Growing and finishing feedlot performance of steers fed diets with rolled corn or rolled barley and medium- or low-fat dry distillers grains with solubles

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Feeding low- or medium-fat dried distillers grains with solubles (DDGS) at 26 percent of the diet dry matter to steers in growing and finishing diets appears to influence animal performance and carcass attributes similarly. When fed at similar diet dry-matter levels, rolled barley and rolled corn have similar effects on animal performance and carcass characteristics. Barley appears to result in similar feed efficiency with corn in the growing phase but showed improved feed efficiency in the finishing phase as a result of lower dry-matter intake and similar performance when compared with corn-based diets.

Summary

Crossbred steers (n = 154), with an initial body weight (BW) of 684 pounds, were used in a 189-day growing and finishing feedlot study evaluating the effects of corn or barley and two fat levels of dry distillers grains with solubles (DDGS). Steers were blocked by initial BW into four weight blocks and assigned randomly to one of 16 pens. Pens were assigned to one of four dietary treatments within weight blocks. Treatments were arranged as a 2 × 2 factorial with grain type (dry rolled corn or dry rolled barley) as one factor and fat content of DDGS (med-fat, 9.6 percent fat or low-fat, 5.8 percent fat) as the other factor. No grain type (corn or barley) by DDGS fat level (9.6 or 5.8 percent fat) interactions were detected ($P \geq 0.29$). Initial and final BW, average daily gain (ADG), dry-matter intake (DMI) and gain:feed (G:F; pounds BW gain/pound of feed consumed) were similar ($P \geq 0.11$) for low- and med-fat DDGS for the growing and finishing phases. Dressing percent, hot carcass weight (HCW), yield grade, longissimus muscle (LM) area, marbling score and back fat (BF) did not differ between DDGS treatments ($P \geq 0.18$). Steers fed corn- and barley-based diets had similar initial and final growing ($P \geq 0.16$) and finishing ($P \geq 0.17$) BW and ADG. Growing DMI was similar ($P = 0.37$) for corn and barley grain, resulting in similar G:F in the growing phase ($P = 0.26$). However, cattle on the corn finishing diets had greater ($P = 0.02$) DMI than barley, resulting in a tendency ($P = 0.08$) for barley to be more efficient than corn during the finishing phase. Overall, barley-fed steers had greater ($P = 0.002$) G:F than corn-fed steers. The carcass parameters dressing percent, HCW, yield grade, LM area, marbling score and BF were all similar ($P \geq 0.09$) for barley- and corn-fed cattle. Low-fat and medium-fat DDGS can be fed with corn and barley grain at similar levels without affecting animal performance. Additionally, rolled corn and rolled barley are comparable grain sources for growing and finishing feedlot steers.

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Introduction

Corn distillers grain (DG) is produced at multiple ethanol plants in North Dakota. Primarily three moisture levels of corn distillers grain products are available: dry (about 90 to 95 percent dry matter, DDGS), modified (49 to 52 percent dry mater, MDGS) or wet (less than 48 percent dry matter, WDGS). The DDGS product is the most shelf stable and transportable due to the lower moisture content.

The current process for ethanol plants involves a step to remove corn oil (fat) from DG during ethanol production. Ethanol plants remove corn oil from DG for higher-value biodiesel and feed markets. Some plants remove a greater proportion of oil than others, resulting in fat levels of DG ranging from 4 to 10 percent, depending on the plant process.

Fat is high in energy, thus oil removal may alter the nutrient density of the resulting distillers grain feedstuff. While certain nutrients such as protein are slightly increased, the main concern is a reduction in energy value related to fat removal and its effect on animal performance.

A portion of the distillers grains produced in North Dakota is fed in the state, but the majority is exported to other locations in the U.S., Canada and other international locations. Typically, feedlot diets in the U.S. include corn grain as the primary grain source. However, in Canada and at times in North Dakota, barley is the primary grain source. Barley is higher in protein and fiber and lower in starch than corn; however, corn starch may be less digestible unless it is steam-flaked (Gibb and McAllister, 2003).

