute to differences in starch utilization by ruminants. Increased accessibility of starch to ruminal microflora may increase ruminal digestibility, although excessive rates of starch digestion may predispose cattle to digestive disorders. Steam flaking of grain increases the ruminal and total tract digestibility of corn by improving the utilization of starch that is embedded in the protein matrix. Currently, there is little information pertaining to the relative suitability of different endosperm types for steam flaking.

Widespread use of transgenic crops for improving agronomic productivity has led to an abundance of modified grains that are used for livestock feed. Grain that is modified with the Herculex I Cry 1F protein resists many of the insects that damage yields and productivity. Determining the nutritional bioequivalency of corn hybrids that are genetically altered will support future agronomic endeavors that seek to enhance crop production.

The objective of this experiment was to evaluate corn hybrids that differed in endosperm type when fed in finishing diets based on steam-flaked corn. We also compared the feeding value of a transgenic hybrid containing the Herculex I Cry1F protein with its isogenic, conventional counterpart.

Experimental Procedures

In the spring of 2003, 80 beef heifers (initial body weight = 795 ± 18 lb) were vaccinated for common viral and bacterial diseases, treated for internal and external parasites, identified, implanted with Revalor-H, weighed, and assigned to one of four individual barns according to weight. Barns contained twenty individual stalls that allowed for individual access to feed. Cattle were blocked by barn and stratified by weight within each barn to one of four treatments. Treatments consisted of finishing diets based on steam-flaked corn that contained hybrids with vitreous (HARD), opaque (SOFT), or intermediate (INT) types of endosperm (Table 1). Additionally, within HARD endodsperm type, a hybrid containing the Herculex I Cry1F protein (GMO) was compared with its nontransgenic, conventional (CONV) counterpart. Because of the extreme dryness (≅ 94% dry matter) of three hybrids (HARD-GMO, HARD-CONV, and INT), all corn was tempered to 84% dry matter before flaking. Each hybrid was flaked approximately twice per week. Corn was steam-flaked to a density of 26 lb/bushel, and diets were fed for 118 days. Flaked-grain samples were collected daily and analyzed for dry matter. Starch availability was determined by incubating whole flakes in a buffered, 2.5% amyloglucosidase solution for 15 minutes. The resultant soluble supernatant was measured on a commercial refractometer.

Cattle were fed once daily at approximately 2 p.m. and were allowed ad libitum access to diets. One heifer died during the experiment, and another heifer became lame and was consequently removed from the experiment. Because crude protein of each of the corn sources was different, the concentration of soybean meal differed among diets to maintain similar amounts of dietary crude protein. All diets were formulated to contain excess crude protein to ensure that differences among grain sources were due to differences in energy availability. We used a non-genetically modified soybean meal to eliminate the possibility of confounding our results with other genetically modified ingredients. On day 53, diets were altered because of an anticipated shortage in non-genetically modified soybean meal. Diet compositions after day 53 are presented in Table 1.

At the completion of the experiment, heifers were weighed and transported to a commercial abattoir in Emporia, Kansas, where carcass data were collected. Hot carcass weight and liver scores were obtained at harvest. The percentages of kidney, pelvic, and heart fat; subcutaneous fat thickness; ribeye area; marbling score; and USDA quality and yield grades were determined after a 24-hour chill.

Results and Discussion

No statistically significant differences were observed among treatments for any of the performance data, including dry matter intake, average daily gain, and feed efficiency (Table 2). However, final weight, average daily gain, and gain efficiency were numerically improved as corn endosperm became softer in texture. Other research has demonstrated improvements in cattle performance by feeding corn hybrids with opaque endosperm in diets based on dry-rolled corn. Steam flaking may disrupt the extensive protein-starch matrix in vitreous hybrids however, and create a flake with feeding value similar to that of the opaque hybrid. Heifers fed HARD-GMO performed comparably to those fed HARD-CONV, in as much as intakes, gains, and efficiencies were similar for these treatments. The incidence of liver abscesses was extremely small (2.5%) and was not different among treatments. No differences were observed between treatments for hot carcass weight; dressing percentage; kidney, pelvic, and heart fat; or ribeye area. Cattle fed the INT endosperm type tended ($P=0.09$, quadratic) to have less fat over the 12th rib and numerically had the most USDA Yield Grade 1 and 2 carcasses. Cattle fed HARD-CONV had the fewest (P<0.01) USDA Yield Grade 1 and 2 carcasses and tended (P=0.06) to have more carcasses with better marbling scores. Interestingly, starch availability measured throughout the experiment was greater (P<0.001; Table 1) for HARD-CONV flakes than for HARD-GMO flakes. Previous research conducted at Kansas State has indicated that cattle consuming flakes with greater starch availability deposit adipose to a greater extent than cattle consuming less available flakes.

Performance of cattle fed a corn hybrid containing the Herculex Cry1F protein was similar to that of cattle fed its isogenic, conventional counterpart. Furthermore, corn endosperm hardness did not alter performance of beef heifers fed steam-flaked corn, based diets.

