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Summary and Implications

A large pen study was conducted with a commercial feedlot to investigate the influence of corn particle size on performance of steers fed diets containing 35% (DM basis) wet distillers grains plus solubles (WDGS). Feedlot cattle in the Midwest are often fed distillers grains from ethanol production that are low in starch. Therefore, this study was designed to evaluate a practical question asked by producers if feeding moderate levels of WDGS would reduce the acidosis risk and allow fine grinding of corn to improve cattle performance. While fine grinding of corn did not improve performance compared to cattle fed a more traditional particle size of corn, starch digestibility of cattle fed finely ground corn was more favorable.

Introduction

Decreasing particle size of corn increases starch availability to the animal, but corn ground too finely often results in rapid fermentation in the rumen leading to acidosis. Starch comprises nearly two-thirds of the nutrients in the corn kernel and is the primary substrate for alcohol fermentation during the ethanol production process. Therefore, the remaining co-product is low in starch (typically less than 5% starch DM basis). While previous research with finely ground corn has been less successful due to acidosis, we hypothesized that feeding moderate amounts of distillers grains would lower acidosis risk, and reduced corn particle size would increased rumen starch availability allowing for improved cattle performance.

Materials and Methods

Five hundred yearling stocker steers were purchased from a single source and transported to a commercial feedlot. Upon arrival, steers were implanted with Synovex Choice, vaccinated for respiratory disease (Bovi-Shield GOLD One Shot, Ultrabac CD, Somubac), and dewormed with ProMectin B Pour-on and Dectomax injectable. Steers (816 ± 10.4 lbs, SEM) were blocked by weight and randomly assigned to 1 of 2 diets: coarsely-cracked (2350 microns) corn-based control diet (CON) or finely ground (500 microns) corn diet (FINE) with both treatment diets containing 35% WDGS (DM basis; Table 1). Steers were housed in a slotted confinement facility with rubber mats with 8 pens (*n* = 4 pens/ treatment) with 60 or 64 steers/pen to maintain a similar pen density of 21.5 ft^2/steer.

Interim body weights (BW) were collected on day 72 and steers were re-implanted with Revalor 200. For the last 21 or 22 days of the trials, steers were fed Optaflexx at a rate of 300 $mg \cdot steer^{-1} \cdot day^{-1}$. On day 127 or 128, steers were harvested by pen weight blocks at a commercial abattoir (Tyson Foods, Inc., Dakota City, NE). Individual carcass camera data and liver abscess scores (LAS; collected by representatives of Elanco Animal Health) were collected at the plant. Five steers were removed from the trial due to injury or death for reasons unrelated to treatment, and their data was not used in analysis.

At two time points during the trial (days 71 and 72 and days 102 and 103), fecal collections were taken for apparent total starch digestibility calculation. On each collection day, eight fresh samples were randomly taken from each pen and a single pen composite was made. Samples were sent to Dairyland Laboratories, Inc. for crude protein (CP) and starch analysis. Starch digestion was averaged for each pen over the two consecutive days of collection (Fecal-1 for days 71 and 72 and Fecal-2 for days 102 and 103). Total mixed rations were also collected at the same time point for CP and starch analysis. Apparent total tract starch digestibility was estimated using the equation described by Zinn et al. (2007): starch digestion (expressed as a percentage of intake) is equivalent to $100\ \{1 - [(0.938 - 0.497 \times FN + 0.0853 \times FN^2) \times FS \div DS]\}$ where FN is fecal nitrogen concentration (% DM), FS is fecal starch concentration (% DM), and DS is dietary starch concentration (% DM).

Performance, carcass, and starch digestibility data were analyzed by ANOVA using the Mixed procedure of SAS (SAS Institute, Inc., Cary, NC) as a complete block design with pen as the experimental unit (*n* = 4/treatment). The model included the fixed effects of treatment and block. Treatment distributions of yield grade (YG), quality grade (QG), and LAS data were determined using PROC Glimmix of SAS. The effect of LAS on average daily gain (ADG) was also tested using the Mixed procedure with steer as the experimental unit (*n* = 495 steers). Significance was declared at $P \leq 0.05$ and tendencies were declared from $P =$ 0.06 to 0.10. Means reported are least square means (LSMEANS) ± SEM.

