

Effects of whole or rolled corn and 20 or 40 percent forage levels on finishing performance of yearling steers

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The objective of this project was to evaluate whole and rolled corn in diets for finishing yearling steers with 20 or 40 percent forage as grass hay. Results indicated that corn processing type does not interact with forage level, and feeding dry-rolled corn provides a slight advantage over whole corn because dry-rolled corn tended to have improved feed efficiency. However, whole- and rolled-corn diets produced carcasses with similar characteristics. Diets with 20 percent forage had higher calculated energy values and, as expected, resulted in improved feed efficiency and overall average daily gain (ADG). We found a tendency for yield grade to be lower for 40 percent forage; however, hot carcass weight, marbling score, rib-eye area and backfat were similar across the two forage levels.

Summary

One hundred eight black crossbred yearling steers (917 ± 2.5 pounds body weight) were used to evaluate feeding whole or dry-rolled corn in diets with 20 or 40 percent of the diet dry matter included from grass hay. The four treatments were: 1) 55 percent whole corn with 20 percent grass hay, 2) 55 percent dry-rolled corn with 20 percent grass hay, 3) 35 percent whole corn with 40 percent grass hay or 4) 35 percent dry-rolled corn with 40 percent grass hay. Corn type (whole or dry-rolled) did not influence ($P \geq 0.21$) performance across the two forage levels; therefore, the data are presented as main effects of whole vs. rolled corn and 20 percent vs. 40 percent forage. Weights at the start of the trial were similar ($P = 0.96$) among treatments, and steer body weights were similar ($P \geq 0.47$)

for whole and rolled-corn treatments across all five weight periods. Overall average daily gain (ADG) was similar ($P \geq 0.25$) across all weight periods, with the exception of days 28 to 56, when the steers on the rolled-corn treatment gained 4.31 pounds/head/day, compared with those on the whole corn, which had an ADG of 3.56 pounds/head/day ($P = 0.03$). Dry-matter intake (DMI) was similar for whole and rolled corn overall and across all weight periods ($P \geq 0.42$). While the overall feed-to-gain ratio tended ($P = 0.09$) to favor dry-rolled corn (6.93 pounds:1 pound), compared with whole corn (7.35 pounds:1 pound), all the interim periods had similar ($P \geq 0.29$) feed-to-gain ratios with the exception of days 28 to 56, when dry-rolled corn was lower than whole corn (7.13 pounds:1 pound, compared with 9.04 pounds:1

pound; $P = 0.003$). Carcass attributes were similar ($P \geq 0.11$) for whole and rolled corn. Body weight was similar ($P \geq 0.69$) in steers fed the two forage levels at the start and through day 56; however, at each subsequent period from day 56 through market, body weights were greater ($P \leq 0.03$) for 20 percent forage. Average daily gains were greater for the 20 percent forage for the first three periods and overall. While DMI was similar ($P \geq 0.20$) for steers fed 20 and 40 percent forage treatments across all periods, and thus for the whole 141-day feeding period, the feed-to-gain ratio followed a similar pattern as with ADG. The 20 percent forage-fed cattle used less feed to gain a pound of body weight for the first three trial periods and overall, compared with 40 percent forage-fed cattle ($P \leq 0.03$). Carcass attributes, including hot carcass weight, rib-eye area, marbling score, back fat and dressing percent, were similar among 20 and 40 percent forage ($P \geq 0.16$). However, yield grade tended ($P = 0.06$) to be greater for 20 percent forage.

Introduction

Corn included in growing and finishing feedlot diets typically is processed by dry rolling, grinding or steam flaking. Corn processing research trials have had mixed results through the years, with some reporting processed corn increasing digestibility and improving the performance of feedlot cattle and others showing no difference between processed and whole corn.

The topic of how much processing and when to process still is debated among producers and nu-

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tritionists. Forage level and moisture content of dietary ingredients, as well as other unknown factors, may interact with the processing level and contribute to the variability in animal response. Our objective was to evaluate effects on animal performance and carcass characteristics from feeding whole or rolled corn in finishing diets with 20 or 40 percent of the diet dry matter inclusion from grass hay.

