January 2001

Corn Processing Method in Finishing Diets Containing Wet Corn Gluten Feed

Tony Scott
University of Nebraska-Lincoln

Todd Milton
University of Nebraska-Lincoln

Terry J. Klopfenstein
University of Nebraska-Lincoln, tklopfenstein1@unl.edu

Rick Stock
University of Nebraska-Lincoln

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Feed efficiency and dietary net energy available for gain tended to be improved by more intensively processing corn in finishing diets containing wet corn gluten feed.

Summary

Two trials were conducted to determine the effects on performance and carcass characteristics of corn grain diets differing in degree of processing and containing wet corn gluten feed. Generally, more intensive processing methods such as fine-grinding, high moisture ensiling, and steam-flaking resulted in lower daily feed consumption compared to feeding rolled or whole corn. Feed efficiency and dietary net energy concentration tended to be improved by more intensive processing methods in finishing diets containing wet corn gluten feed.

Introduction

Inclusion of wet corn gluten feed in place of corn grain replaces dietary starch with highly digestible fiber. The resultant effect can be increased feed intake and daily gain as well as decreased incidence and severity of acidosis in finishing cattle. While feeding wet corn gluten feed is a widely accepted practice, limited information is available about the effects different grain processing methods may have in diets containing wet corn gluten feed.

The objectives of this research were to evaluate the effects of corn processing method in finishing diets containing wet corn gluten feed and to evaluate the value of feeding wet corn gluten feed in minimal (dry-rolled) and intensive (steam-flaked) processed corn-based finishing diets on performance and carcass characteristics of finishing calves.

Procedure

Trial 1

Four hundred eighty crossbred steer calves (667 lb) were stratified by weight and randomly assigned to one of 32 pens (15 head/pen). Each pen was randomly assigned to one of eight treatments. Four treatments were designed based on dry-rolled corn

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(DRC) or steam-flaked corn (SFC; 29 lb/bu) with or without replacement of corn with 32% Sweet Bran 60® wet corn gluten feed (WCGF). Also, a finishing diet in which DRC replaced SFC in an equal proportion to the replacement of SFC with WCGF was fed.

The three other treatments were finishing diets containing 32% WCGF (DM basis) and either finely ground corn (FGC), early harvested (30% moisture) and rolled high-moisture corn (HMC), or whole corn (WC). Data from all of the treatments containing 32% WCGF were analyzed to determine the performance and carcass responses to grain processing method in finishing diets containing WCGF. The cost of gain for each treatment was calculated with ration cost adjustments for each grain processing method. The adjustments were based upon the average of the values reported by Cooper et al. elsewhere in this report (Economic Evaluation Of Corn Processing For Finishing Cattle) with the exception of finely ground corn for which an additional 3% was added to the cost of dry-rolling and whole corn which was assessed no processing charge. The ingredient costs (as-is basis) for corn grain ($2.49/bu), alfalfa hay ($60.72/ton), and soybean meal ($209.20/ton) were based on 10-year average prices (1988-1997) paid/received by Nebraska producers. Other ingredient costs were based on the previous year's average paid by the University of Nebraska feedmill.

Adaptation diets contained 45, 35, 25, and 15% alfalfa hay (DM basis). The final diets (Table 1) were formulated to contain a minimum of 13.4% CP, .70% Ca, .35% P, and .65% K, and contained 27 g/ton Rumensin® and 10 g/ton Tylan® (DM basis). The supplement in diets not containing WCGF included 5% soybean meal (DM basis) as a source of naturally degradable protein to ensure sufficient metabolizable protein. Due to bunk management problems related to the accumulation of fines, the molasses level in the FGC diet was increased to 6% (DM basis) on day 87. Steers were implanted with Synovex®-S on day 1 and reimplanted with Synovex®-Plus on day 87.

Table 1. Composition of Trial 1 finishing diets (100% DM basis).

