HIGH MOISTURE EAR-CORN WITH NO ADDED ROUGHAGE FOR FEEDLOT STEERS

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Story in Brief

Crossbred exotic steer calves (n=180, 714 lb.) were utilized in a 137-day feeding trial to determine the relative feeding values of 1) high moisture ear corn with no added roughage at two protein levels (12.5 and 13.5), 2) high moisture ear corn with 8% added ground alfalfa hay at 12.5% CP and 3) high moisture corn grain with 8% added roughage at two protein levels (12.5 and 13.5). Steers were stratified into three weight replications and assigned randomly to treatment. For the total trial, differences between treatments in daily gain, feed efficiency and calculated dietary energy values were small and not significant. However, during the first half of the trial, feed intake, daily gain and efficiency of feed use tended to be greater for ear corn than corn grain. No health or performance problems were encountered using the ground corn cob inherent in high moisture ear corn as the sole roughage source for these steers. Compared at the single level of protein tested, addition of alfalfa to the ear corn diet did not depress performance or efficiency. Calculated metabolizable energy values for dry matter from high moisture ear corn and high moisture corn grain were 3.48 and 3.51 Mcal/kg. Harvest of the cob with the grain increased dry matter yield per acre by 18% and thereby increased potential beef production per acre by 17%. Results suggest that dry matter from high moisture ear corn has a feeding value essentially equal to that of corn grain, but the increased dry matter yield per acre gives it a superior economic value. Additionally the fact that roughage need not be added when feeding ear corn would decrease operating costs associated with purchasing, transporting, and processing roughage.

(Key Words: Feedlot Performance, Net Energy Values, High Moisture Corn.)

Introduction

Millions of feedlot cattle are fed high moisture corn grain. High moisture corn has a low storage cost. Anaerobic fermentation lowers the pH of the corn

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which deters bacterial spoilage and mold. Corn grain usually is rolled or ground prior to ensiling. Processing increases surface area. Coupled with fermentation which softens the waxy pericarp, high moisture corn grain has a rapid rate of ruminal fermentation which can predispose animals to acidosis. To prevent acidosis, roughage must be fed. However, roughage levels above about 8% are avoided because roughage is expensive per unit of net energy and additional expense is involved in transporting and processing roughage. High moisture ear corn, in which the cob remains with the grain even though the husk is removed, contains the cob as a "built-in" roughage. Presence of the cob may displace the need for adding roughage while increasing dry matter yield per acre harvested. The purpose of this research was to determine the feasibility of harvesting and feeding high moisture ear corn (corn and cob meal) without any added roughage (EAR). And secondly, compare its feeding value with that of high moisture ear corn with 8% added alfalfa (ALF) and that of traditional high moisture corn diet with 8% added alfalfa hay (GRAIN).

Materials and Methods

Animals and diets: The cattle were housed in 12 large outside pens (10 calves/pen, 6 pens/treatment) with no access to shelter. Animals were handled and fed diets described elsewhere in this publication (Secrist et al., 1995). Data collection also was described in that research report. In brief, diets for EAR and GRAIN either 12.5% or 13.5% CP while the ALF was fed at only the 12.5% CP level. All cattle were weighed on days 0, 27, 62, 98, 120 and 137. To reduce dependence on weights obtained on individual days, ADG was calculated by regressing the unshrunk live-weight against days fed. These regressions were calcalated for each individual animal and then averaged by pen. Statistical analysis was performed by the general linear models procedures of SAS and orthogonal contrasts utilized for detection of treatment differences. Individual contrasts were EAR (12.5% and 13.5% CP) vs GRAIN (12.5% and 13.5% CP) and EAR vs ALF and GRAIN vs ALF at only the 12.5% CP.

Results and Discussion

No protein level by corn treatment interactions were detected; hence, only the main effects of corn treatment will be present. No differences between steers fed EAR and those fed GRAIN in total trial ADG, feed:gain, calculated ME or NE were detected (Table 1). However, examination of data for the first half of the trial revealed that dry matter intake (DMI) tended to be about 1 lb or 5.8% higher ($P<.08$) and ADG was 0.38 lb. or 9.4% higher ($P<.02$) for steers fed GRAIN than EAR. Efficiency of feed use also tended to be better for steers fed GRAIN during the first half of the study. During the second half of the trial, gains were identical but DMI remained about 0.5 lb. greater for steers fed

GRAIN. For the total trial, DMI tended to be higher (P<.09) by 3.3% for steers fed GRAIN; this matches the trend for a higher rate of gain (3.6%) for these steers. Despite 8% greater diet digestibility for GRAIN than EAR, these diets were virtually identical in ME or NE as calculated from cattle weights, rates of gain, and feed intakes. To assure that these live weights were not biased by differences in gut fill, dressing percentages for the heavy weight group were checked. Dressing percentages were 62.49, 62.29, and 61.12 for steers fed GRAIN, EAR, and ALF, respectively, suggesting that live weights should have adequately paralleled carcass weights.

