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Summary

An experiment was conducted to determine if dietary metabolizable protein **(MP)** could be manipulated to reduce N content of feedlot effluent without compromising production rates in yearling steers fed high grain content diets. Three feeding programs included: LO) 11% CP fed throughout; HI) 13% CP fed throughout; and LHL) 11% fed from d 1 to 35, 13% CP (HI) fed d 36 to 94 and 11% CP **(LO)** fed from d 95 to 117. An estradiol-trenbalone acetate implant was administered on d 35. There were 5 pens of 8 steers (BW=756lb) assigned to each treatment. The MP allowed ADG for the diets were 3.3 and 4.0 lb for the LO and HI diets respectively. Cumulative ADG and feed efficiency were improved (P<.05) by feeding the HI diet. Fluctuations in interim growth rates obscured the determination of specifically when this effect occurred. The faster growth rate was associated with heavier and fatter carcasses. An evaluation of serum urea-N concentrations suggested that the influence of the growth promotant on N metabolism was beginning to diminish within 56d. The HI diet caused higher (P< .05) serum urea-N levels at 63, 91 and 117d on feed. Total N intake was calculated by pen and increased (P< .01) from 41.4 to 47.3 to 51.2 lb/steer for treatments LO, LHL and HI respectively. The N intake/100 BW gained increased (P< .01) from 9.89 to 10.90 to 11.33 lb for LO, LHL and HI treatments respectively. These results indicate that increasing production efficiency by elevating the MP content of diets may not cause a concomitant improvement in the efficiency of N retention on the feedlot scale.

Key words: feedlot, steers, crude protein

Introduction

Growth promotant implants can dramatically increase the growth rate of cattle fed high grain diets. They also cause animals to have more muscle mass at a common body weight. Presumably these conditions would increase the dietary CP requirements of a steer. That increased CP requirement has been demonstrated in controlled research studies. In response to those data and for other reasons the dietary CP level in most cattle finishing diets is greater than 12.5% CP.

Most of the increase in growth rate associated with higher CP diets occurs early in the feeding program. This coincides with a less physically mature stage of growth that should include proportionally greater muscle growth than occurs later in the feeding period. Typically, this also coincides with peak implant activity since we traditionally administered implants as cattle are placed on feed.

Recently there has been an increase in the practice of delaying administration of the more potent implants available until after cattle are on full feed. There is also an increased awareness of the N balance in feedlots and there are new regulations controlling the handling of N in feedlot effluent. Both management changes could affect the optimization of CP supplementation of feedlot cattle fed high grain diets. The N metabolism models available in the current NRC Nutrient Requirements for beef cattle allows us to evaluate potential metabolizable protein requirements and ways to optimize N usage. These model estimates must then be compared with production experiments to verify biologic and economic responses.

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Methods

The experiment was designed to evaluate production efficiencies and the efficiency of N utilization in three dietary management schemes for yearling steers. The three treatments compared were: LO) 11% CP diet fed throughout; HI) 13% CP diet fed throughout; and LHL) 11% CP diet fed for 35d, followed by the 13% CP diet fed for 59d and then returned to the 11% CP diet. The timing of diet switches corresponded with the anticipated period of peak activity of an estradiol-trenbalone acetate implant (revalor-s[4]) administered on d 35.

Yearling steers (n=120, BW=756) were received in two drafts 3 and 7d prior to initiating the experiment. Initial processing included individual identification and BW determination as well as vaccination against clostridia sp[5] IBR[6] BVD[6] PI_3[6] BRSV[6]and H. somnus[5] and treatment for internal and external parasites[7]. This processing weight was used to eliminate outliers, block steers into two BW groups (BWG) and then to allot them to treatment. For allotment, steers were ranked by BW within BWG and then randomly assigned a treatment code. Once assigned to a BWG and treatment, the process was repeated to assign to replicates. Each BWG x treatment x replicate assignment corresponded to a pen. There were 5 pens of 8 steers assigned to each treatment. Two of these replicates were included in the light BWG and 3 pen replicates were from the heavy BWG. Final diets used are outlined in Table 1. Three step-up diets involving the substitution of ground hay and oat silage for corn were used during the initial 14d on feed. Cattle were fed twice daily. Feed ingredients were sampled weekly for composition analyses. Final diet composition was calculated on a weekly basis based upon actual feed batching records and ingredient analyses.

Steers were weighed on the first day of the experiment and after 35, 63, 91 and 117d on feed. Implanting was done on d 35. All BW determinations were done in the morning prior to feeding. There was no restriction of feed or water prior to weighing steers. Feed records were compiled to correspond with interim BW data. Blood was collected by jugular vena-puncture during the weighing process after 63, 91 and 117d on the same 5 steers from each pen for determination of serum urea-N (SUN) content.

Steers were shipped (140 mi.) to a packing plant after 118d on feed. Individual steer identity was maintained for collection of carcass data that included hot carcass weight, ribfat depth, ribeye area, (all measured) and KPH% and marbling (estimated by USDA Grader on duty).

