Influence of dry-rolled corn processing and increasing dried corn distillers grains plus solubles inclusion for finishing cattle on growth performance and feeding behavior

K.C. Swanson[1], A. Islas[1], Z.E. Carlson[1], R.S. Goulart[1], T.C. Gilbery[1] and M.L. Bauer[1]

The objectives of this study were to determine the effect of the degree of dry-rolled corn processing (coarse vs. fine; 2.68 vs. 1.46 centimeters [cm], or a bit smaller than 1/16 and 7/64 inch) and dried corn distillers grains plus solubles (DDGS; 20 vs. 40 percent) on feed intake, average daily gain, gain efficiency, carcass characteristics and feeding behavior in steers fed finishing diets. Feeding 40 percent DDGS improved feed efficiency, while corn processing and increasing the DDGS altered feeding and ruminating behavior.

Summary

Sixty-four yearling steers (758 ± 9.2 pounds body weight [BW]) were used to study the effects of dry-rolled corn processing and distillers grains inclusion on feeding and ruminating behavior, gain efficiency and carcass quality. Steers were assigned randomly to one of four experimental treatments (n = 16 per treatment): 1) finely rolled corn and 20 percent DDGS, 2) finely rolled corn and 40 percent DDGS, 3) coarsely rolled corn and 20 percent DDGS and 4) coarsely rolled corn and 40 percent DDGS. Final BW and average daily gain (ADG) were not affected by corn processing or DDGS. Dry-matter intake (pounds/day and percentage of BW) and feed:gain were decreased ($P \leq 0.03$) with increasing DDGS inclusion. The meal number was increased ($P = 0.001$) and meal size decreased ($P < 0.001$) with smaller dry-rolled corn processing, and the meal number increased ($P = 0.05$) and meal size decreased ($P < 0.001$) with more DDGS inclusion. Drinking time was decreased ($P = 0.03$) with smaller dry-rolled corn processing and tended to increase ($P = 0.06$) with more DDGS inclusion. Rumination time while standing decreased ($P = 0.03$) with more DDGS inclusion. Finely or coarsely dried-rolled corn fed in combination with 40 percent DDGS decreased intake, improved efficiency and altered feeding behaviors of finishing steers consuming a 90 percent concentrate diet without affecting performance and carcass quality.

[1]Department of Animal Sciences, NDSU

Introduction

Feed costs represent a large proportion of the total costs of beef production. Optimizing utilization of corn grain in combination with DDGS is critical for maximizing efficiency. Increased grain processing generally improves the utilization of corn grain, yet the inclusion of DDGS may influence the optimal processing method (Corrigan et al., 2009).

Less information is available regarding different particle size reduction for dry-rolled corn. Feeding more finely rolled corn increased intake and gain when wet corn gluten feed was included in a finishing diet but did not alter gain efficiency (Loe et al., 2006). Interactions among feeding behavior, rumen function and digestibility likely are influenced largely by dietary composition and feed processing.

We hypothesize that the degree of dry-rolled corn processing and DDGS inclusion will influence feeding and ruminating behavior as well as cattle performance. The objectives are to determine the effect of the degree of dry-rolled corn grain processing and DDGS inclusion level on feeding and ruminating behavior, feed efficiency and carcass quality.

Experimental Procedures

Sixty-four steers (758 ± 9.2 pounds BW) predominately of Angus, Simmental and Shorthorn breeding were used in a 2-by-2 factorial arrangement of treatments and blocked by BW into three pens at the NDSU Beef Cattle Research Complex. Steers were assigned randomly to one of four experimental treatment diets (Table 1; n = 16 per treatment) within pen: 1) finely rolled (1.46 cm) corn and 20 percent DDGS, 2) finely rolled corn and 40 percent DDGS, 3) coarsely rolled (2.68 cm) corn and 20 percent DDGS and 4) coarsely rolled corn and 40 percent DDGS.

Diets were offered for ad libitum intake in Insentec feeders (two feeders per pen per treatment), which allow for offering specific diets to individual animals out of common feeding stations and recording the amounts and times of all feeding events. Steers were adapted to experimental diets during 21 days, fed for 112 days (n = 39) or 145 days (n = 24), and trucked to a processing facility, where carcass traits were recorded.

Steers were weighed prior to feed delivery for two consecutive days at the beginning and ending of the feeding period and every 28 days throughout the feeding period. Average daily gain was calculated by regressing BW on day of the experiment. Steers were implanted with Synovex Plus. Feed samples were collected weekly for analysis. Total feed intake and feeding behavior traits were summarized (Montanholi *et al.*, 2010). A meal was defined as eating periods that might include short breaks separated by intervals not longer than seven minutes.