	Treatment[a]							
Ingredient	DRC	DRC WCGF	SFC WCGF	SFC	DRC SFC	FGC WGCF	HMC WCGF	WC WCGF
DRC	81.55	52.50			30.99			
FGC						52.50		
HMC							52.50	
SFC			81.55	52.50	50.56			
WC								52.50
WCGF		32.00		32.00		32.00	32.00	32.00
Alfalfa hay	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Molasses	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Supplement	7.95	5.00	7.95	5.00	7.95	5.00	5.00	5.00

[a]DRC = dry-rolled corn; FGC = finely-ground corn; HMC = high-moisture corn; SFC = steam-flaked corn; WC = whole corn; WCGF = wet corn gluten feed.

Table 2. Composition of Trial 2 finishing diets (100% DM basis).

	Treatment[a]					
Ingredient	DRC	DRC WCGF	SFC	SFC WCGF	FRC WGCF	HMC WCGF
DRC	82.50	62.50				
FRC					62.50	
HMC						62.50
SFC			84.50	62.50		
WC						
WCGF		22.00		22.00	22.00	22.00
Alfalfa hay	7.50	7.50	7.50	7.50	7.50	7.50
Molasses	3.00	3.00	3.00	3.00	3.00	3.00
Supplement	7.00	5.00	5.00	5.00	5.00	5.00

[a]DRC = dry-rolled corn; FGC = finely-rolled corn; HMC = high-moisture corn; SFC = steam-flaked corn; WC = whole corn; WCGF = wet corn gluten feed.

Trial 2

Two hundred eighty-eight crossbred yearling steers (888 lb) were stratified by weight and randomly assigned to one of 24 pens (12 head/pen). Each pen was randomly assigned to one of six treatments. Four treatments were designed based on dry-rolled corn (DRC) or steam-flaked corn (SFC; 29 lb/bu) with or without replacement of corn with 22% Sweet Bran 60® wet corn gluten feed (WCGF).

The two other treatments were finishing diets containing 22% WCGF (DM basis) and either finely rolled corn (FRC) or early harvested (30% moisture) and rolled high-moisture corn (HMC). Data from all of the treatments containing 22% WCGF were analyzed to determine the performance and carcass responses to grain processing method in finishing diets containing WCGF. The cost of gain for each treatment was calculated with ration cost adjustments for each grain processing method. The adjustments were the same as in Trial 1 with the exception of finely rolling corn for which an additional 3% was added to the cost of dry-rolling.

Adaptation diets contained 45, 35, 25, and 15% alfalfa hay (DM basis). The final diets (Table 2) were formulated to contain a minimum of 13.5% CP, .70% Ca, .35% P, and .65% K, and contained 27 g/ton Rumensin® and 10 g/ton Tylan® (DM basis). Supplemental protein in all finishing diets was supplied with urea and soybean meal in a 60:40 ratio (CP basis). Steers were implanted with Synovex-®-Plus on day 28.

In both Trials 1 and 2, steers were fed once daily and allowed ad libitum access to feed and water. Final weights were calculated by adjusting hot carcass weights to a common dressing percentage (63%). Steers were slaughtered at a commercial packing plant where car-

Table 3. Effects of grain processing method and wet corn gluten feed inclusion in finishing diets on performance and carcass characteristics (Trial 1).

	Treatment[a]					
	DRC	DRC WCGF	SFC	SFC WCGF	SFC DRC	SEM
Days on feed, days	169	169	169	169	169	
Initial wt., lb	666	665	666	670	668	1
Final wt., lb[bcd]	1319	1381	1338	1387	1342	9
DMI, lb/day[de]	20.61[k]	23.42[i]	20.41[k]	22.03[j]	20.83[k]	.22
ADG, lb[cd]	3.86	4.24	3.98	4.25	3.99	.04
Feed:gain[f]	5.35	5.52	5.13	5.18	5.24	
Diet NEg, Mcal/cwt[cf]	68.9	66.0	71.8	70.9	70.5	.9
Cost of gain, $/cwt[cdfg]	39.31	36.91	38.80	35.68	39.05	.46
Hot carcass wt, lb[cd]	831	870	843	874	846	6
Marbling score[ch]	525	559	528	552	519	13
Percent Choice, %	74.7	70.0	67.5	80.0	61.7	10.0
Yield grade	2.7	2.9	2.9	2.9	2.8	.1
Fat thickness, in	.58	.59	.58	.60	.57	.01