Production data were evaluated by considering pen as the experimental unit. Cumulative performance was calculated by assigning a 4% shrink to BW on d 117 and also by assuming a constant dressing percentage of 62.26% which was the overall average value. Carcass data and SUN data analysis involved using each individual as an experimental unit. The statistical model was a 2 x 3 factorial arrangement of treatments where sums of squares were partitioned into body weight group (n=2), diet management (n=3) and their interaction.

This experiment was conducted from January 27 to May 26, 1999.

Results

Actual CP content of diets was only slightly lower than projected. This occurred because of decreases in the CP content of the oat silage fed over the course of the feeding period. This would have uniformly affected each dietary treatment. The CP levels during the experiment were d 1 to 7 11.5% (LO) and 13.8% (HI); d 36 to 42 10.8% (LO) and 13.4%(HI); d 71 to 77 10.3% (LO) and 12.8% (HI); d 105 to 112 10.4% (LO) and 12.7% (HI).

One steer died after 44d on feed from a respiratory infection. Three other steers in that pen were hospitalized at that time. The problem was limited to one pen and affected (depressed) performance for the LO treatment during the period 36 to 63d on feed. The BWG affected most traits measured (Table 2), but BWG x treatment interactions were not evident in the data. The target harvest point was .4" ribfat. The overall mean ribfat depth was near this value (.385"), but there was a significant difference between BWG. Differences in marbling levels were consistent with this

[4]Hoechst Roussell
[5]Ultrabac 7, Pfizer
[6]Resvac 4, Smithline
[7]Dectomax, Pfizer

observation. Only 41% of BWG 1 steers graded choice or higher, while 65% of the heavier, fatter steers (BWG 2) graded Choice or higher.

Cumulative ADG calculated by either shrinking final BW or estimated from hot carcass weight resulted in ADG similar to the ME allowed ADG predicted by NRC 96. This growth rate (3.72 lb/d) was well above the MP allowed ADG of 3.3 as predicted by the NCR for the LO treatment (Table 1). The HI treatment should have provided adequate MP for the cumulative ADG exhibited by the steers. When growth was evaluated on a carcass weight basis the HI treatment increased (P<.05) ADG and reduced feed/gain (P<.05) over the LO treatment.

The cumulative performance of the LHL treatment was intermediate to and not different from the LO and HI treatments (Table 3). Cumulative DMI was not affected by treatment. There were no detectable differences in production rates due to treatment in any of the interim periods. This experiment spanned winter to spring seasons and changing environmental conditions may have masked treatment effects during interim periods.

Carcass weight increased with increasing dietary CP (P<.05, Table 4). Higher CP intake also resulted in fatter carcasses (P<.05) which was probably a consequence of faster growth and heavier final body weight. There was a reduction (P<.05) in marbling associated with the LHL treatment. These treatments should be re-evaluated with more cattle to determine if this effect was real or was an artifact of the allotment of steers to treatments. While numerical differences in quality grade distributions existed, the limited population size precludes drawing any conclusions regarding treatment.

The SUN values were determined as a more direct indicator than growth of status of N metabolism. At 63d on feed SUN was lower in steers fed the 11% CP diet than in steers fed the 13% CP diet (Table 5). With additional time on feed the requirement for metabolizable protein would be expected to decline. In turn SUN would be expected to increase. The SUN levels were higher at d 91 than at d 63 and the increase in SUN was greater for steers being fed the 13% CP diet. This suggests that the 13% CP diet was providing an excess of MP for steers implanted with an estradiol-trenbalone acetate implant just 56d earlier.

The LHL treatment involved changing from the 13% CP diet back to the 11% CP diet on 94d. This caused lower SUN levels for the LHL treatment at 117d. SUN was reduced to a level lower than that for the steers persistently fed the 11% CP diet (treatment LO), suggesting some type of compensation process was involved.

Average daily N intake was calculated using daily feed records for each pen and the weekly CP determinations of each dietary ingredient. These data were totaled by pen over the 117d on feed and expressed on a per steer basis (Table 6). As expected total N consumed increased (P<.01) across LO to LHL to HI treatments. The efficiency of use of this N was determined as total N intake, lb. ÷ total live weight gain (using the carcass weight derived final BW). Although the HI treatment caused higher total weight gains with similar DMI than the LO treatment, the efficiency of N use per 100lb weight gain was lower (P<.01; Table 6). The 1.44 lb N/100lb live weight gain difference between LO and HI treatments would presumably all be lost to the environment. Future research evaluating CP supplementation should address the efficiency of N utilization as well as the production efficiencies that are typically evaluated since both variables affect the cost of beef production.

These results suggest that the dietary CP requirement of steers fed high grain diets and implanted with estradiol-trenbalone acetate growth promotants is somewhere between 11 and 13%. It also appears (based upon SUN levels) that the demand for MP caused by growth promotants begins to diminish within 56d of exposure to the implant. Careful management of dietary CP can cause significant reductions in feedlot emissions of N per unit of growth in steers.

