Fat Addition and Restricted Feeding of Corn Gluten Feed Diets For Cattle Exposed to Environmental Stress

Jill Heemstra
University of Nebraska-Lincoln, jheemstra3@unl.edu

Terry L. Mader
University of Nebraska-Lincoln, tmader1@unl.edu

Tony Scott
University of Nebraska-Lincoln

John Gaughan
University of Queensland-Gatton, j.gaughan@uq.edu.au

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Diets containing corn gluten feed appeared to have greater energy values during the summer than in the winter.

Summary

One winter and one summer trial were conducted comparing dry rolled corn (DRC) to DRC + corn gluten feed (CGF) finishing diets. No performance differences among winter study treatment groups were found. In the 106-day summer trial, DRC or CGF (40 percent DM)-based diets were fed as high-energy, 8 percent roughage diets either ad libitum (HE), restricted to approximately 90 percent of HE (RE) or fed as moderate energy, 20 percent roughage diets (HR). Feeding CGF diets or lowering metabolizable energy (ME) intake through RE or HR diet regimes did not improve feed to gain ratios or appear to reduce effects of heat load. However, only a limited number of high heat load days occurred.

Introduction

Adverse environmental conditions can negatively affect animal performance, largely through increased maintenance energy requirements. Increasing the energy intake of feedlot cattle in the winter may help offset decreased performance. Adding fat to feedlot finishing diets increases the energy density of the diet and has been shown to improve feed efficiency and daily gain, although results have been variable with corn-based diets. Another way to improve performance of cold-stressed cattle may be to replace some of the roughage or grain with highly digestible fiber in the diet. CGF contains highly digestible fiber and an energy value similar to corn.

During exposure to high heat load, animals must expend energy to dissipate heat. Additionally, metabolic heat load increases as energy intake increases. Restricting intake to feedlot cattle may be one way to reduce and manage heat load. Another strategy may be to decrease the energy density of the diet. A third strategy may be to formulate diets with ingredients that lower overall heat increment or peak metabolic heat load. Feed ingredients like dried beet pulp and corn gluten feed (CGF) contain highly digestible fiber and have been suggested to reduce diet heat increment. The objectives of this research were to assess the use of CGF in diets of animals exposed to hot (summer) and cold (winter) environmental conditions.

Procedure

Winter trial

The 76-day feeding trial was conducted as a 2X2+1 factorial arrangement and began on November 30, 1995. Steers (75 head) were blocked by weight and randomly assigned within block to one of five treatments with three pens (replicates) per treatment. Diets were either DRC or DRC plus CGF (35 percent DM) fed with (3 percent) or without supplemental fat (tallow and yellow grease blend). The cattle were fed in minimally-sheltered facilities. An additional treatment group was fed the no supplemental fat, CGF diet in pens provided with shelterbelts located on the north and west sides. At trial initiation all cattle were implanted with Synovex-S. Diets fed in the winter trial are shown in Table 1.

Table 1. Composition of diets fed in winter trial.

	DRC		CGF	
	No fat	Fat	No fat	Fat
Ingredient, %DM				
Alfalfa hay	6.1	6.1	6.0	6.1
Corn gluten feed	—	—	35.0	35.0
Corn silage	6.1	6.1	—	—
Dry rolled corn	78.8	75.2	55.7	52.2
Soybean meal	2.9	3.2	—	—
Fat	—	3.0	—	3.0
Cattlyst supplement[a]	3.2	3.2	3.2	3.2
Urea supplement[b]	2.9	3.2	—	.5
Composition, DM basis				
Dry matter, %	77.3	77.6	60.8	61.0
Crude protein, %	12.2	12.2	12.3	12.3
Ca, %	0.66	0.66	0.69	0.69
P, %	0.35	0.34	0.39	0.38
Calculated Mcal NEg/lb	0.646	0.672	0.646	0.672

[a]Commercial supplement containing, on a DM basis, 22.2% CP, 17.2% Ca, .28% P, 5.0% salt, .56% K, 100,000 IU vitamin A/lb, 40,000 IU vitamin D/lb, 33.3 IU vitamin E/lb, thiamine 111 mg/lb, Cattlyst 356 g/ton, and trace minerals to meet or exceed NRC (1996) requirements.
[b]Corn-based supplement with urea containing 65% CP.