Experimental Procedures

All procedures were approved by the NDSU Animal Care and Use Committee. One hundred eight black crossbred yearling steers (917 ± 2.5 pounds body weight) were used to evaluate feeding whole or dry-rolled corn in diets with 20 or 40 percent of the diet dry matter included from grass hay.

Steers were assigned randomly to one of 12 pens (nine animals/pen) at the NDSU Carrington Research Extension Center. Each pen was assigned randomly to one of four treatments: 1) 55 percent whole corn with 20 percent grass hay, 2) 55

percent dry-rolled corn with 20 percent grass hay, 3) 35 percent whole corn with 40 percent grass hay or 4) 35 percent dry-rolled corn with 40 percent grass hay (Table 1).

Diets were formulated to be similar in crude protein and meet or exceed the National Research Council (NRC) recommendations. Modified corn distillers grain was included in each treatment diet at a set level of 25 percent. All diets included a supplement containing an ionophore, vitamins and minerals.

Each corn type was analyzed for particle size following the procedures of Behnke (1985) at a commercial laboratory using a Tyler Ro-Tap Shaker Model RX-29 and 14 Sieves [4, 6, 8, 12, 16, 20 (with brush), 30 (with brush), 40 (with brush), 50 (with brush), 70 (with brush), 100 (with brush and ball), 140 (with brush), 200 (with brush and ball) and 270 screens plus bottom pan and cover lid]. Mean particle size for the whole and dry-rolled corn was 5,516 ± 1.15 millimeters (mm) and 2,824 ± 1.45 mm, respectively.

Steers were weighed and

implanted with 120 milligrams (mg) trembelone acetate and 24 mg estradiol (Revalor S; Merck Animal Health) at the start of the trial (day 0). Steers were weighed approximately every 28 days for the 141-day feeding period. One steer died in the first 28 days from complications not related to treatment, and one steer on the 55 percent rolled corn/20 percent forage treatment died one month prior to harvest from complications due to bloat.

All cattle were harvested on the same date at Tyson Fresh Meats, Dakota City, Neb. Hot carcass weights were obtained at harvest. The following carcass attributes were evaluated by a trained grader after a 24-hour chill: 12th rib-fat depth; rib-eye area; kidney, pelvic, and heart fat (KPH); marbling score; and U.S. Department of Agriculture yield grade. Performance and carcass characteristics were analyzed using the GLM procedure of SAS (SAS Inst. Inc., Cary, N.C.) and pen was the experimental unit.

Results and Discussion

During the 141-day feeding period, corn type (whole or dry-rolled) did not influence ($P \geq 0.21$) performance across the two forage levels, therefore the data is presented as main effects of whole corn vs. rolled corn and 20 percent forage vs. 40 percent forage (Table 2). This also was observed in a study by Turgeon et al., 1983, in which diets with whole, cracked and fine-ground corn were fed with three levels of alfalfa hay (5, 10 and 15 percent) and by Gorocica-Buenfil and Loerch (2005), in which two levels of corn silage were fed (18.2 and 5.2 percent) with whole or cracked corn.

This study consisted of five 28-day weight periods during the 141-day feeding trial. Weights at the

Table 1. Formulation and nutrient composition of diets for yearling steers fed whole or dry-rolled corn and 20 or 40 percent grass hay.

Ingredients, Dry-matter Basis	40% Forage Whole Corn	40% Forage Rolled Corn	20% Forage Whole Corn	20% Forage Rolled Corn
Corn, % ¹	32.54	33.48	51.47	52.39
MDGS, % ²	25.67	25.27	25.65	25.07
Hay, %	39.75	39.15	20.73	20.32
Supplement, % ³	2.04	2.10	2.20	2.21
Nutrient Composition				
CP, %	14.29	14.07	14.51	14.17
NEg, Mcal/lb.	0.47	0.48	0.56	0.56
DM, %	74.10	73.02	72.91	74.59
Diet concentrate, %	60.25	60.85	79.27	79.68
Diet forage, %	39.75	39.15	20.73	20.32

¹Mean particle size for the whole and dry-rolled corn was 5,516 ± 1.15 mm and 2,824 ± 1.45 mm, respectively.

