Effects of Corn Particle Size and Forage Level on Performance and Carcass Traits of Yearling Steers during Finishing

Chanda Engel, Vern Anderson, and Chris Schauer

Introduction

Corn is typically processed either by dry rolling, grinding or steam flaking in most feedlot rations. Corn processing has been reported to increase starch digestibility and improve performance of feedlot cattle. Processing corn through a roller or hammer mill breaks open the kernel, exposing the starch fraction and increasing the surface area for moistening and bacterial attachment, which increases the rate of digestion in the rumen. Forage level, moisture content of other dietary ingredients, as well as other unknown factors, may interact with processing level and contribute to variability in animal response. Our objective was to evaluate the response to differences in corn particle size when higher dietary forage levels were utilized for finishing yearling steers.

Procedures

All procedures were approved by the NDSU Animal Care and Use Committee. One hundred-twenty black crossbred yearling steers (897 ± 2.52 lbs BW) were used to evaluate three corn processing levels in feedlot finishing diets across three decreasing forage levels in a randomized complete block design. Steers were blocked by receiving body weight (4 weight blocks) and allotted to one of 12 pens (10 animals per pen) at the NDSU Carrington Research Extension Center. Within each block, pens were assigned randomly to one of three corn processing treatments to achieve different corn particle sizes: 1) whole corn (WC), 2) Dry-rolled corn (RC), 3) Finely-ground corn (GC) (Table 1). Diets were formulated to be similar in protein and energy, to meet or exceed NRC nutrient requirements, and included Rumensin®, vitamins, and minerals. The amount of forage in the diet for all three corn processing treatments in the initial feeding period was 31.5 percent (DM basis) and decreased at 41-day intervals to 25.0 and 15.5 percent, followed by a final level of 13.5 percent for the last 22 days of the experiment. Forage levels are defined as the sum of the hay and 50 percent of the diet corn silage components. Totally-mixed diets were offered *ad libitum* and delivered to fenceline bunks once per day. Dietary ingredient samples were collected every 28 days and analyzed for nutritional composition at a commercial lab. Each corn processing 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, rolled, and ground corn was 5.49 ± 0.14 mm, 2.84 ± 0.12 mm, and 1.35 ± 0.16 mm, respectively.

Table 1. Formulation and nutrient composition of diets for yearling steers fed whole, dry-rolled, or finely-ground corn with decreasing forage levels.

Ingredient	31.5% Forage Period 1[1]	25% Forage Period 2[1]	15.5% Forage Period 3[1]	13.5% Forage Period 4[2]	Overall[3]
			Dry matter basis		
Corn, %[4]	23.0	35.0	53.0	55.0	41.0
MDGS, %	24.0	25.0	24.0	24.0	24.0
Corn Silage, %	39.0	28.0	13.0	11.0	23.0
Hay, %	12.0	11.0	9.0	8.0	10.0
Supplement, %	2.0	2.0	2.0	2.0	2.0
Item					
CP, %	13.40	13.80	14.10	14.10	13.80
NEg, Mcal/lb	0.49	0.53	0.57	0.58	0.54
DM, %	45.20	50.50	60.70	62.30	53.20
Diet concentrate, %	68.50	75.00	84.50	86.50	78.50
Diet forage, %	31.50	25.00	15.50	13.50	21.50

[1] 41 days in each period. [2]22 days in the period. [3] Diet composition averaged over the entire 145 day finishing trial. [4] All three treatment diets, within respective forage level periods, were similar in composition, the only difference was how the corn was processed (whole, dry rolled, or finely ground).

Steers were weighed and implanted with 120 mg of trenbolone acetate and 24 mg of estradiol (Revalor S; Merck Animal Health, Whitehouse Station, NJ) at the start of the trial. Steers were weighed every 41 days for the 145-day feeding period, with the final feeding period of 22 days. One steer died due to causes not related to treatment. All cattle were harvested on the same date at Tyson Fresh Meats, Dakota City, NE. Hot carcass weights were obtained at harvest. Carcass attributes were evaluated by a trained grader after a 24-hour chill were 12th rib fat depth, ribeye area, kidney, pelvic, and heart fat (KPH), marbling, and USDA 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

