PROTEIN LEVELS FOR FEEDLOT STEERS FED HIGH MOISTURE CORN

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Story in Brief

The effects of two protein levels on feedlot performance were investigated using 120 crossbred steers (711 lb). The 92% concentrate diets, based on high moisture ear corn or corn grain, contained 12.5 or 13.5% crude protein including 0.5% urea. Steers were implanted with Synovex-S® on d 0 and with Revalor ® on d 62 of the 137 d feeding trial. Steers gained an average of 4 lb/d during the study. Dry matter intakes, daily gain and efficiency of feed use were not altered by protein level during the first half of the study. But during the second half (d 62 to 137), steers fed the higher protein level tended to have less weight gain (7.2%) and poorer feed efficiency (4.2%). Metabolizable energy value of the diets, calculated from steer ADG and feed intake, was 1.8 % lower for the higher protein diets. No differences in carcass characteristics were detected. Dry matter and crude protein digestibilities and fecal starch concentrations were not altered by protein level of the diet. Increasing protein level in the diet above 12.5% of dry matter did not increase performance of rapidly growing steers in this study. Indeed, the higher protein level (13.5% CP) appeared to depress gain and efficiency during the last half of the feeding period. Less dietary protein should be needed to meet ruminal ammonia needs with diets composed of high moisture corn, which contains a high amount of soluble protein, than with diets based on flaked or dry corn grain.

(Key Words: Cattle, Requirements, Grain.)

Introduction

Protein makes a sizable contribution to the weight and cost of supplements for feedlot cattle. In recent years, protein levels fed in commercial feedlots have been increasing based on the assumption that cattle with greater rates of lean tissue deposition, due to genetics or use of trenbolone acetate implants, require higher concentrations of protein in the diet. Much of dietary protein is degraded in the rumen to yield ammonia for use by bacteria for protein

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synthesis. Compared with dry rolled grain, steam flaking should increase need for supplemental urea or protein for two reasons. First, the need for ammonia in the rumen is increased because rate and extent of starch digestion in the rumen and thereby bacterial protein synthesis is increased. Secondly, the ruminal supply of ammonia is reduced because heat processing decreases the extent of degradation of grain protein in the rumen. Ensiled grain should similarly increase the need for ruminal ammonia, but protein degradation in the rumen, rather than being decreased, probably is increased as protein solubility increases during the ensiling process. Hence, processing by flaking should increase the amount of protein that can be used, while processing by ensiling should have less impact on urea or protein needs. Therefore, it probably is erroneous to extrapolate protein and urea needs from one type of processed grain to another. Further, in view of the high marginal cost of supplemental protein and the potentially deleterious effects of diets containing protein concentrations beyond those required   have been observed in dairy cattle, surpluses of protein, like deficiencies of protein, should be avoided. The objective of this research was to determine the response of feedlot cattle to higher, yet economically realistic dietary protein concentrations than those typically fed with high moisture corn diets (12.5% of dry matter).

Materials and Methods

Animals and diets: One hundred twenty crossbred steers of exotic breeding were shipped from South Dakota to Guymon, OK on January 18, 1994. Upon arrival, these spring-born calves were vaccinated, dewormed and implanted (Synovex-S®). Ten days later (d 0), these cattle were hauled 15 miles to the Panhandle State University feedlot research unit at Goodwell, OK. Upon arrival, the cattle were weighed, stratified into three weight replicates and assigned randomly to treatment. Treatments included high (13.5 % CP) and normal (12.5 % CP) protein levels with both EAR and GRAIN and one protein level (12.5 % CP) for high moisture ear corn with 8% added alfalfa (ALF). The cattle were housed in twelve large outside pens (ten calves/pen, six pens/treatment) with no access to shelter. All cattle were reimplanted on d 56 with Revalor-S®.

All corn was harvested from one 86 acre flood-irrigated field containing one variety of Pioneer Hy-Bred® corn at Goodwell, OK with a John Deere® combine. Ear corn, at 64% dry matter, was harvested by modifying combine settings: decreasing the concave clearance so that the cob was crushed during harvest, removing all the sieves from the rear of the combine, except the one directly below the concave auger, and increasing the fan speed to ensure removal of the husk and trash. Corn grain, harvested one d later, had 70.6% dry matter. All corn was ground through a 0.5 inch screen with a commercial

tub grinder, stored in Agbags® and allowed to ferment for at least 90 days prior to initiating feeding.

Diets (as shown in Table 1) were available to steers continuously with fresh feed added once daily to fence-line concrete bunks. Feed samples were taken prior to feeding periodically during the study. Nutrient content of the basal ingredients (corn, ear corn, alfalfa hay) was determined so that supplements could be formulated for each diet to precisely meet NRC (1984) requirements for large frame compensating yearlings and experimental objectives. Each diet contained 0.5 % urea and 3.0 % cottonseed meal with the amount of soybean meal adjusted to provide the concentration of protein desired.