Table 2. Composition of diets fed in summer trial.

	DRC		CGF	
	HE/RE	HR	HE/RE	HR
Ingredient, %DM				
Alfalfa hay	8.0	12.0	8.0	12.0
Corn gluten feed	—	—	40.0	40.0
Corn silage	—	16.0	—	16.0
Dry rolled corn	81.3	62.5	48.2	28.5
Soybean meal	3.4	2.9	—	—
Limestone	0.9	0.7	0.8	0.5
Rumensin supplement[a]	2.0	2.0	2.0	2.0
Urea supplement[b]	3.4	2.9	—	—
Vitamin/mineral supplement[c]	1.0	1.0	1.0	1.0
Composition, DM basis				
Dry matter, %	87.2	67.1	60.6	49.9
Crude protein, %	13.2	12.9	12.9	13.1
Ca, %	0.60	0.63	0.60	0.60
P, %	0.35	0.34	0.41	0.40
Mcal, ME/lb	1.40	1.34	1.35	1.29
Calculated Mcal NEg/lb	0.65	0.61	0.61	0.57

[a]Corn and soybean meal based supplement containing 1333 g/t Rumensin, 400 g/t Tylan, and 460 g/t thiamine, 30% CP, .18% Ca, .53% P, and 1.26% K, DM basis.
[b]Corn-based supplement with urea containing 65% CP.
[c]Corn-based supplement containing 4% CP, 20% salt, 14.2% Ca, 3.9% P, .2% K, 100,000 IU vitamin A/lb and trace minerals to meet or exceed NRC (1996) requirements.

Summer trial

The 106-day feeding trial was conducted as a 2X3 factorial arrangement and started on May 29, 1996. One group of 144 steers was blocked into low, medium and high weight groups and randomly assigned within block to one of six treatments. These cattle were fed in pens with shade via overhead shelter at feed bunk. Another group of 96 steers was blocked into low and high weight groups and randomly assigned within block to one of the same six treatments. These cattle were fed in pens with no access to shade. There were a total of five pens (replicates) per treatment. All cattle were implanted with Revalor-S at trial initiation. Diets energy sources were either DRC or DRC plus CGF (40 percent DM; Table 2). Diet treatments were: 1) high energy 8 percent roughage diets fed ad libitum (HE); 2) restricted to approximately 90 percent of HE intake (RE); or 3) moderate energy, 20 percent roughage diets fed ad libitum (HR). The RE and HR diets were fed for a 43 days in the mid-portion of the trial only, during the time of greatest heat load potential. HE diets were fed to these groups for the balance of the trial, the first 26 days and last 37 days.

In the summer trial, visual observations of the level of heat stress experienced by the cattle were made between 1600 and 1700 hours each day the temperature-humidity index (THI) was above 71. Typically, moderate heat stress begins at a THI of 74 or above. Each animal in each pen was assigned one of four panting scores with 0 = no panting, 1 = slight, 2 = moderate (noticeable panting and/or salivation) and 3 = severe (open mouth, tongue out). The percentage of animals in each pen observed panting (score 1 or greater) and the percentage experiencing severe heat load (score 2 or greater) were compared among treatment groups.

For winter and summer trials, initial weight was the average of weights taken on two consecutive days before feeding. The final weight was based on hot carcass weight assuming 62 percent dress. Cattle were fed once daily starting at 0800 hours.

Statistical analyses for both trials were done using the GLM procedures of SAS (1991) with treatment and replicate included as the independent variables. Each pen was maintained as the experimental unit. Treatment means were compared using least significant differences. Orthogonal contrasts were used to make further comparisons of means in the winter trial. In the summer trial, orthogonal and non-orthogonal contrasts were also performed. For the summer trial, all heat stress data (percent panting, percent heat-stressed) were analyzed by frequency procedure of SAS (1991) using the Chi-squared option.

Table 3. Treatment effects on animal performance and carcass characteristics in the winter trial.