²Modified corn distillers grains, 52 percent dry matter.

³Supplement included vitamins, minerals and an ionophore.

start of the trial were similar ($P = 0.96$) among treatments, and steer body weights were similar ($P \geq 0.47$) for whole and rolled corn treatments across all five weight periods (Table 2). Similarly, overall average daily gain (ADG) was similar ($P \geq 0.25$) across all weight periods, with the exception of days 28 to 56, when the steers on the rolled corn treatment gained 4.31 pounds/head/day, compared with those on the whole corn, which had an ADG of 3.56 pounds/head/day ($P = 0.03$).

Similarly, Vance et al. (1972) observed similar ADG when whole or crimped corn was fed. Dry-matter intake was similar for whole and rolled corn overall and across all weight periods ($P \geq 0.42$). While the overall feed-to-gain ratio tended ($P = 0.09$) to favor dry-rolled corn (6.93:1), compared with whole corn (7.35:1), all the interim periods had similar ($P \geq 0.29$) feed-to-gain ratios with the exception of days 28 to 56, when dry-rolled corn was lower than whole corn (7.13:1 compared

with 9.04:1; $P = 0.003$).

In a summary of published research, Owens et al. (1997) reported feeding diets with whole corn resulted in higher feed efficiencies than dry rolled corn. The greater efficiency for whole-corn diets was attributed to lower dietary forage levels (less than 15 percent), which are typical for feedlot finishing diets. In contrast, in a study with high (18.2 percent) or low (5.2 percent) corn silage inclusion, Gorocica-Buenfil and Loerch (2005) observed

Table 2. Performance of yearling steers fed diets with whole or rolled corn and 20 or 40 percent grass hay.

Variable	Rolled Corn	Whole Corn	20% Forage	40% Forage	SEM	Corn Trt P-value	Forage Trt P-value	Corn x forage level P-value
Experimental unit, pen	6	6	6	6				
Weight, lb								
Weight, day 0	920.00	916.17	916.83	919.33	2.49	0.31	0.50	0.96
Weight, day 28	1,085.50	1,079.17	1,092.83	1,071.83	7.86	0.58	0.10	0.69
Weight, day 56	1,202.00	1,175.17	1,207.50	1,169.67	10.16	0.10	0.03	0.50
Weight, day 85	1,325.50	1,293.50	1,340.83	1,278.17	12.11	0.10	0.01	0.47
Weight, day 113	1,422.83	1,390.17	1,441.83	1,371.17	14.07	0.14	0.01	0.57
Weight, day 141	1,531.83	1,495.50	1,549.50	1,477.83	18.49	0.20	0.03	0.77
Average daily gain, lb/hd/d								
ADG, days 0-28	5.91	5.82	6.29	5.45	0.30	0.84	0.08	0.69
ADG, days 28-56	4.31	3.56	4.25	3.62	0.21	0.03	0.07	0.51
ADG, days 56-85	4.26	4.08	4.60	3.74	0.13	0.35	0.002	0.60
ADG, days 85-113	3.48	3.45	3.61	3.32	0.29	0.96	0.51	0.91
ADG, days 113-141	3.89	3.76	3.85	3.81	0.22	0.68	0.91	0.68
ADG, days 0-141	4.17	3.94	4.31	3.80	0.13	0.25	0.02	0.76
Dry-matter intake, lb/hd/d								
DMI, days 0-28	26.56	26.86	26.76	26.66	0.58	0.72	0.91	0.68
DMI, days 28-56	30.44	31.68	31.03	31.09	1.04	0.42	0.97	0.21
DMI, days 56-85	28.57	28.96	28.79	28.75	1.29	0.84	0.98	0.22
DMI, days 85-113	28.39	27.82	27.57	28.63	1.07	0.72	0.50	0.48
DMI, days 113-141	30.98	29.89	29.07	31.80	1.36	0.59	0.20	0.40
DMI, days 0-141	28.77	28.82	28.43	29.16	0.96	0.97	0.60	0.56
Feed:Gain, lb:lb								
Feed:Gain, days 0-28	4.54	4.67	4.30	4.92	0.16	0.60	0.03	0.68
Feed:gain, days 28-56	7.13	9.04	7.46	8.70	0.33	0.003	0.03	0.42
Feed:gain, days 56-85	6.77	7.19	6.28	7.68	0.26	0.29	0.01	0.20
Feed:gain, days 85-113	8.19	8.58	7.74	9.03	0.85	0.76	0.31	0.54
Feed:gain, days 113-141	8.01	8.01	7.65	8.38	0.42	1.00	0.25	0.66
Feed:gain, days 0-141	6.93	7.35	6.61	7.67	0.15	0.09	0.001	0.48