Table 1. Composition of Experimental Diets (% of Dry Matter)

	Corn Endosperm Type[a]							
Ingredient	HARD-GMO		HARD-CONV		INT		SOFT	
Steam-flaked corn	74.9	(76.4)[b]	74.4	(76.0)	75.3	(76.9)	76.8	(78.4)
Alfalfa hay	7.7	(7.7)	7.7	(7.7)	7.7	(7.7)	7.6	(7.6)
Soybean meal	6.8	(5.3)	7.3	(5.7)	6.4	(4.8)	5.1	(3.5)
Cane molasses	4.7	(4.7)	4.7	(4.7)	4.7	(4.7)	4.6	(4.6)
Tallow	3.0	(3.0)	3.0	(3.0)	3.0	(3.0)	3.0	(3.0)
Limestone	1.4	(1.4)	1.4	(1.4)	1.4	(1.4)	1.4	(1.4)
Urea	1.1	(1.1)	1.1	(1.1)	1.1	(1.1)	1.1	(1.1)
Salt	0.3	(0.3)	0.3	(0.3)	0.3	(0.3)	0.3	(0.3)
Premix[c]	0.1	(0.1)	0.1	(0.1)	0.1	(0.1)	0.1	(0.1)
Nutrient, analyzed								
Crude protein	14.6	(13.9)	14.6	(13.9)	14.8	(14.0)	14.5	(13.8)
Calcium	0.7	(0.7)	0.7	(0.7)	0.7	(0.7)	0.7	(0.7)
Phosphorus	0.3	(0.3)	0.3	(0.3)	0.3	(0.3)	0.3	(0.3)
Crude protein of corn	7.7		7.4		8.0		8.7	
Starch availability of flaked corn, %[d]	53.1		55.3		53.7		53.7	

[a]Steam-flaked corn originated from corn hybrids expressing vitreous (HARD), opaque (SOFT), or intermediate (INT) types of corn endosperm. Within HARD endosperm type, a hybrid containing the Herculex I Cry1F protein (HARD-GMO) was compared with its nontransgenic, conventional (HARD-CONV) counterpart.
[b]Diets were reformulated on day 53. Diet composition from day 53 to day 118 is shown in parentheses.
[c]Formulated to provide the following (total diet dry matter): 1,280 IU of vitamin A/lb, 15 IU of vitamin E/lb, 0.1 ppm cobalt, 8.3 ppm copper, 0.5 ppm iodine, 0.1 ppm iron, 50 ppm manganese, 0.25 ppm selenium, 67 ppm zinc, 30 g/ton Rumensin, 9 g/ton Tylan, and 0.05 g/ton MGA.
[d]HARD-GMO was significantly less than HARD-CONV, P<0.001, SEM=0.44; 107 samples analyzed for each hybrid.

Table 2. Performance and Carcass Characteristics of Heifers Fed Finishing Diets Based on Steam-Flaked Corn from Corn Hybrids Containing Hard (HARD), Intermediate (INT), or Soft (SOFT) Textured Endosperm

	Corn Endosperm Type[a]					Treatment Comparison[b]		
Item	HARD-GMO	HARD-CONV	INT	SOFT	SEM	GMO vs. CONV	HARD vs. SOFT	Quad[c]
No. of heifers	19	20	20	19				
Initial body weight, lb	796	795	795	795	4.1	0.96	0.91	1.00
Final body weight, lb[d]	1186	1182	1191	1202	15	0.83	0.34	0.90
Dry matter intake, lb/day	17.67	18.15	17.70	18.09	0.52	0.53	0.78	0.63
Average daily gain, lb	3.31	3.27	3.35	3.45	0.12	0.83	0.30	0.90
Gain/feed	0.189	0.181	0.189	0.190	0.0047	0.22	0.34	0.84
Liver abscesses, %	5.0	5.0	0.0	0.0	3.5	0.98	0.29	0.51
Hot carcass weight, lb	753	750	756	763	9.6	0.83	0.33	0.90
Dressing percentage	66.1	65.6	65.6	65.1	0.40	0.37	0.16	0.83
Kidney, pelvic & heart fat, %	2.31	2.38	2.33	2.45	0.078	0.58	0.28	0.44
12th rib fat, inches	0.59	0.66	0.51	0.62	0.053	0.36	0.96	0.09
Ribeye area, square inches	12.7	12.7	12.8	12.9	0.31	0.92	0.56	0.98
Marbling[e]	Sm^{22}	Sm^{89}	Sm^{54}	Sm^{36}	23.3	0.06	0.52	0.76
USDA Yield grade						P-value[b]		
Yield grade 1 & 2, %	32	5	35	26		<0.01		
Yield grade 3, %	36	50	40	42		0.86		
Yield grade 4, %	21	40	20	21		0.47		
Yield grade 5, %	11	5	5	11		0.84		
USDA quality grade								
Prime and Choice, %	68	85	60	58		0.14		
Select and Standard, %	32	15	40	42		0.14		

[a]Within hard endosperm type, a transgenic hybrid containing the Herculex I Cry1F protein (GMO) was evaluated with its conventional, isogenic counterpart (CONV).
[b]P-values indicate the probability that differences of the magnitude observed were due to random chance.
[c]INT vs. average of HARD and SOFT.
[d]Estimated as hot carcass weight/0.635.
[e]Sm=small.