Because ALF diets contained only 12.5% CP, comparisons with HMC and EAR were made at only the 12.5% CP protein level (Table 2). No differences in performance of cattle between corn treatments were detected for any of the measured parameters. These results do not agree with those of Van Koevering et al. (1994) who reported that a diet similar to ALF containing ear corn plus 8% alfalfa produced 5% slower gains with 9.6% higher DMI for 15% poorer efficiency than a GRAIN diet. The reason for these discrepancies are not clear but might be ascribed to differences in corn variety, corn moisture at harvest, greater feed consumption of ALF in the previous trial, or more finely ground cob and greater acidosis potential in the current trial. In general, one would expect that adding 8% alfalfa to a diet already containing over 10% roughage from the corn cob would increase DMI and decrease efficiency without altering rate of gain. However, regression analysis of the literature (Owens et al., 1994) shows that efficiency does not always decline when only 8% alfalfa is added, perhaps due to reduced propensity of cattle fed more roughage to experience subclinical acidosis. Weichenthal et al. (1988) suggested that high moisture ear corn contains insufficient net energy to maximize rate of gain of feedlot steers and that grain should be added to maximize performance. However, presence or absence of the husk, amount of cob, and starch availability, which in turn depends on fineness of grind and moisture content at harvest, would influence energy density of high moisture ear corn.

Energy value calculations for the five different treatments are shown in Table 3. First, ME of GRAIN, EAR and ALF were calculated from performance assuming that the net energy equations for compensating yearling steers would match performance of these cattle. From those values, the ME provided by alfalfa and supplement components was subtracted. The residual ME presumably was all coming from the grain which comprised from 83 to 92% of diet dry matter. Dividing the residual ME by the percentage of ear corn or corn grain in the diet DM yielded ME values of DM from the ear corn or corn grain. Based on these calculations, the ME of dry matter from high moisture ear was 3.48 Mcal/kg, some 7 to 16% greater than the NRC (1984; 1989) values for corn and cob meal. The ME value for dry matter from the high moisture grain was 3.51 Mcal/kg or 1 to 4% greater than NRC values.

According to NRC (1984; 1989), high moisture corn has 3 to 11% more ME than dry corn; hence, it is not surprising that high moisture ear corn should have a higher value than dry ear corn (corn and cob meal). However, the high value for high moisture ear corn, 99% that of corn grain, suggests that energy availability of the corn cob in high moisture corn grain has ME nearly equal to grain (over 90% assuming that ear corn dry matter is 10% cob). This seems illogical, yet when calculated and averaged across two years data, Weichenthal et al. (1988) also found that high moisture ear corn had 99% the value of high moisture corn grain and could be fed successfully without added roughage. One added factor that influences energy value of ensiled corn grain is moisture content. In numerous previous studies with ensiled corn grain, the wetter the grain, the higher its energy value. Note that including the cob with the grain increases the moisture content of the mixture; this would be expected to increase the ME value of the grain.

Relative economics of harvesting high moisture ear corn or corn grain for feeding to feedlot cattle depends on a number of factors. These include harvest cost, storage cost and loss, dry matter yield, and feed:gain ratio. Harvest speed for the 8-row combine was reduced from about 6 to 4 mph for ear vs. grain harvest which would increase time involved with harvest by up to 33%. Bulkiness of the ear corn, requiring about 20% more space per unit weight together with an increased wet weight yield of 18% (Table 4) for hauling and ensiling, would increase cost for transport and storage.

Measured yield in bushels per acre from our 1994 harvest, assuming 15.5% moisture grain and 56 and 72 lb bushel weights, was 8% lower (131 vs. 143 bushel/acre) for ear corn than corn grain (Table 4). These bushel weights are calculated based on the assumption that 72 lb of ear corn yields 56 lb of grain plus 16 lb (22%) of cobs. This assumption is obsolete. Although the cob may have comprised 22% of the dry weight of ear corn with varieties of corn hybrids in decades past, in modern corn grain varieties, our measurements indicate that the cob comprises only 9 to 13% of the dry matter of ear corn. This means that bushel weight for ear corn should be about 63 lb, not 72 lb. With modern hybrid corn grain, use of the 72 lb figure will undercompensate producers selling ear corn by over 15%!

Yields of ME from high moisture ear corn and corn grain are shown in Table 4. Wet weight harvested was 30% greater for ear corn than corn grain, but due to the lower dry matter content of the ear corn (64 vs. 71%), dry matter yield was 18% greater for ear corn than corn grain. Using ME values determined in these trials, beef production per acre should be 17% greater from ear corn than corn grain. If last years ME values for ear corn and corn grain were used (Van Koevering et al., 1994), beef production per acre would have been 6% greater from ear corn than corn grain. Individual producers who harvest and feed their own grain can decide whether this increase adequately compensates for the costs mentioned above. For commercial feedyards, purchasing high moisture ear corn presents three additional problems: measuring moisture content, determining the percentage of cob, and pricing. Electrical conductivity moisture testers work well for grain, but not for cobs. And cobs "float" and separate from grain during handling and transport; this makes it difficult to obtain a sample with is representative of a load of ear corn. Elsewhere in this publication, a method for calculating weight of grain dry matter from wet weight of ear corn and the moisture content of the grain portion is presented. That might be used as a guide until more precise methods become available.