Shelter:	Minimum				Shelterbelt
Diet:	DRC		35% CGF		
Fat:	0	3%	0	3%	0
Weight, lb					
Initial	941.7	943.2	940.5	945.0	944.3
35d	1059.6	1055.2	1083.9	1068.0	1085.2
Final	1108.4	1115.2	1122.0	1130.2	1149.3
Daily gain, lb	2.20	2.26	2.39	2.44	2.70
DMI, lb	23.11	22.99	23.81	23.05	24.37
Feed:gain, lb	10.55	10.14	9.99	9.47	9.12
ME Intake, Mcal	32.18	32.88	33.17	32.98	33.95
ME Intake:gain	14.69	14.51	13.92	13.55	12.70
Predicted:calculated NEg	0.781	0.778	0.778	0.794	0.804
Hot carcass weight, lb	687.2	691.4	695.7	700.7	712.6
Dressing %	60.68	60.85	60.36	61.12	61.44
Fat thickness, in	0.410	0.430	0.463	0.447	0.411
KPH, %	3.03	3.00	2.93	3.00	3.00
Rib-eye area, in[a]	11.71	11.52	11.85	11.31	12.0
Quality grade[b]	18.47	18.07	17.93	18.40	18.37
%Choice or better	73.33	46.67	53.33	73.33	56.67
Yield grade[c]	2.27	2.40	2.53	2.67	2.43

[a]Fat level effect ($P < .10$).
[b]18 = high Select and 19 = low Choice.
[c]Diet effect ($P < .10$).

Results

Winter trial

The performance and carcass characteristics of each treatment group are shown in Table 3. Average temperature

(Continued on next page)

Table 4. Treatment effects on animal performance and carcass characteristics in the summer trial[a].

Diet:	DRC			CGF		
Treatment:	Ad libitum	Restricted	High roughage	Ad libitum	Restricted	High roughage
Weight, lb						
Initial	851.2	849.6	854.0	850.7	852.0	851.7
27d[e]	933.4[d]	939.0[cd]	934.3[cd]	960.9[b]	951.5[bc]	959.0[b]
84d[f]	1146.6	1124.4	1134.0	1156.5	1141.2	1146.3
Final[ef]	1212.9	1190.9	1197.8	1238.5	1210.9	1221.2
Daily gain, lb[ef]	3.41	3.22	3.24	3.66	3.39	3.49
DMI, lb						
0-26[e]	19.30[d]	20.10b[cd]	19.32[d]	20.40[bc]	21.06[b]	21.06[b]
27-69, test period[f]	22.86[bc]	20.23[d]	23.83[b]	23.55[b]	21.78[c]	22.84[bc]
70-83	24.81	24.28	25.55	24.99	24.40	25.35
84-106[eg]	23.13[d]	23.75[cd]	24.73[c]	25.85[b]	26.18[b]	26.44[b]
0-106[ef]	22.32[cd]	21.53[d]	23.16[bc]	23.43[b]	22.88[bc]	23.49[b]
Feed:gain, lb[g]	6.49	6.70	7.16	6.41	6.77	6.79
ME intake, Mcal[f]	31.27	30.17	31.89	31.57	30.82	31.10
MEI:gain[eg]	9.19	9.38	9.86	8.64	9.12	8.97
Predicted:calculated NEg[e]	0.874	0.870	0.853	0.925	0.896	0.908
Hot carcass weight, lb[ef]	752.0	738.3	742.6	767.9	750.8	757.1
Dressing %	61.60	61.31	61.12	61.59	61.59	61.55
Fat thickness, in[f,g]	0.374	0.347	0.325	0.382	0.318	0.322
KPH, %[g]	2.29	2.26	2.22	2.49	2.36	2.38
Marbling[h]	489.2	476.8	488.0	484.8	480.2	477.4
%Choice or better	50.0	42.5	45.0	52.5	47.5	47.5
Yield grade	2.43	2.30	2.35	2.45	2.23	2.28

[a]All cattle within diet (DRC and CGF) were fed ad libitum except during days 27 through 69, when the restricted and higher roughage diet regimes were imposed.
[b,c,d]Means within a row having different superscripts differ ($P < .10$).
[e]Diet effect ($P < .10$).
[f]Ad lib versus Restricted ($P < .10$).
[g]Ad lib versus High roughage ($P < .10$).
[h]450 = average Slight and 550 = average Small.

was within .5°F of normal and wind speed was slightly below normal during the trial period. No differences in gain, intake or efficiency were observed among treatments. Cattle fed additional fat had smaller ribeye areas than cattle fed no additional fat, regardless of diet base. Those fed DRC had lower yield grade scores than those fed CGF. Cattle fed the CGF diet without additional fat in sheltered pens had larger ribeye areas when contrasted with cattle fed the same diet in unsheltered pens. There was also a trend toward higher gains in cattle fed the CGF diet without additional fat in sheltered pens when contrasted with cattle fed the same diet in unsheltered pens. There were no differences among treatments in predicted:calculated NEg ratios, although all were fairly low. Based upon the environmental conditions during the trial, the 1996 NRC model did not entirely account for all the increased maintenance energy requirements and/or decreased diet digestibility in cold-stressed cattle in this trial.