[a]DRC = dry-rolled corn; SFC = steam-flaked corn; WCGF = wet corn gluten feed.
[b]Final wt. = Hot carcass wt. / .63 (common dressing percentage).
[c]Effect of WCGF (P<.10).
[d]Effect of replacing SFC with WCGF versus DRC (P<.01).
[e]Processing method x WCGF interaction (P<.05).
[f]Effect of grain processing method (P<.10).
[g]Values used in calculations: Ration prices: DRC = $115.55/ton; DRC+WCGF = 105.56/ton; SFC = $119.10/ton; SFC+WCGF = $107.84/ton; SFC+DRC = 117.75; Yardage = $0.30/d; interest on 1/2 feed = 10%. Cattle interest not included.
[h]Marbling score: 500 = Small 0 (low Choice).
[ijk]Means within a row with unlike superscripts differ (P<.01).

Table 4. Effect of grain processing method on performance and carcass characteristics of calves fed finishing diets containing wet corn gluten feed (Trial 1).

	Treatment[a]					
	SFC WCGF	HMC WCGF	FGC WCGF	DRC WCGF	WC WCGF	SEM
Days on feed, days	169	169	169	169	169	
Initial wt., lb	670	667	667	665	668	2
Final wt., lb[b]	1387	1368	1371	1381	1375	8
DMI, lb/day	22.03[g]	21.82[g]	22.19[g]	23.42[f]	24.79[e]	.25
ADG, lb	4.25	4.15	4.17	4.24	4.18	.04
Feed:gain	5.18[e]	5.26[ef]	5.32[f]	5.52[g]	5.92[h]	
Diet NEg, Mcal/cwt	70.9[h]	69.8[gh]	68.8[g]	66.0[f]	61.2[e]	.5
Cost of gain, $/cwt[c]	35.68[e]	35.66[e]	35.97[e]	36.91[f]	39.05[g]	.23
Hot carcass wt, lb	874	862	864	870	866	5
Marbling score[d]	552	537	532	559	549	12
Percent Choice, %	80.0	68.1	71.7	70.0	68.3	7.3
Yield grade	2.9	3.0	2.8	2.9	2.8	.1
Fat thickness, in	.60	.63	.59	.59	.61	.02

[a]DRC = dry-rolled corn; FGC = finely-ground corn; HMC = high-moisture corn; SFC = steam-flaked corn; WC = whole corn; WCGF = wet corn gluten feed.
[b]Final wt. = Hot carcass wt. / .63 (common dressing percentage).
[c]Values used in calculations: Ration prices: DRC = $105.56/ton; FGC = 105.58/ton; HMC = $105.56/ton; SFC = $107.84/ton; WC = $104.76/ton; Yardage = $0.30/d; interest on 1/2 feed = 10%. Cattle interest not included.
[d]Marbling score: 500 = Small 0 (low Choice).
[efgh]Means within a row with unlike superscripts differ (P<.10).

cass data were collected following a 24-hour chill. The NEg of each diet was calculated using initial weight, carcass adjusted final weight, DMI and ADG for each pen.

Results

Trial 1

The performance and carcass data from the DRC and SFC treatments are presented in Table 3. A significant (P<.05) grain processing method x WCGF interaction existed for DMI. When DRC was fed, DMI was increased by 2.81 lb/day when WCGF was fed, whereas, when SFC was fed, DMI was increased by 1.62 lb/day when WCGF was fed. Additionally, the replacement of SFC with DRC resulted in a significantly (P<.01) lower DMI than replacing SFC with WCGF.

Grain processing method did not affect daily gain. However, daily gain was increased (P<.10) 7.7% by replacing corn grain with WCGF. Likewise, replacement of SFC with WCGF resulted in a 6.5% improvement (P<.01) in daily gain compared to replacing SFC with DRC.

