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More intensively processed corn, such as dry fine-grinding, early ensiling of high-moisture, or steam-flaking corn improved feed conversion by 3.7, 7.8, or 11.7%, respectively, compared to dry-rolling in finishing diets that contained wet corn gluten feed.

Summary

Three hundred twenty crossbred steer calves were used to evaluate corn processing method and crude protein level in finishing diets that included wet corn gluten feed. There was no response due to crude protein level (14 vs 15%) observed in this trial. As corn processing method became more intensive (fine-grinding, high-moisture ensiling, and steam-flaking corn) compared to dry-rolling, daily intake was reduced. Daily gain was similar across corn processing methods. Feed efficiency and cost of gain improved as corn processing method intensity increased.

Introduction

Using products such as wet corn gluten feed (WCGF) to replace corn in finishing diets has been shown to improve feed intake and daily gain while maintaining or improving feed efficiency. Most of this work has been done with dry-rolled corn replacement, although it has been shown that there are improvements in feed efficiency when corn is more intensely processed and WCGF is included in finishing diets (*2001 Nebraska Beef Report, pp. 59-63*) fed to yearlings or calves.

Research at Nebraska has shown that steam-flaked corn and high-moisture corn have similar ruminal starch digestion, with both being greater than dry-rolled corn (Cooper et al., 2002 JAS). However, postruminal starch digestion was higher for steam-flaked corn than high-moisture or dry-rolled corn. High-moisture corn used in the previous trial was rolled and stored in a bunker at 29% moisture. Harvesting high-moisture corn at an earlier stage and grinding to a smaller particle size may provide some opportunity to increase starch digestion postruminally. However, when fed to cattle, decreasing particle size raises some concerns about acidosis and separation in the feedbunk. Inclusion of WCGF alleviates these concerns (*1995 Nebraska Beef Report, pp. 34-36*).

By controlling acidosis (the increasing ruminal pH) with the inclusion of WCGF, microbial efficiency presumably increases. An increase in microbial efficiency will increase degradable intake protein (DIP) requirements in finishing diets. Previous work (*2001 Nebraska Beef Report*, *pp. 54-57*) illustrated more intensive corn processing methods (high-moisture and steam-flaked corn), compared to DRC, increased DIP requirements. Finishing diets that contain WCGF and have

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intensely processed corn may have a higher DIP requirement than when that grain is fed alone. Therefore, the objectives of this research were to determine: 1) if more intensive processing of HMC can improve animal performance in diets containing WCGF, 2) energy values of corn processed by different methods with the inclusion of WCGF, and 3) DIP requirement in finishing diets with different methods of corn processing in finishing diets containing WCGF.

Procedure

Three hundred twenty crossbred steer calves (677 lb) were stratified by weight and assigned randomly to 1 of 40 pens (8 steers/pen). Pens were assigned randomly to 1 of 10 treatments. Treatments were assigned based on a 2 × 5 factorial design with factors of crude protein level and grain processing method. Crude protein levels were formulated to be 13 or 14% with the additional CP supplemented by urea. However, actual CP analyses were 13.9 and 14.9% (Table 1). Grain processing methods were dry-rolled (DRC), fine-ground (FGC), high-moisture rolled (RHMC), high-moisture ground (GHMC), and steam-flaked corn (SFC). *Sweet Bran*® wet corn gluten feed (WCGF) was fed at 25% of the diet dry matter. High-moisture corn was harvested all in one day at 30% moisture, processed, and stored in silo bags. All diets were formulated to contain a minimum of 0.70% calcium, 0.51% phosphorus, 0.65% potassium, 31 g/ton Rumensin, and 10 g/ton Tylan (Table 1, DM basis). Feed ingredients were sampled weekly and then composited by month for crude protein analysis. Supplements were fed in two phases. Phase 1, UIP was supplemented to calves using feather and blood meal (50:50) at 1% of the dietary DM. Phase 2, UIP was replaced with urea when the cattle were estimated to weigh 875 lb. Corn silage was included in all diets, including step-up diets, at 10% of the DM. Cattle were adapted to grain by feeding 35%, 25%, 15% and 5% alfalfa hay (DM basis) replace with the respective corn treatment and fed for 3, 4, 7 and 7 days, respectively.

Table 1. Finishing diet ingredient and nutrient composition.