Data Collection: All cattle were weighed on days 0, 27, 62, 98, 120 and 137. From d 88 to 98, cottonseed hull-based pellets containing chromic oxide were added to the diet to provide each animal with 10 g chromic oxide per d. Fecal samples were collected from steers in each pen on days 96 (PM), 97 (AM and PM) and 98 (AM). Samples were analyzed for chromium and total tract organic matter digestibility was calculated. Total tract digestibilities of organic matter and crude protein were calculated and starch content of feces was measured.

Steers of the heavy weight replicate were slaughtered on d 127 at Dumas, TX; carcass data were collected after a 24-h chill. Steers of the medium and light weight replicate were slaughtered on d 160. Because the supply of grain was all consumed on d 145, before the two lighter replicates were slaughtered, data collection ceased on d 137. Weights obtained on this day were used as a final live-weight for these two replicate weight groups of cattle. Carcass information was not obtained for the light and medium weight replicate groups.

To reduce dependence on weights obtained on individual days, ADG was calculated by regressing the unshrunk live-weight against days fed. ADG, both during two segments of the study (the first 62 days and the remainder of the study) and for the total trial, was considered equal to the linear regression slope. These regressions were calculated for each individual animal and then averaged by pen. Net energy values were calculated based on performance, body weight and feed intake utilizing the net energy equations (NRC, 1984) using net energy retention values for compensating yearlings due to very rapid growth rates and leanness of the steers in this study. Data for two steers were removed, one for an abnormally low rate of gain and another due to weight loss during one period. Feed consumption for each of these steers was subtracted from feed intake for its home pen based on weight gain by the steers and calculated net energy of the diet it was being fed. For statistical analysis, we compared treatments using pen means in the General Linear Models procedure

of SAS. We also conducted tests of individual preplanned comparisons using orthogonal contrast statements (12.5 vs. 13.5% CP; EAR vs. GRAIN averaged across protein levels; interaction of EAR vs. GRAIN with protein level). For calculations of performance, data for ALF were excluded. But for calculating energy values of the diets, data for steers fed ALF were included,

Results and Discussion

Cattle Performance: The effects of protein level on cattle performance are summarized in Table 2. Dressing percentage, measured only with the heavy weight replicate of steers did not differ due to protein level. Consequently, other comparisons were based on unshrunk live animal weights. DMI did not differ at any time during the trial. Averaged over the total 137 days, ADG (P=.11), efficiency of feed use (P=.18), and calculated dietary energy values (P=.21) tended to be higher for steers fed the 12.5% CP diets. None of these factors were altered during the first 62 days. Differences were attributable fully to effects during the last half of the feeding study.

Carcass Characteristics. Carcass data were obtained only for the heavy replicate group of steers (n=40). Carcass weights and USDA grade and yield were obtained. No differences were detected in this limited data.

Digestibility. Digestibility data are summarized in Table 2. No differences were detected in dry matter or protein digestibility. Starch and protein content of the feces did not differ due to treatment. Added protein did not increase protein content of feces nor did it enhance digestibility of the diet. Differences in energetic efficiency are not attributable to decreases in energy digestibility at higher protein intakes.

Dietary Energy Values. Energy values for the various diets, as calculated from ADG and feed intake, are presented in Table 3. The mean ME of the total diet was 2% lower (P=.21) for the 13.5 than the 12.5% CP diets (1.50 vs. 1.47 Mcal/lb). Therefore, the ME value of the grain portion of the ear corn and corn grain diets also was calculated. Adjusting for differences in other diet components, the ME of the corn portion of the diet calculated to be 3.4% lower for the higher protein diet. These results agree with those of previous studies in which feed intakes have been lower and feed efficiency poorer in the last half of feeding studies for steers fed higher protein levels (Owens et al., 1977; Gill et al., 1979). However, these results conflict with those from studies from Iowa State University (Trenkle et al., 1994) and California (Zinn et al., 1993) with dry or flaked corn diets in which protein concentrations above 12% of dry matter have increased rate and efficiency of gain of rapidly growing cattle. The difference may be due to the type of grain being fed. The high concentrations of soluble nitrogen and non-protein nitrogen in high moisture corn would

reduce the need for ruminally degraded protein. Because, protein concentration was increased, soybean meal was replacing corn. The energy value of soybean meal is slightly less than of corn.