Concern has developed among nutritionists and feedlot managers that the variation in fat levels in the current distillers grains products on the market could affect animal performance when corn or barley is fed as the primary grain source. The objective of this study was to evaluate the effects on animal performance and carcass characteristics of feedlot cattle fed diets with moderate- or low-fat DDGS with rolled corn or rolled barley grain.

Experimental Procedures

All trial procedures were approved by the NDSU Animal Care and Use Committee. Crossbred steers (n = 154), with an initial BW of 684 pounds, were used in a 189-day feedlot study evaluating the effects of corn or barley and two fat levels of DDGS. The study, conducted at the NDSU Carrington Research Extension Center, included a 57-day growing phase (day 0 to day 57) and an approximately 132-day finishing phase (day 58 to end).

The heavy block (four pens) was marketed at day 180 and the remaining three blocks (12 pens) were marketed on day 194. Steers were consigned by North Dakota producers through the Dakota Feeder Calf Show producer feedout program.

Steers were implanted with 120 milligrams (mg) of trenbolone acetate and 24 mg of estradiol (Revalor S, Merck Animal Health) on day 0 and day 85. Upon arrival, steers were blocked by initial BW into four weight blocks and assigned randomly to one of 16 pens.

Pens were assigned to one of four dietary treatments within block in the 2 x 2 factorial design. Grain type (dry rolled corn or dry rolled barley), as one factor, was fed at 30 and 51 percent of the diet DM for the growing and finishing diets, respectively. Two fat levels of DDGS (med-fat, 9.6 percent fat or low-fat, 5.8 percent fat) were included as the other factor and fed at 26 percent diet DM in the growing and finishing diets.

Growing diets included 19 percent grass hay, 22 percent corn silage, and 3 percent vitamin and mineral supplement with an ionophore (DM basis). Finishing diets included 20 percent corn silage, and 3 percent supplement vitamin and mineral supplement with an ionophore (DM basis; Table 1 and 2).

Steers were weighed on day 0 and every 28 days until harvest. Steers were marketed at a commercial abattoir (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

Table 1. Growing diets for steers fed two fat levels of dry distillers grains (DDGS) and corn or barley.

	Medium-fat DDGS		Low-fat DDGS	
Ingredient, % Dry Matter	Barley	Corn	Barley	Corn
Barley	30.2	–	30.3	–
Corn	–	30.8	–	30.7
DDGS, low-fat	–	–	25.6	25.5
DDGS, med-fat	25.7	25.6	–	–
Corn silage	22.1	21.9	22.0	21.8
Grass hay	18.6	18.4	18.5	18.4
Supplement	3.4	3.3	3.7	3.7
Diet dry matter, %	76.0	76.5	76.2	76.5
Crude protein, %	15.3	14.2	15.2	14.2
NEg, Mcal/lb.	49.1	51.8	47.5	50.1
Fat, %	4.1	4.6	3.1	3.6

Table 2. Finishing rations for steers fed two fat levels of dry distillers grains (DDGS) and corn or barley.

	Medium-fat DDGS		Low-fat DDGS	
Ingredient, % Dry Matter	Barley	Corn	Barley	Corn
Barley	50.9	–	51.1	–
Corn	–	51.4	–	51.5
DDGS, low-fat	–	–	25.9	25.8
DDGS, med-fat	26.1	25.9	–	–
Corn silage	19.5	19.4	19.4	19.3
Grass hay	0.7	0.8	0.7	0.6
Supplement	2.8	2.6	2.9	2.8
Diet dry matter, %	76.8	77.5	77.1	77.5
Crude protein, %	16.3	14.5	16.3	14.5
NEg, Mcal/lb.	56.5	60.9	55.0	59.3
Fat, %	4.2	5.0	3.2	4.0

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

No grain type (corn or barley) by DDGS fat level (9.6 or 5.8 percent fat) interactions were detected ($P \geq 0.29$); steers fed corn and barley responded to dietary treatments similarly across the two fat levels of DDGS fed at 26 percent of the diet dry matter, thus data is presented as main effects of DDGS fat level or grain type.