Feed efficiency was improved (P<.10) 5.4% when steers were fed SFC compared to DRC. Feed efficiency tended (P=.10) to be improved by feeding corn grain alone (5.24 and 5.35 for corn grain and WCGF, respectively). Feed efficiency was similar when DRC or WCGF replaced SFC. Dietary NEg was 5.3% higher (P<.10) in SFC diets than in DRC diets, while the addition of WCGF reduced (P<.10) dietary NEg by 3.9%. There was no difference in the dietary NEg when DRC or WCGF replaced SFC. Cost of gain was decreased (P<.10) both by feeding SFC and by feeding WCGF. Replacement of SFC with WCGF decreased (P<.01) cost of gain compared to replacing SFC with DRC.

Inclusion of WCGF in the diet increased (P<.10) hot carcass weights. Likewise, replacement of SFC with WCGF increased (P<.01) hot carcass weights compared to replacement of SFC with DRC. Marbling score was increased (P<.10) by inclusion of WCGF compared to feeding corn grain alone. The percentage of animals grading Choice or greater was 75% in diets containing WCGF and 71% in diets containing corn grain alone. Neither processing method nor replacement of SFC with DRC influenced marbling score. Yield grade and fat thickness were not affected by treatment.

The performance and carcass data from all diets containing 32% WGCF are presented in Table 4. Feed

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consumption was higher (P<.10) when feeding WC with DRC being intermediate and FGC, HMC and SFC being similar. Feeding WC increased DMI by 10.8% when compared to the average of the other four treatments. Daily gain was similar among the treatments. On average, feeding SFC improved (P<.10) efficiency 7.1% compared with feeding DRC, FGC, or WC. Efficiency was similar between calves fed SFC or HMC. Finely grinding corn improved (P<.10) efficiency compared to feeding DRC or WC. Feeding unprocessed corn (WC) in the finishing diet reduced (P<.10) feed efficiency compared with all other treatments. Dietary NEg was higher (P<.10) when feeding SFC compared to feeding DRC, FGC, or WC. Net energy available for gain was similar when feeding SFC or HMC. Finely grinding corn improved (P<.10) dietary NEg compared to feeding DRC or WC. Cost of gain was decreased (P<.10) by feeding FGC, HMC and SFC compared to feeding DRC or WC. Cattle fed WC had a higher (P<.10) cost of gain than all other treatments. Hot carcass weight, marbling score, yield grade and fat thickness were not affected by treatment.

Trial 2

The performance data from the SFC and DRC treatments are shown in Table 5. A grain processing x WCGF interaction (P<.10) similar to that observed in Trial 1 was detected for DMI. The increase in DMI observed with the addition of WCGF to the diet was greater when feeding DRC than when feeding SFC (2.28 lb/day versus 1.00 lb/day, respectively). In addition, cattle fed SFC alone consumed slightly more feed than cattle fed DRC alone which contrasts with previous research results.

Grain processing had a significant effect (P<.10) on daily gain. Feeding SFC improved daily gain 8.1% compared to DRC. Inclusion of WCGF improved (P<.10) daily gain 7.0% compared to feeding corn grain alone.

Grain processing significantly affected (P<.10) efficiency with SFC improving efficiency 8.3% compared to DRC. Inclusion of WCGF had no effect on efficiency or dietary NEg. Feeding SFC increased (P<.10) NEg compared to feeding DRC. Cost of gain was decreased (P<.10) by feeding SFC and by feeding WCGF.

Feeding SFC increased (P<.10) hot carcass weights compared to feeding DRC. Inclusion of WCGF also increased (P<.10) hot carcass weights compared to feeding corn grain alone. Marbling scores were unaffected by grain processing method; however, similar to Trial 1,

Table 5. Effects of grain processing method and wet corn gluten feed inclusion in finishing diets on performance and carcass characteristics (Trial 2).