Results and Discussion

Performance and carcass results are presented in Table 2. While initial BW and interim BW (day 72) were not different ($P \geq 0.16$) between treatment groups, final BW was heavier ($P \leq 0.01$) for steers finished on CON compared to FINE. Dry matter intake (DMI) and ADG were greater ($P \leq 0.01$) for steers finished on CON compared to those finished on FINE. However, F:G was not different ($P = 0.22$) between treatment groups. Average hot carcass weight (HCW) of CON fed cattle was heavier ($P = 0.01$) than steers fed FINE, but ribeye area, backfat thickness, and YG were not different ($P \geq 0.38$) between treatments.

Although distributions of USDA QG of average choice and higher and low choice were not affected by treatment ($P \geq 0.17$), percentage of cattle grading select tended to be greater ($P = 0.07$) for cattle finished on FINE. Yield grade distributions were not different ($P \geq 0.20$) regardless of treatment (Table 3).

As shown in Table 3, there were no differences ($P \geq 0.39$) in LAS distributions as affected by treatment. As expected, there was a tendency ($P = 0.10$) for LAS to influence ADG over the duration of the trial, with steers having a LAS of A+ gaining less compared to steers with no LAS (score of 0) or a score of A (Table 4). Interestingly, during Period 1 (day 0 – 72), ADG was not different ($P = 0.30$) due to LAS; however, during Period 2 (day 73 – 127 or 128), ADG of steers that had a LAS of A+ was approximately 0.80 lb less than steers with a LAS 0 or A. This suggests that the negative performance associated with severe LAS occur later in the feeding period.

Fine grinding of the corn reduced fecal starch concentrations (14.3% and 17.6%, SEM 0.86, for CON vs. 3.0% and 3.2% for FINE, for Fecal-1 and Fecal-2, respectively) and improved apparent total tract starch digestibility in this study (Figure 1). A treatment by time interaction ($P \leq 0.01$) was observed for apparent total tract starch digestibility of steers. While starch digestibility of steers fed CON diets decreased overtime (90.3% and 85.7%, SEM 0.81, for Fecal-1 and Fecal-2, respectively), apparent total tract starch digestibility of steers fed FINE diets did not differ over time (98.0% and 97.6% for Fecal-1 and Fecal-2, respectively).

Conclusions

Contrary to our hypothesis, fine grinding of the corn did not improve feed conversion and actually resulted in reduced DMI and ADG compared to coarsely cracked corn when moderate inclusions of WDGS were included in the diet. Previous research has shown that rapid fermentation of the finely ground corn often contributes to sub-acute acidosis in high grain diets. While indicators of acidosis such as LAS were not significant between CON or FINE treatments, the reduction in DMI outweighed the increase in starch digestibility and therefore, limited cattle performance. Fine grinding of corn in diets with moderate to high inclusions of co-product should be evaluated in diets with more than 35% distillers grains or less than 45% corn grain in the diet.

Acknowledgments

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Table 1. Ingredient and nutrient composition of diets (% DM basis)

	CON[1]	FINE[1]
Coarsely-cracked corn[2]	45.0	–
Finely ground corn[2]	–	45.0
Wet distillers grains plus solubles	35.2	35.2
Corn silage	10.0	10.0
Corn stalks	6.5	6.5
Liquid supplement[3]	3.3	3.3
Analyzed composition[4]		
Crude protein	18.1	18.2
Neutral detergent fiber	29.6	26.8
Starch	36.9	35.2
Fat	5.1	4.9

[1]Treatments: CON=coarsely-cracked corn diet; FINE=finely ground corn diet

[2]Coarsely-cracked corn, 2350 microns; finely ground corn, 500 microns

[3]Liquid supplement includes vitamins, minerals, salt, and monensin sodium provided at 30g/ton

[4]Diets were analyzed by Dairyland Laboratories, Inc. (Arcadia, WI)

Table 2. Influence of corn particle size on steer performance and carcass characteristics