Initial and final body weight (BW) for the growing ($P \geq 0.18$) and finishing phases ($P \geq 0.11$) were similar for low- and med-fat DDGS (Table 3). Similarly, ADG, DMI and gain:feed (G:F; pounds BW gain/pound of feed consumed) were similar for growing ($P \geq 0.19$) and finishing ($P \geq 0.17$) phases for low- and med-fat DDGS. This is consistent with results observed in a previous feedlot study evaluating high- (12 percent fat), medium- (8 percent fat) and low- (4.5 percent fat) fat DDGS fed at 20 percent of the diet dry matter for finishing steers (Anderson and Engel, 2014).

In contrast, research conducted at Agriculture and Agri-food Canada, Lethbridge Research Centre, found that feeding growing feedlot diets to steers with 60 percent corn silage and 24.3 or 15 percent barley with 10 or 20 percent low- or medium-fat DDGS resulted in higher dry-matter intake and increased average daily gain for low-fat DDGS diets, compared with the medium-fat DDGS treatments (Ribeiro et al., 2016).

In the finishing phase of the Lethbridge study, barley replaced DDGS and levels were decreased to 5 and 10 percent for low- and medium-fat DDGS. The steers fed medium-fat DDGS in the finishing phase displayed improved feed efficiency conversion, compared with low-fat DDGS.

In a metabolism trial with diets similar to the current trial, Keomanivong et al. (2015) found that diets with low-fat DDGS had increased ruminal amylase activity. Additionally, this increased amylase activity was observed to be greater in diets with barley, compared with corn.

In a comparison of low-fat and traditional (high-fat) DDGS replacing corn in feedlot rations, Ceconi et al. (2012) observed lower rumen ammonia-nitrogen and greater volatile fatty acid concentrations in low-fat DDGS diets, compared with high-fat DDGS. The metabolism data from these studies (Keomanivong et. al., 2015 and Ceconi et. al., 2012) indicate that low-fat DDGS may enhance or higher-fat DDGS may suppress ruminal microorganism growth and activity.

In the current study, dressing percent, hot carcass weight, yield grade, longissimus muscle area,

Table 3. Growing and finishing performance of steers fed diets with two fat levels of dry distillers grains (DDGS) and corn or barley.

	DDGS		Grain			*P*-Value		Interaction
	Low-fat	Medium-fat	Barley	Corn	SEM	Grain	DDGs	Grain x DDGS
No. pens, n	8	8	8	8	–	–	–	–
Initial weight	683	690	690	682	3.38	0.16	0.18	0.70
Weight-d57[1]	860	870	873	857	7.96	0.17	0.43	0.37
Final weight[2]	1,398	1,419	1,413	1,393	12.86	0.30	0.11	0.40
ADG, d0-57	3.1	3.2	3.2	3.1	0.12	0.37	0.80	0.39
ADG, d58-end	4.0	4.1	4.1	4.1	0.07	0.80	0.33	0.42
ADG, d0-End	3.8	3.8	3.8	3.8	0.06	0.76	0.36	0.29
DMI, d 0-57	17.3	18.6	17.8	18.2	0.65	0.65	0.19	0.50
DMI, d58-end	22.1	23.0	21.7	23.4	0.42	0.02	0.17	0.35
DMI, d0-End	20.7	21.7	20.5	21.8	0.40	0.05	0.12	0.32
Feed:Gain, d0-57	5.6	5.9	5.5	5.9	0.18	0.15	0.29	0.69
Feed:Gain, d58-End	5.5	5.6	5.3	5.7	0.10	0.07	0.26	0.72
Feed:Gain, d0-End	5.5	5.7	5.4	5.8	0.08	0.002	0.20	0.85
Gain:Feed, d0-57	0.182	0.172	0.182	0.172	0.006	0.26	0.26	0.73
Gain:Feed, d58-End	0.184	0.180	0.187	0.177	0.003	0.08	0.25	0.73
Gain:Feed, d0-End	0.183	0.178	0.185	0.175	0.003	0.002	0.19	0.76

[1]The growing diet was fed from day 0 to day 57.