Ingredient[a], %	DRC	FGC	RHMC	GHMC	SFC
DRC	60.0	—	—	—	—
FGC	—	60.0	—	—	—
RHMC	—	—	60.0	—	—
GHMC	—	—	—	60.0	—
SFC	—	—	—	—	60.0
Wet corn gluten feed	25.0	25.0	25.0	25.0	25.0
Corn silage	10.0	10.0	10.0	10.0	10.0
Dry meal supplement	5.0	5.0	5.0	5.0	5.0
Nutrient[b], %					
High Protein					
CP	15.1	15.1	14.8	14.8	14.8
DIP	9.6	9.6	10.6	10.6	9.5
Low Protein					
CP	14.2	14.1	13.8	13.8	13.8
DIP	8.6	8.6	9.6	9.6	8.5

[a]DRC = dry-rolled corn, FGC = fine-ground corn, RHMC = rolled high-moisture corn, GHMC = ground high-moisture corn, and SFC = steam-flaked corn.
[b]High Protein = high protein diet and Low Protein = low protein diet.

Initial weights were determined as the average of two consecutive early morning weights before feeding at the initiation of the trial. Steers were fed once daily and allowed ad libitum access to feed and water. Steers were implanted with Synovex-S on day 1 and reimplanted with Revalor-S on day 51. At reimplant, fecal samples from individual animals were taken and composited by pen. One half tablespoon of as-is feces was used to composite fecal samples by pen. Composites were stored frozen, freeze-dried, ground to pass through a 1 mm screen and starch analysis was completed. Net energy was calculated for the different corn processing methods, according to methods outlined by Owens, et al. (2002 Proc. ASAS, abst. 1089). Cattle were fed for 152 days (November 21, 2001 to April 22, 2002) and harvested at a commercial packing plant where carcass data were collected. Hot carcass weight was collected the day of harvest with fat, marbling score, and yield grade data collected following a 24-hour chill.

Cost of gain was calculated for each treatment by using ration cost adjusted for processing method. Adjustments for processing were used from previous published *2001 Nebraska Beef Report, pp. 51-54*. Dry-rolling corn was given no adjustment and used as the control. Fine-ground corn was calculated with a 10% increase in energy cost compared to dry-rolling which related to $0.09/ton more than dry-rolling. Rolled high-moisture corn was calculated at a cost of $0.74/ton more than dry-rolling. Ground high-moisture corn was calculated with the additional $0.09/ton for grinding plus $0.74/ton as high-moisture corn compared to the dry-rolling. Steam-flaking corn was calculated at $5.56/ton more than dry-rolling. Ten-year average prices in Nebraska (1992-2001) for alfalfa hay (baled) and corn were used. Ingredient costs were ground alfalfa hay ($73.75/ton), corn ($97.00/ton), corn silage ($67.00/ton), dry supplement ($95.00/ton) and WCGF priced equal to corn.

Results

Overall cattle performance was exceptional for this experiment, presumably due to a mild winter/spring with no mud. No significant protein x grain processing interactions occurred for any of the variables observed, therefore only main effects are presented. Protein level had no effect on any of the variables measured. Based on analysis of ingredients, finishing diets contained approximately 1% unit higher CP levels than formulated concentrations. For this reason, the low protein diets met the DIP require-

Table 2. Effects of grain processing and protein level on animal performance and carcass characteristics.

Item	Treatments[a]					SEM	P-values[b]		
	DRC	FGC	RHMC	GHMC	SFC		Protein	Process	Inter
Days on feed	152	152	152	152	152				
Initial wt., lb	677	678	678	677	677	1	0.07	0.94	0.78
Final wt., lb[c]	1320	1339	1318	1321	1335	7	0.70	0.15	0.36
DMI, lb/day	23.2[d]	23.0[d]	21.6[e]	21.4[e]	21.3[e]	0.2	0.18	<0.01	0.89
ADG, lb	4.23	4.35	4.21	4.24	4.33	0.05	0.86	0.16	0.39
Feed:gain	5.49[d]	5.29[e]	5.13[f]	5.05[f]	4.91[g]		0.31	<0.01	0.39
NEg, Mcal/cwt[h]	70.0[d]	73.4[e]	76.4[f]	77.7[f]	80.4[g]	0.9	0.31	<0.01	0.37
Hot carcass, lb	831	843	830	829	838	5	0.75	0.20	0.17
Marbling score[i]	492	497	508	483	505	9	0.93	0.31	0.48
Choice or above, %	47.3	47.8	57.8	42.2	52.5	6.6	0.16	0.54	0.54
Fat thickness, in	0.47[d]	0.56[e]	0.54[f]	0.52[d]	0.53[e]	0.02	0.89	0.05	0.37
Yield grade	2.3[d]	2.7[e]	2.6[ef]	2.4[df]	2.5[de]	0.1	0.90	0.02	0.29
Cost of gain, $/cwt[j]	35.34[d]	34.12[e]	33.59[f]	33.21[f]	33.09[f]	0.31	0.36	<0.01	0.36
Fecal starch, %	19.2[d]	11.8[e]	10.6[ef]	8.4[f]	4.1[g]	1.3	0.40	<0.01	0.59