	CON[1]	FINE[1]	SEM	*P*-value
Growth performance[2]				
Initial BW, *lb*	811	818	3.40	0.20
Interim BW, *lb*[3]	1102	1089	7.58	0.16
Final BW, *lb*	1375	1334	3.95	<0.01
DMI, *lb/d*	25.93	24.41	0.22	<0.01
ADG, *lb/d*	4.43	4.06	0.07	<0.01
F:G	6.23	6.43	0.12	0.22
Carcass characteristics				
HCW, *lb*	860	833	3.48	0.01
Ribeye area, in^2	12.99	12.87	0.18	0.56
Backfat thickness, *in*	0.48	0.47	0.02	0.56
YG	3.2	3.1	0.09	0.38

[1]Treatments: CON=coarsely-cracked corn diet; FINE=finely ground corn diet
[2]A 4% pencil shrink was applied to all live weights. Final body weights were calculated from HCW using a common dressing percentage of 62.4% which was used in calculation of DMI, ADG, and F:G over the duration of the trial
[3]Interim body weights were collected on day 72

Table 3. Influence of coarsely-cracked or finely ground corn on distribution of quality grade, yield grade, and liver abscess scores

	CON[1]	FINE[1]	SEM	*P*-value
Quality grade, %				
Average choice and higher	16.3	10.8	2.21	0.17
Low choice	51.9	45.6	3.20	0.28
Select	28.9	41.1	3.14	0.07
Yield grade, %				
1	2.0	3.5	1.34	0.37
2	33.0	38.3	3.07	0.31
3	55.4	48.1	3.20	0.20
4/5	8.6	8.9	1.80	0.90
Liver abscess score[2], %				
0	91.3	88.8	1.90	0.42
A	6.0	6.8	1.56	0.74
A+	2.4	4.0	1.11	0.39

[1]Treatments: CON=coarsely-cracked corn diet; FINE=finely ground corn diet
[2]Liver abscess score: 0=no abscesses; A=one or two small abscesses; A+=one or more large abscesses

Table 4. Influence of liver abscess score on average daily gain

	Liver abscess score[1]				
	0	A	A+	SEM	*P*-value
ADG, *lb/d*					
Overall trial	3.98^c	4.06^c	3.71^d	0.134	0.10
Period 1[2]	4.05	4.21	4.20	0.120	0.30
Period 2[3]	3.90^a	3.87^a	3.09^b	0.199	<0.01

[1]Liver abscess score: 0=no abscesses; A=one or two small abscesses; A+=one or more large abscesses
[2]Day 0 - 72 of trial
[3]Day 73 - 127 or 128 of trial
[ab]Means without a common subscript differ ($P \leq 0.05$)
[cd]Means without a common subscript tend to differ ($P \leq 0.10$)

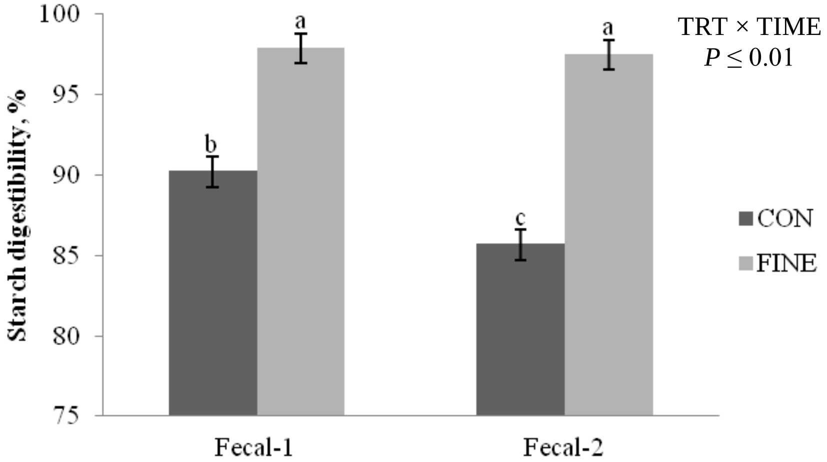

Figure 1. Apparent total tract starch digestibility. Each bar represents total tract starch digestibility calculated at two time points: Fecal-1 (average digestibility of days 71 and 72) and Fecal-2 (average digestibility of days 102 and 103). Error bars indicate pooled SEM of 0.856. [abc]Means without a common superscript differ ($P \leq 0.05$).