similar feed efficiency for cattle fed whole or cracked corn. In both of these reports, the dietary forage levels were less than both of the forage levels fed in the current study.

All carcass attributes were similar between whole- and rolled-corn diets ($P \geq 0.11$; Table 3).

Body weight was similar ($P \geq 0.69$) in steers fed the two forage levels at the start and through day 56; however, at each subsequent period from day 56 through market, body weights were greater ($P \leq 0.03$) for 20 percent forage. Average daily gains were greater for the 20 percent forage for the first three periods and overall (days 0 to 141; Table 2).

While DMI was similar ($P \geq 0.20$) for steers fed 20 and 40 percent forage treatments across all periods and thus for the whole 141-day feeding period, the feed-to-gain ratio followed a similar pattern as with ADG. The 20 percent forage-fed cattle used less feed to gain a pound of body weight for the first three trial periods and overall, compared with 40 percent forage-fed cattle ($P \leq 0.03$).

Improved dry matter conversions also were observed by Turgeon et al. (1983), but in contrast, they

observed a linear increase in dry-matter intake when forage levels increased from 5 to 15 percent of the diet dry matter. Carcass attributes, including hot carcass weight, rib-eye area, marbling score, back fat and dressing percent, were similar among 20 and 40 percent forage ($P \geq 0.16$). However, yield grade tended ($P = 0.06$) to be greater for 20 percent forage.

These results indicate that when feeding forage above 20 percent of the diet dry matter, corn type (whole or rolled) does not interact differently with forage level. Feeding diets with 20 percent forage had higher calculated energy values and, as expected, resulted in improved feed efficiency and overall ADG. However, hot carcass weight and carcass quality grade were similar for the two forage levels.

Feeding dry-rolled corn provides a slight advantage over whole corn, as indicated by improved feed efficiency. However, whole-corn and rolled corn diets produced carcasses with similar carcass characteristics at harvest. When the cost to roll corn exceeds the production benefits or rolling is not available, feeding whole corn is a viable option for finishing yearling steers.

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Table 3. Carcass performance of yearling steers fed diets with whole or rolled corn and 20 and 40 percent grass hay.

Variable	Rolled Corn	Whole Corn	20% Forage	40% Forage	SEM	Corn P-value	Forage P-value	Corn by forage level interaction P-value
Hot carcass weight, lb.	906.99	888.01	908.86	886.15	10.41	0.23	0.16	0.07
Yield grade ¹	3.80	3.71	3.87	3.65	0.07	0.39	0.06	0.17
Rib-eye area, sq. in.	12.31	12.16	12.19	12.27	0.18	0.57	0.78	0.58
Marbling score ²	457.58	439.80	440.90	456.48	6.89	0.11	0.14	0.85
Back fat, in.	0.52	0.51	0.53	0.50	0.02	0.62	0.33	0.22
KPH, %	1.74	1.78	1.74	1.77	0.02	0.26	0.39	0.14

¹Yield grade is composite calculation of fat to lean yield in a carcass based on a relationship of hot carcass weight, rib-eye area, fat thickness and KPH; low values = lean carcasses.

²USDA quality grades based on scores of 300-399 = select, 400-499 = low choice, 500-599 = average choice, 600-699 = high choice, 700+ = prime.