[a]DRC = dry-rolled corn, FGC = fine-ground corn, RHMC = rolled high-moisture corn, GHMC = ground high-moisture corn, SFC = steam-flaked corn.
[b]Protein= main effect of protein level, Process= main effect of processing method, Inter = interaction between protein level and processing method.
[c]Final weight calculated as hot carcass weight divided by 0.63.
[d,e,f,g]Means within a row with unlike superscripts differ (P < 0.10).
[h]Calculated net energy values of the processed corn.
[i]Marbling score: 400 = Slight 0, 450 = Slight 50, 500 = Small 0, etc.
[j]Values used in calculation: Ration prices: DRC = $97.91/ton, FGC = $97.98/ton, RHMC = $98.35/ton, GHMC = $98.46/ton, SFC = $101.39/ton; Yardage = 0.30/day; and interest on half the feed = 10%. Cattle interest is not include.

ments of the animals and the additional DIP had no effect. Because no difference was observed for the main effect of protein level (P > 0.15), these data are not shown. The low protein diets supplied DIP levels that would be similar to requirements stated in previous research (*2001 Nebraska Beef Report, pp. 54-67*, and *2002 Nebraska Beef Report, pp. 68-71*).

Grain processing methods did have an effect on cattle performance. Dry matter intake decreased as the degree of processing increased (Table 2). Dry-rolled corn and FGC had similar daily intakes but had higher (P < 0.05) intakes than RHMC, GHMC, or SFC. Rolled high-moisture corn, GHMC, and SFC had similar intakes. Gains were similar across all treatments. Steam-flaked corn had the lowest feed conversion compared to all other treatments. Steam-flaking corn improved (P < 0.05) feed conversion by 11.7, 7.7, and 3.6% compared with dry-rolling, dry fine-grinding, or early ensiling of high-moisture corn, respectively. Fine-grinding dry corn improved (P = 0.01) feed conversion by 3.7% compared to dry-rolling corn. Feed conversion was similar between the two processing methods for early ensiled high-moisture corn, and feeding high-moisture corn improved feed conversion by 7.8% compared with dry-rolling corn. Calculations of net energy values for the processed corns were improved by 4.8, 9.1, 11.0, and 14.8% for fine-grinding dry, rolling high-moisture, fine-grinding high-moisture, and steam-flaking corn, respectively, compared to dry-rolling corn. Acidosis and diet separation due to fine particles appeared to be controlled using WCGF.

Hot carcass weight and marbling score were similar among treatments. Fat thickness was greater (P < 0.05) for RHMC, FGC, and SFC compared to DRC and GHMC. Dry-rolled corn, GHMC, and SFC had similar USDA yield grades. Dry-rolled corn had lower USDA yield grades compared to FGC and RHMC. Fine-ground corn, RHMC, and SFC had similar USDA yield grades.

Cost of gain was highest for DRC. Cost of gain was decreased (P < 0.01) by $1.22/cwt when corn was fine-ground compared to dry-rolling. Cost of gain was similar for RHMC, GHMC, and SFC though feed cost of gain was decreased (P < 0.01) by $1.75, 2.13, and 2.25/cwt, respectively, compared to DRC. Fine-ground corn had a similar cost of gain compared to RHMC but higher than GHMC or SFC.

Fecal starch content may indicate how much starch is used. Fecal starch was the highest for DRC and the lowest for SFC among treatments (Table 2). Fine-grinding corn reduced fecal starch by 7.4 percentage units compared to DRC. Fine-ground corn had similar fecal starch content compared with RHMC, but higher than GHMC or SFC. Ground high moisture corn had similar fecal starch content compared to RHMC. Both GHMC and RHMC had higher fecal starch compared to SFC. Fecal starch content supports the difference in feed conversions among treatments ($R^2 = 0.95$; feed conversion = 0.0394 * % fecal starch + 4.7454).

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