	Treatment[a]				
	DRC	DRC WCGF	SFC	SFC WCGF	SEM
Days on feed, days	117	117	117	117	
Initial wt., lb	836	845	844	847	4
Final wt., lb[bcd]	1263	1310	1315	1341	9
DMI, lb/day[e]	21.93[h]	24.21[i]	22.35[h]	23.35[i]	.35
ADG, lb[cd]	3.64	3.98	4.02	4.22	.08
Feed:gain[c]	6.02	6.08	5.56	5.54	
Diet NEg, Mcal/cwt[c]	64.6	63.3	69.3	69.5	1.0
Cost of gain, $/cwt[cdf]	43.25	40.91	39.03	38.31	.62
Hot carcass wt, lb[cd]	796	826	828	845	6
Marbling score[dg]	488	513	496	516	10
Percent Choice, %	47.5	55.8	54.9	60.4	7.1
Yield grade[cd]	2.0	2.5	2.3	2.6	.1
Fat thickness, in[cd]	.44	.48	.51	.55	.02

[a]DRC = dry-rolled corn; SFC = steam-flaked corn; WCGF = wet corn gluten feed.
[b]Final wt. = Hot carcass wt. / .63 (common dressing percentage).
[c]Effect of grain processing method (P<.10).
[d]Effect of WCGF (P<.10)
[e]Processing method x WCGF interaction (P<.10).
[f]Values used in calculations: Ration prices (DM basis): DRC = $114.38/ton; DRC+WCGF = 108.00/ton; SFC = $111.65/ton; SFC+WCGF = $110.72/ton; Yardage = $0.30/d; interest on 1/2 feed = 10%. Cattle interest not included.
[g]Marbling score: 500 = Small 0 (low Choice).
[hi]Means within a row with unlike superscripts differ (P<.10).

Table 6.Effect of grain processing method on performance and carcass characteristics of calves fed finishing diets containing wet corn gluten feed (Trial 2).

	Treatment[a]				
	SFC WCGF	HMC WCGF	FRC WCGF	DRC WCGF	SEM
Days on feed, days	117	117	117	117	
Initial wt., lb	847	848	841	845	4
Final wt., lb[b]	1341[f]	1318[ef]	1303[e]	1310[e]	9
DMI, lb/day	23.35	24.01	24.30	24.21	.32
ADG, lb	4.22[e]	4.02[f]	3.95[f]	3.98[f]	.07
Feed:gain	5.54[e]	5.97[f]	6.15[g]	6.09[fg]	
Diet NEg, Mcal/cwt	69.5[g]	64.6[f]	62.4[e]	63.3[ef]	.8
Cost of gain, $/cwt[e]	38.31[e]	40.21[f]	41.39[fg]	40.92[g]	.45
Hot carcass wt, lb	845[f]	831[ef]	821[e]	826[e]	6
Marbling score[d]	516	516	503	513	12
Percent Choice, %	60.4	63.2	61.4	55.8	7.6
Yield grade	2.6	2.4	2.4	2.5	.1
Fat thickness, in	.55	.53	.50	.48	.02

[a]DRC = dry-rolled corn; FRC = finely-rolled corn; HMC = high-moisture corn; SFC = steam-flaked corn; WCGF = wet corn gluten feed.
[b]Final wt. = Hot carcass wt. / .63 (common dressing percentage).
[c]Values used in calculations: Ration prices (DM basis): DRC = $108.00/ton; FRC = 108.02/ton; HMC = $108.00/ton; SFC = $110.72/ton; Yardage = $0.30/d; interest on 1/2 feed = 10%. Cattle interest not included.
[d]Marbling score: 500 = Small 0 (low Choice).
[efg]Means within a row with unlike superscripts differ (P<.10).

inclusion of WCGF increased (P<.10) marbling scores. The percentage of animals grading Choice or greater was 58% in diets containing WCGF and 51% in diets containing corn grain alone. Both grain processing and inclusion of WCGF affected yield grade and fat thickness. Steers fed SFC had higher yield grades (P<.10) and were fatter (P<.10) than steers fed DRC. Similarly, inclusion of WCGF increased (P<.10) both yield grade and fat thickness (P<.10) when compared to feeding corn grain.