Body weight and average daily gain (ADG) were similar ($P \geq 0.19$) within each forage level period and over the entire feeding period (Table 2). Gorocica- Buenfil and Loerch (2005) observed a similar effect on animal performance among cattle fed whole corn, cracked corn or a shifting diet combination of both whole or cracked corn with high (18.2% corn silage) or low (5.2% corn silage) forage diets. Swanson et al. (2014) found that decreasing corn particle size, through different degrees of dry rolling, did not impact ADG, DMI or G:F. In this study, dry matter intake (DMI) was similar ($P = 0.24$) for DR (29.9 lbs) and GC (29.2 lbs) and greatest ($P \leq 0.01$) for WC (31.8 lbs) (Table 2). Over the entire study, efficiency of gain was greatest ($P = 0.003$) with RC (0.169) and GC (0.166) and lowest with WC (0.154). A similar efficiency response was observed ($P \leq 0.01$) in the 31.5 percent and 25 percent forage feeding periods, but the effect diminished as forage levels decreased below 15.5 percent. Vander Pol et al., (2008) found that feed intake decreased as level of corn processing increased. They also found feed efficiency was improved for cracked corn over whole and fine-ground corn diets. In a review of the literature, Owens et al. (1997) reported that feed efficiency was not improved by dry rolling over feeding whole corn. The lack of difference was partially attributed to dietary roughage levels being lower in diets containing whole corn compared to dry rolled corn (6.0% vs. 7.9%). In the current study, forage levels were greater over the entire feeding period than the studies reviewed by Owens et al. (1997) and may explain why dry matter intake decreased with processed corn treatments and both RC and GC showed similar improvements in feed efficiency over WC. All carcass characteristics, with the exception of percent kidney pelvic and heart fat (KPH), were similar ($P \geq 0.07$) among corn processing

levels (Table 3). The percent KPH was similar ($P > 0.05$) for RC and GC but greater for WC ($P = 0.01$). These results may indicate when forage levels are greater than 15.5 percent on a dry matter basis, processing corn by dry rolling or fine grinding, to maintain a particle size greater than 1.35 ± 0.16 mm and less than 5.49 ± 0.14 mm (2.84 ± 0.12 mm on average) will result in improved DMI and gain efficiency for finishing yearling steers.

Table 2. Animal performance for yearling steers fed diets containing whole, dry-rolled, or finely-ground corn with decreasing forage levels.

	Whole	Rolled	Ground	Std Err	*P*-Value
31.5% Forage, period 1 [1]					
Body weight, lb	1141	1153	1148	6.56	0.52
ADG, lb/d	5.73	6.17	5.93	0.15	0.19
DMI, lb/d	27.5	26.5	26.2	0.34	0.07
G:F	0.208[b]	0.233[a]	0.227[a]	0.005	0.04
25% Forage, period 2 [1]					
Body weight, lb	1318	1340	1337	8.35	0.24
ADG, lb/d	4.12	4.35	4.39	0.12	0.3
DMI, lb/d	31.7	30.6	30.8	0.51	0.31
G:F	0.130[b]	0.143[a]	0.143[a]	0.002	0.01
15.5% Forage, period 3 [1]					
Body weight, lb	1510	1530	1512	15.99	0.71
ADG, lb/d	4.83	4.64	4.27	0.25	0.35
DMI, lb/d	35.0[a]	32.3[b]	30.9[b]	0.64	0.01
G:F	0.138	0.144	0.138	0.006	0.65
13.5% Forage, period 4 [2]					
Body weight, lb	1610	1625	1604	10.17	0.36
ADG, lb/d	5	5.04	4.84	0.39	0.93
DMI, lb/d	34.2[a]	30.2[b]	28.6[b]	0.66	0.002
G:F	0.146	0.167	0.17	0.016	0.66
Overall[3]					
Initial body weight, lb	901	894	899	2.52	0.17
Final body weight, lb	1610	1625	1604	10.17	0.36
ADG, lb/d	4.89	5.05	4.86	0.07	0.21
DMI, lb/d	31.8[a]	29.9[b]	29.2[b]	0.37	0.01
G:F	0.154[b]	0.169[a]	0.166[a]	0.002	0.002

[1]41 days in the period. [2]22 days in the period. [3] overall days on feed, 145 days. [abc] Means within rows with common superscripts are similar, $P > 0.05$.

Table 3. Carcass performance for yearling steers fed diets containing whole, dry-rolled, or finely-ground corn with decreasing forage levels.

	Whole	Rolled	Ground	Std Err	*P*-Value
Marbling score[1]	552.9	538.0	579.3	12.01	0.12
Hot carcass weight, lb	959.3	964.2	948.5	7.13	0.34
Backfat, in.	0.69	0.74	0.72	0.01	0.15
REA, sq. In.	14.16	14.06	14.38	0.13	0.26
Yield grade[2]	3.84	3.98	3.76	0.05	0.07
KPH, %	2.46[a]	2.29[b]	2.35[b]	0.03	0.01
Dressing percent, %	62.8	62.5	62.5	0.22	0.67

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

[2] Yield grade is a 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.

[abc] Means within rows with common superscripts are similar, $P > 0.05$.

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