[2]Finishing ration was fed from day 58 to d 180 for four heavy pens and day 194 for 12 remaining pens.

marbling score and back fat did not differ among DDGS treatments ($P \geq 0.18$; Table 4). Anderson and Engel (2014) observed similar results for carcass characteristics in feedlot diets with three fat levels of distillers, with the exception of yield grade and marbling score.

Marbling score increased with increasing fat levels in DDGS and USDA yield grade was greater for high-fat but similar between medium- and low-fat DDGS diets. Similarly, Ribeiro et al. (2016) found carcass quality and liver abscesses were unaffected by type of DDGS and inclusion level.

In the current study, dietary fat levels ranged from 3.1 to 4.6 percent for the growing diets and 3.2 to 5 percent for the finishing diets (Table 1 and 2). Total dietary fat was 1 percent greater in the medium-fat DDGS diets, compared with the low-fat DDGS diets, when compared within the same grain type diets. Corn grain diets were slightly higher in total fat than the barley diets.

Steers fed corn- and barley-based diets had similar BW at trial initiation ($P = 0.16$), at the end of the growing phase ($P = 0.17$) and at trial completion ($P = 0.30$). Growing and finishing phase ADG was similar ($P \geq 0.37$) between grain sources. Growing DMI was similar ($P = 0.65$) for corn and barley grain (Table 3). However, cattle on the corn finishing diets had greater ($P = 0.02$) DMI than barley, resulting in similar ($P = 0.26$) growing phase G:F but had a tendency ($P = 0.08$) for barley to be more efficient than corn in the finishing phase.

Overall, barley-fed steers had greater ($P = 0.002$) G:F than corn-fed steers. Anderson and Ilse (2012) observed that as barley replaced corn at 0, 33, 67 and 100 percent of the diet for finishing steers, a linear decrease in feed intake, similar overall gains and a linear improvement in feed efficiency. Pritchard and Robbins (1991) substituted rolled barley for 0, 25, 50, 75 or 100 percent whole shelled corn in finishing diets. Increasing barley substitution resulted in decreased ADG and DMI but did not affect feed conversion.

We expected that as DMI decreased, ADG also would decrease. However, the lack of difference in feed conversion would support the idea that the energy value of barley may be underestimated (Owens et al., 1997) and the energy value of corn may be overestimated (Zinn et al., 2002).

While corn is generally higher in starch than barley, differences in the kernel structure and starch matrix arrangement between these grains likely account for the differences in performance. The starch and protein fractions of barley are more digestible than they are in corn (Gibb and McAllister, 2003). The carcass parameters for dressing percent, HCW, yield grade, LM area, marbling score and BF were all similar ($P \geq 0.09$) for barley- and corn-fed cattle (Table 4).

Feeding low- or med-fat DDGS at 26 percent of the diet dry matter in the growing and finishing phases appears to influence animal performance and carcass attributes similarly. When fed at similar diet dry-matter levels, rolled barley and rolled corn have similar effects on animal performance and carcass characteristics. Additionally, barley appears to result in similar feed efficiency with corn in the growing phase but may improve feed efficiency, compared with corn in the finishing phase.

Table 4. Carcass performance for steers fed growing and finishing diets with two fat levels of dry distillers grains (DDGS) and corn or barley.

	DDGS		Grain			*P*-Value		Interaction
	Low-fat	Medium-fat	Barley	Corn	SEM	Grain	DDGs	Grain x DDGS
No. Pens, n	8	8	8	8	–	–	–	–
Shrunk dressing percent	63.6	63.2	63.0	63.9	0.004	0.09	0.46	0.88
Hot carcass weight, lb.	838	853	846	846	7.2	1.00	0.18	0.41
Yield grade[1]	3.1	3.1	3.1	3.2	0.12	0.47	0.85	0.73
Longissimus muscle area, sq in.	13.6	13.5	13.6	13.5	0.18	0.55	0.94	0.09
Marbling score[2]	455	475	451	478	10.15	0.10	0.19	0.29
Back fat, in.	0.54	0.53	0.52	0.55	0.02	0.38	0.84	0.50

[1]Yield 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.

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

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