The performance data from all diets containing 22% WCGF are presented in Table 6. Grain treatment had no effect on DMI. Daily gain was improved (P<.10) 6.0% by feeding SFC compared with all other treatments. Feeding DRC, FRC or HMC resulted in similar daily gains. Feeding SFC resulted in an 8.7% improvement (P<.10) in efficiency compared to the average of the other treatments. Efficiency was similar when feeding HMC or DRC; however, feeding HMC improved (P<.10) efficiency when compared to feeding FRC. Dietary NEg was higher (P<.10) when feeding SFC compared with the other treatments. Dietary NEg was similar when feeding DRC or HMC. Feeding HMC improved NEg compared to feeding FRC. Cost of gain was reduced (P<.10) by feeding SFC with all other treatments being similar. Feeding SFC increased (P<.10) hot carcass weights compared with feeding DRC or FRC with HMC being intermediate. Other carcass characteristics were not affected by treatment.

The slight numerical reductions in efficiency observed in both Trials 1 and 2 with the addition of WCGF to a DRC-based finishing diet are in contrast to previous research conducted at the University of Nebraska. In Trial 1, efficiency was reduced 3.2% when comparing DRC and DRC with WCGF. In Trial 2, a smaller numerical reduction (1.2%) in efficiency was observed. In a summary of five finishing trials conducted at the University of Nebraska from 1996-1998 (Stock, et al., Journal of Animal Science, 2000), feeding finishing diets containing an average of 34.8% WCGF (DM basis; Cargill Corn Milling, Blair, NE) resulted in a 5.1% improvement in efficiency. However, the data of Scott et al. published elsewhere in this report (Programmed Gain Finishing Systems In Yearling Steers Fed Dry-rolled Corn Or Wet Corn Gluten Feed Finishing Diets) support the reduced efficiency response observed in this study. A 4.8% improvement in efficiency was observed when comparing a DRC control diet to a DRC diet containing 35% WCGF in steers offered ad libitum access to feed. A portion of the improvement in efficiency when feeding WCGF in DRC finishing diets has been attributed to a reduction in subacute acidosis. Therefore, a possible explanation for the differing efficiency responses may be due to a difference in the degree to which acidosis occurred in the respective control (DRC) groups in these studies and that of Scott et al. compared with those of the summary. Changes in milling procedures may have resulted in differences in the extent to which acidosis was occurring. In the summary data, a double-roller mill was used.

If subacute acidosis is controlled, increased processing of corn grain increases starch availability and feed efficiency. If acidosis occurs, improved feed efficiency will not be observed in response to increased processing of corn grain. Wet corn gluten feed has been shown to reduce acidosis; therefore, corn-based finishing diets that contain WCGF may allow corn grain to be more extensively processed without increasing the risk of acidosis. Generally, the data from these trials indicate that feed conversion was improved as the degree of processing was increased in diets containing WCGF. Processing methods such as steam-flaking, high moisture ensiling, and fine-grinding tended to improve efficiency when compared to either minimal processing methods (i.e., rolling) or no processing. Also, on the pen surface, there was a significant amount of whole corn kernels in the feces of steers fed WC and a significant amount of whole and large broken kernels in the feces of steers fed DRC. The amount of whole and broken kernels observed on the pen surface in the other treatments was limited. The increased intake observed when feeding WCGF may increase rate of passage which would likely reduce the starch digestion of the large grain particles, the consequence of which is reduced efficiency despite similar or greater daily gain. Therefore, increasing the extent to which grain is processed may improve efficiency in diets containing WCGF.

These results indicate that feeding SFC results in improved feed efficiency with or without inclusion of WCGF compared to DRC. These data also indicate that grain processing methods more intensive than dry-rolling (i.e., fine-grinding, high moisture ensiling, steam-flaking) can be used to improve feed efficiency and dietary net energy available for gain in finishing diets containing WCGF.

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[1]Tony Scott, research technician, Animal Science, Lincoln; Todd Milton, adjunct professor, Terry Klopfenstein, professor, and Rick Stock, adjunct professor, Animal Science, Lincoln.