Based on these results, high moisture ear corn per unit of dry matter had a feeding value of 99% that of high moisture corn grain. With an increased dry matter yield per acre of 18%, partly due to recovery of the cob and partly due to decreased field loss of grain, this translates into an increase in beef production per acre of 17%. In addition, high moisture ear corn can be fed satisfactorily without added roughage. Sparing or eliminating roughage in finishing rations, and thereby avoiding the problems of transport, handling and processing inherent with roughage, provides is a further incentive for substituting high moisture ear corn for high moisture corn grain in diets for feedlot cattle.

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Table 1. Feedlot performance of steers fed high moisture ear corn or corn grain diets averaged across protein levels.

Measurement	Grain	Ear
DMI, Total, lb	19.6[a]	19.0[b]
d 0-62	18.0[a]	17.0[b]
d 62-end	21.2	20.7
ADG, Total, lb[e]	4.07	3.93
d 0-62	4.41[c]	4.03[d]
d 62-end	3.78	3.79
Feed/gain, Total, lb[e]	4.83	4.84
d 0-62	4.08[b]	4.23[a]
d 62-end	5.64	5.47
Calculated Net Energys[e]		
ME, Mcal/lb	1.49	1.49
NEm, Mcal/cwt	103.0	103.4
NEg, Mcal/cwt	66.9	67.1
Digestibility, %	77.2[c]	71.5[d]

[a,b,c,d] Means in a row with different superscripts differ. [ab] $P<.10$; [cd] $P<.05$.

[e] Measurements involving body weight or gain were derived from regressions of live weight on days on feed.

Table 2. Feedlot performance of steers fed 12.5% protein diets composed of high moisture ear corn, corn grain or ear corn with 8% added alfalfa (unshrunk).

Measurement	Grain	Ear	Alfalfa	Ear vs Alfalfa Probability, P=	Grain vs Alfafa Probability, P=
DMI, Total, lb	19.5	19.4	19.4	.89	.75
d 0-62	18.1	17.3	17.9	.48	.79
d 62-end	20.8	21.3	20.7	.46	.91
ADG, Total, lb[a]	4.12	4.10	4.02	.64	.56
d 0-62	4.39	4.19	4.25	.77	.45
d 62-end	3.84	3.97	3.83	.46	.92
Feed/gain, Total, lb[a]	4.74	4.74	4.82	.55	.55
d 0-62	4.11	4.15	4.21	.57	.36
d 62-end	5.40	5.36	5.43	.83	.93
Calculated Net Energys[a]					
ME, Mcal/lb	1.51	1.51	1.50	.61	.61
NEm, Mcal/cwt	105.2	105.2	103.8	.63	.63
NEg, Mcal/cwt	67.9	67.9	67.2	.58	.59
Digestibility, %	78.4	71.1	75.6	.15	.36

a Measurements involving body weight or gain were derived from regressions of live weight on days on feed.

Table 3. Calculations of ME (Mcal/lb) for dry matter from high moisture ear corn and high moisture corn grain for feedlot steers.

Corn Form Alfalfa, % Protein, %	Ear 0 12.5	Ear 0 13.5	Ear 8 12.5	Ear- Mean Values	Grain 8 12.5	Grain 8 13.5	Grain Mean Values
Diet ME, measured	1.51	1.48	1.5		1.51	1.47	
ME from other feeds							
Alfalfa	0	0	.076		.076	.076	
Soybean meal	.036	.07	.01		.009	.044	
Cottonseed meal	.039	.039	0		.039	.039	
Total	.074	.109	.087		.124	.159	
ME from corn portion	1.44	1.37	1.41		1.39	1.31	
Corn in diet, %	91.7	89.3	86.0		85.9	83.5	
ME of corn DM	1.57	1.54	1.64	1.58	1.62	1.57	1.59
NRC values of corn cob meal or Grain							
Beef NRC (1984)				1.36			1.53
Dairy NRC (1989)				1.48			1.58

Table 4. Yields of wet matter, dry matter,bushels and metabolizable energy from high moisture ear corn or corn grain.

Measurement	Ear Corn	Corn Grain	Percentage, Ear/Grain
Wet wt. harvested, lb	371,440	540,280	
Area harvested, acres	29.74	56.46	
Wet yield, lb/acre	12,491	9,569	130.5
Dry matter, %	63.76	70.55	
Dry yield, lb/acre	7,964	6,751	118.0
Yield, bushel/acre	130.9	142.7	91.8
ME			
Mcal/lb	1.58	1.59	
Mcal/acre	12,582	10,758	117.0