Cattle also were monitored for activity (lying, ruminating, drinking, resting while standing and resting while lying) using visual observation measurements (Maekawa et al., 2002) on a subset of six cattle from each treatment during a three-day period to encompass 24 hours starting on day 98. Data were analyzed using the GLM procedure of SAS.

Results and Discussion

Initial BW, final BW and ADG were not influenced by dry-rolled corn processing or DDGS inclusion (Table 2). Dry-matter intake (pounds/day and percentage of BW) was not influenced by dry-rolled corn processing and was decreased ($P < 0.001$) with increasing DDGS inclusion. Feed:gain (pounds/pounds) was not influenced by dry-rolled corn processing and was decreased ($P = 0.03$) with increasing DDGS inclusion. Hot carcass weight, 12th rib fat thickness, rib-eye area and marbling score were not influenced by dry-rolled corn processing or DDGS inclusion.

Table 1. Dietary composition and analyzed nutrient concentration of diets (DM basis).

	Coarse		Fine	
Item	**20**	**40**	**20**	**40**
Diet Composition, %				
Coarsely rolled corn	62.8	42.8	-	-
Finely rolled corn	-	-	62.8	42.8
Dried corn distillers grains with solubles	20.0	40.0	20.0	40.0
Grass-legume hay	5.0	5.0	5.0	5.0
Corn silage	5.0	5.0	5.0	5.0
Corn distillers solubles	5.0	5.0	5.0	5.0
Limestone	1.6	1.9	1.6	1.9
Urea	0.27	-	0.27	-
Salt	0.20	0.20	0.20	0.20
Vitamin premix	0.05	0.05	0.05	0.05
Trace mineral premix	0.05	0.05	0.05	0.05
Rumensin/Tylan premix	0.03	0.03	0.03	0.03
Concentrated separator byproduct	0.02	0.02	0.02	0.02
Nutrient Analysis, % of DM				
OM	93.8	93.1	94.1	93.6
CP	14.6	17.4	15.0	17.8
NDF	27.6	29.6	27.5	29.4
ADF	10.6	10.6	10.0	10.4
Ether extract	10.6	13.7	10.9	12.9
Starch	41.2	29.4	39.3	30.1

Table 2. Influence of dry-rolled corn processing and distiller grains on performance and carcass traits in finishing cattle.

	Treatment					*P*-value		
	Coarse		Fine					
Items	**20**	**40**	**20**	**40**	**SEM**	**Processing**	**DDGS**	**Process × DDGS**
Initial BW, lb.	760	767	763	760	18	0.91	0.92	0.75
Final BW, lb.	1333	1341	1324	1327	20	0.57	0.78	0.91
ADG, lb./day	4.54	4.48	4.39	4.31	0.11	0.13	0.51	0.92
Dry matter intake, lb./day	26.7	24.2	25.8	24.1	0.52	0.32	<0.001	0.43
DMI, % of BW	2.55	2.31	2.47	2.31	0.58	0.82	<0.001	0.50
Feed:gain, lb./lb.	6.04	5.57	6.02	5.80	0.16	0.53	0.03	0.41
Hot carcass weight, lb.	796	813	795	793	14	0.46	0.57	0.49
Fat thickness, in.	0.42	0.54	0.50	0.50	0.04	0.47	0.09	0.11
Ribeye area, in.^{2}	12.7	12.7	12.6	12.9	0.37	0.92	0.69	0.62
Marbling score	422	414	455	407	22.1	0.56	0.17	0.34

The number of visits per day was not influenced by dry-rolled corn processing or DDGS inclusion (Table 3). The number of meals per day increased ($P = 0.001$) with finer dry-rolled corn processing, and the meal number increased ($P = 0.05$) and meal size decreased ($P < 0.001$) with increased DDGS inclusion.

The time eating per visit and per meal was not influenced by dry-rolled corn processing and DDGS inclusion. The time eating per day was greater ($P = 0.02$) with finer dry-rolled corn processing but was not influenced by DDGS inclusion. The eating rate per visit was not influenced by dry-rolled corn processing or DDGS inclusion. The eating rate per meal and per minute was less ($P \leq 0.006$) with finer dry-rolled corn and increased DDGS inclusion.