Table 1. Diet Formulations

	11% CP	13% CP
Oat Silage, %	9.50	9.50
WSC, %	86.25	78.80
LS475U, %	4.25	4.25
Dried Distillers Grains + Solubles, %		4.00
SBM, %		2.70
Blood Meal, %		.35
Feather meal, %		.40
CP, %	11.1 (10.5)[a]	13.6 (12.9)[a]
DIP, %	59.3	56.1
DIP Balance, g/d	-139	-31
NE_m, Mcal/lb	1.04	1.04
NE_g, Mcal/lb	.63	.63
P, %	.293	.325
Allowed ADG		
ME	3.81	3.77
MP	3.3	4.0

[a]Values on parentheses are actual values

Table 2. Comparison of Performance and Carcass Traits Between Initial Body Weight Groups[a]

	Light	Heavy	Var
Initial BW, lb[c]	713	785	25
Final BW, lb[c]	1139	1227	415
ADG, lb	3.64	3.77	.0271
DMI, lb[c]	21.09	23.21	.5594
F/G[c]	5.81	6.15	.0793
Dress, %[c]	62.65	62.01	2.7012
Hot Carcass WT, lb[c]	714	761	1433
Ribeye area, in^{2c}	12.9	12.4	1.4355
Ribfat, in[c]	.33	.42	.0183
KPH, %	2.3	2.4	.1275
Marbling[bc]	4.87	5.51	.6563
Yield Grade[c]	2.38	2.95	.3830

[a]Least squares means
[b]4.0 = slight°; 5.0 = Small°
[c]P<.05

Table 3. Interim and Cumulative Production Characteristics[a]

	Treatment			
	LO	LHL	HI	
	11%CP	11%/13%/11%CP	13%CP	SEM
Initial BW	747	749	751	2.4
1-35d				
BW 35	906	905	917	7.5
ADG	4.55	4.56	4.76	.162
DMI	19.42	19.36	19.51	.344
F/G	4.29	4.36	4.11	.121
36 to 63d				
BW 63	1001	1016	1036	11.9
ADG	3.41	3.98	4.23	.410
DMI	21.37	21.88	22.25	.787
F/G	6.68	5.69	5.31	.576
64 to 91d				
BW 91	1115	1120	1135	8.8
ADG	4.07	3.69	3.55	.272
DMI	23.39	23.50	23.04	.519
F/G	5.93	6.42	6.47	.406
92 to 117d				
BW 117	1219	1229	1247	9.5
ADG	4.01	4.21	4.28	.179
DMI	24.48	25.09	25.15	.493
F/G	6.15	6.01	5.89	.249
Cumulative (Shrunk)				
Final BW	1171	1180	1197	9.1
ADG	3.63	3.68	3.81	.074
DMI	21.97	22.21	22.26	.334
F/G	6.06	6.04	5.84	.126
Carcass Adjusted				
Final BW	1166[b]	1184[bc]	1202[c]	10.8
ADG	3.58[b]	3.70[bc]	3.86[c]	.086
F/G	6.14[d]	6.03[de]	5.76[e]	.142

[a]least squares means
[b, c]means without common superscripts differ (P<.05)
[d, e]means without common superscripts differ P<.10)

Table 4. Carcass Characteristics by Treatment[a]

	Treatment			
	LO	LHL	HI	
	11%CP	11%/13%/11%CP	13%CP	SEM
Dress, %	62.03	62.40	62.57	.27
Hot carcass wt, lb	726[e]	737[ef]	749[f]	6.1
Ribeye area, in^2	12.47	12.82	12.65	.194
Ribfat depth, in	.34[c]	.39[cd]	.40[d]	.022
KPH, %	2.29	2.35	2.42	.058
Marbling Score[b]	5.34[d]	4.95[c]	5.39[d]	.131
Yield Grade	2.58	2.63	2.79	.100
>Ave. choice, %	15	8	20	
Low choice, %	49	43	35	
Select, %	36	48	43	
Standard, %	0	3	3	

[a]least squares means
[b]4.0 = slight; 5.0 = small
[c, d] means without common superscripts differ (P< .05)
[e, f] means without common superscripts differ (P<.10)

Table 5. Serum Urea-N Levels Across Treatment and Time[a]

	Treatment			
Day on Feed	LO	LHL	HI	Var
		SUN, mg/dl		
63	7.64[b]	9.83[c]	9.91[c]	3.055
91	8.14[b]	12.53[c]	12.75[c]	4.648
117	9.12[b]	8	12.43[c]	3.574

[a]least squares means
[b, c]means without common superscripts differ (P<.05)
*adjacent means differ (P=.06)

Table 6. Nitrogen Intake and Efficiency Differences Due to Treatment[a]

	Treatment			
	LO	LHL	HI	
	11%CP	11%/13%/11%CP	13%CP	SEM
Total N intake, lb	41.4[b]	47.3[c]	51.2[d]	.78
N Intake/100lb BW gain	9.89[b]	10.90[c]	11.33[c]	.255

[a]least squares means
[b, c, d] means without common superscripts differ (P<.01)