Summer trial

The performance and carcass characteristics for each treatment group are shown in Table 4. Cattle fed diets containing CGF had greater feed DMI, ADG, final weight and hot carcass weight than cattle fed DRC-based diets. Feed DM efficiencies were not different between the two diets, although MEI:gain was lower in the diet containing CGF versus the DRC-based diets. In addition, diets containing CGF also had greater predicted:calculated NEg values than DRC-based diets. The 1996 NRC model more accurately predicted dietary NEg in the summer trial than in the winter trial. Cattle fed restricted diets (RE) had lower gains and less backfat than those fed ad libitum (HE), regardless of base diet. During the 14-day adjustment period, intakes tended to be elevated for all treatment groups with no differences found among treatments. Restricting intake did not enhance feed DM or ME utilization. Actual intakes of the RE groups were 88.7 percent of HE for the DRC group and 92.7 percent of HE for the CGF group. It is possible the level of restriction was not severe enough, especially for the CGF group. Animals fed high-roughage diets had higher feed:gain ratios, less backfat and less KPH fat than those fed ad libitum regardless of diet base.

The average temperature during the trial period was 2.7°F below normal and very few animals exhibited visible signs of severe heat load. The effects

Table 5. Effect of energy source and feeding level on panting level in cattle.[a]

Feeding Regime:	Daily 1600 hours THI	THI	Dry-rolled corn Ad libitum	Restricted	High roughage	$\bar{x}$	Corn gluten feed Ad-libitum	Restricted	High roughage	$\bar{x}$
Baseline (6/4-6/96)										
Thermoneutral	62	68								
DMI, lb			16.0	16.3	15.5	15.9	17.6	19.1	19.0	18.6
MEI, Mcal			22.4	22.9	21.7	22.3	23.7	25.8	25.6	25.0
% panting			7.5	2.5	5.8	5.3	5.8	11.7	6.7	8.1
% heat stressed			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diet test period										
Early (6/27-29/96)	77	81								
DMI, lb			20.4	20.2	20.3	20.3	21.8	20.5	17.5	19.9
MEI, Mcal			28.6	28.3	27.4	28.1	29.4	27.6	22.6	26.5
% panting[b]			84.2	73.3	74.2	77.2	80.0	85.8	80.8	82.2
% heat stressed			8.3	6.7	6.7	7.2	10.0	14.2	6.7	10.3
Diet test period										
Late (7/17-19/96)	75	81								
DMI, lb			20.1	20.4	23.3	21.3	22.4	21.8	23.0	22.4
MEI, Mcal			28.2	28.5	31.4	29.4	30.2	29.4	29.7	29.8
% panting			95.0	97.5	90.8	94.4	90.0	95.8	90.0	91.9
% heat stressed			26.7	22.5	22.8	23.9	25.8	23.3	23.3	24.2

[a]Mean of three days.
[b]Chi-square $P \leq .10$ (feeding regime).

of energy source and feeding level on panting are shown in Table 5. Early in the diet test the highest level of panting was in the groups fed ad libitum. There were slightly fewer animals in the restricted group panting and the fewest in the high-roughage group (Chi-square = .07). This relationship tended to be the same between the high energy ad libitum and high-roughage groups for cattle showing signs of heat stress in that time period (Chi-square = .12). In the late test period, slightly more animals consuming DRC were panting than those consuming CGF (Chi-square=.12), while cattle fed the HE diet ad libitum tended to show the greatest signs of heat stress.

[1]Jill Heemstra, former research technician, and Terry Mader, professor Animal Science, Haskell Agricultural Laboratory, Concord; Tony Scott, graduate student, Lincoln; John Gaughan, lecturer, Department of Animal Production, University of Queensland-Gatton, Gatton, Queensland, Australia.