Energetic efficiency also might be depressed directly by excessive protein intake. In studies with dairy cattle (NRC, 1989), excess protein (typically over 18% for lactating cows) has consistently depressed efficiency of energy use. Although no concrete explanation is available, the depressed efficiency has been ascribed to the increased energy expenditure and heat production involved with synthesis and excretion of urea. Alternatively, added protein may increase maintenance requirements. Higher protein levels early in the feeding period, may increase protein mass of growing steers. Tissue protein is more costly to maintain than tissue fat. Secondly, higher protein levels may increase the size of certain high-maintenance organs (liver, intestines). This adverse effect of the higher protein level was more pronounced later in the finishing phase, presumably because protein deposition rate had decreased so that the surplus of protein was greater. Perhaps decreasing the protein levels slightly below 12.5% late in the feeding period for rapidly growing feedlot cattle would increase feed intake and improve energetic efficiency.

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Table 1. Diet and calculated nutrient composition (% of DM) for high moisture ear corn and corn grain diets.

Corn form	Ear corn	Ear corn	Corn grain	Ear corn	Corn grain
Crude protein, %	12.5	12.5	12.5	13.5	13.5
Grain or ear corn	91.70	86.00	85.87	89.30	83.52
Alfalfa hay	0.00	8.00	8.00	0.00	8.00
Cottonseed meal	3.00	3.00	3.00	3.00	3.00
Soybean meal	2.60	.75	.70	5.1	3.20
Urea	.50	.50	.50	.50	.50
Salt	.30	.30	.30	.30	.30
Limestone	.90	.60	.60	.90	.60
Dical	.55	.55	.60	.55	.55
Potassium chloride	.40	.25	.38	.30	.28
Copper sulfate	.0015	.0013	.0013	.0012	.0013
Zinc oxide	.0015	.0016	.0016	.0014	.0014
Vitamin A 30	.011	.011	.011	.011	.011
Rumensin 80	.017	.017	.017	.017	.017
Tylan 40	.0125	.0125	.0125	.0125	.0125
Calculated nutrient composition, dry matter basis.					
NEm , Mcal/cwt	89.19	87.13	96.13	89.15	95.89
NEg, Mcal/cwt	60.14	58.22	62.14	60.12	62.04
Crude Protein, %	12.50	12.5	12.49	13.51	13.50
Potassium, %	.70	.71	.70	.70	.70
Calcium, %	.59	.61	.60	.59	.59
Phosphorus, %	.34	.33	.34	.35	.35
Magnesium, %	.15	.17	.17	.16	.17
Cobalt, ppm	.15	.15	.16	.15	.15
Copper, ppm	8.40	8.1	8.1	8.0	8.5
Iron, ppm	122.6	149.9	159.9	128.0	155.1
Manganese, ppm	40.5	40	40.3	40.3	40.3
Selenium, ppm	.15	.16	.16	.16	.17
Zinc, ppm	30.0	30.6	30.6	30.6	30.4

Table 2. Feedlot performance and diet digestibility.

Item	Low protein 12.5 % CP	High protein 13.5 % CP	Probability P=
Dressing percentage	65.1	64.9	.64
Live-weight, lb[a]			
Initial	712	710	.51
Final	1250	1222	.08
DMI, total, lb/d	19.4	19.0	.44
Day 0 to 62	17.9	17.7	.45
Day 62 to finish	20.6	20.1	.52
ADG, total trial, lb[a]	4.06	3.87	.11
Day 0 to 62	4.27	4.16	.46
Day 62 to finish	3.88	3.60	.11
Feed/gain, total	4.73	4.89	.18
Day 0 to 62	4.20	4.27	.48
Day 62 to finish	5.26	5.49	.21
Calculated diet energy, Mcal/cwt			
ME	151.0	148.3	.21
NEm	105.2	101.2	.21
NEg	67.9	66.1	.21
Digestibility, %			
Dry matter	74.74	73.93	.69
Crude protein	67.14	68.74	.56
Fecal concentration, % of DM			
Starch	9.26	9.20	.97
Protein	16.47	16.27	.78

[a]Weight based on unshrunk live-weight.

Table 3. Calculations of ME (Mcal/lb DM) for diet dry matter for two protein concentrations with high moisture ear corn and high moisture corn grain for feedlot steers.

Corn Form	Ear	Ear	Grain	Mean Value	Ear	Grain	Mean Value
Alfalfa, %	0	8	8		0	8	
Protein, %	12.5	12.5	12.5	12.5	13.5	13.5	13.5
Diet ME, calculated	1.51	1.50	1.51	1.50	1.48	1.47	1.47
ME from other feeds							
Alfalfa	0	.076	.076		0	.076	
Soybean meal	.036	.010	.009		.070	.044	
Cottonseed meal	.039	0	.039		.039	.039	
Total	.075	.086	.124		.109	.159	
ME from corn portion	1.43	1.41	1.38		1.37	1.31	
Corn in diet, %	91.7	86.0	85.9		89.3	83.5	
ME of corn DM	1.56	1.64	1.61	1.61	1.53	1.57	1.55