For observational measurements, the time eating per day was not influenced by dry-rolled corn processing or DDGS inclusion (Table 4). The time spent drinking per day decreased ($P = 0.03$) with finer dry-rolled corn processing and tended to increase ($P = 0.06$) with increased DDGS inclusion.

Total intake time (at feed and water troughs) was not influenced by dry-rolled corn processing and tended to increase ($P = 0.06$) with increased DDGS inclusion. Rumination time while standing was not influenced by dry-rolled corn processing and decreased ($P = 0.03$)

Table 3. Influence of dry-rolled corn processing and distillers grains on feeding behavior in finishing cattle.

	Treatment							
	Course		Fine			P-value		
Item	20	40	20	40	SEM	Processing	DDGS	Interaction
Events, no./day								
Visits	34.0	29.5	32.3	33.2	2.2	0.65	0.42	0.21
Meals	8.5	9.3	9.7	9.9	0.26	0.001	0.05	0.20
Time eating, min.								
Per visit	2.78	3.31	2.92	3.06	0.25	0.85	0.18	0.41
Per meal	10.2	9.5	9.4	9.9	0.51	0.73	0.87	0.21
Per day	84.2	86.5	90.9	97.0	3.8	0.02	0.25	0.60
Eating rate, lb.								
Per visit	0.88	0.91	0.84	0.76	0.064	0.13	0.69	0.36
Per meal	3.19	2.63	2.68	2.46	0.09	<0.001	<0.001	0.06
Per min.	0.32	0.29	0.29	0.25	0.012	0.006	0.002	0.91

Table 4. Influence of dry-rolled corn processing and distillers grains on observational behavior parameters in finishing cattle.

	Treatment							
	Course		Fine			P-value		
Item	20	40	20	40	SEM	Processing	DDGS	Interaction
Intake time, min./day								
Eating	76	102	93	105	12	0.39	0.13	0.56
Drinking	28	43	21	27	5.0	0.03	0.06	0.41
Total	104	144	114	132	14	0.93	0.06	0.43
Rumination time, min./day								
Standing	116	45	88	64	20	0.82	0.03	0.24
Lying	227	192	215	224	34	0.76	0.71	0.53
Total	343	237	303	288	35	0.87	0.11	0.21
Resting time, min./day								
Standing	444	463	441	457	26	0.86	0.52	0.96
Lying	548	604	583	564	39	0.95	0.65	0.35
Total	993	1067	1024	1021	39	0.86	0.38	0.34

with increased DDGS inclusion. Rumination time while lying and total rumination time (standing and lying) was not influenced by dry-rolled corn processing or DDGS inclusion. Resting time while standing and lying, and total resting time (standing and lying) was not influenced by dry-rolled corn processing or DDGS inclusion.

Increasing inclusion of DDGS up to 40 percent of diet DM improved feed efficiency. This is in agreement with past research on distillers grains in finishing diets (Klopfenstein et al., 2008). Decreasing corn particle size and increasing dietary DDGS also increased the number of meals and decreased the eating rate per meal, suggesting that cattle are adapting to diets by altering feeding behavior.

Adaptations in feeding behavior may influence feed efficiency. Further research is needed to study the interactions of diet, feeding behavior and feed efficiency.

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Literature Cited

Corrigan, M.E., G.E. Erickson, T.J. Klopfenstein, M.K. Luebbe, K.J. Vander Pol, N.F. Meyer, C.D. Buckner, S.J. Vanness and K.J. Hanford. 2009. Effect of corn processing method and corn wet distillers grains plus solubles inclusion level in finishing steers. J. Anim Sci. 87:3351-3362.

Klopfenstein, T.J., G.E. Erickson and V.R. Bremer. 2008. Board-invited Review: Use of distillers by-products in the beef cattle feeding industry. J. Anim Sci. 86:1223-1231.

Loe, E.R., M.L. Bauer and G.P. Lardy. 2006. Grain source and processing in diets containing varying concentrations of wet corn gluten feed for finishing cattle. J. Anim Sci. 84:986-996.

Maekawa, M., K.A. Beauchemin and D.A. Christensen. 2002. Effect of concentrate level and feeding management on chewing activities, saliva production, and ruminal pH of lactating dairy cows. J. Dairy Sci. 85:1165-1175.

Montanholi, Y.R., K.C. Swanson, R. Palme, F.S. Schenkel, B.W. McBride, D. Lu and S.P. Miller. 2010. Assessing feed efficiency in beef steers through feeding behavior, infrared thermography and glucocorticoids. Animal. 4:692-701.