Digestibility of crude protein decreased only slightly (non-significant) by the addition of DPW but somewhat more with FPW. Using standard values for digestibility of the protein in the other ration ingredients, it was possible to estimate the protein digestibility for the test ingredient. These estimates were 66-75 percent for DPW protein and 55-59 percent for FPW protein. Thus, the fermentation processed in producing FPW decreased both the protein content and digestibility.

The Effect of a Variable Protein-Energy Ratio on Feedlot Performance and Carcass Traits of Steer Calves

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Story in Brief

Steer calves averaging 205 days in age were weaned and placed on two fairly high energy feedlot rations. One ration was formulated using the National Research Council recommendation of 8.1 percent digestible protein and the other ration was reduced from a high of 11.14 percent digestible protein to 8.00 percent digestible protein in steps throughout the course of the feeding period.

Feedlot gains on the variable protein ration were higher with the largest differences evident during the first third of the feeding period. These data suggest that the NRC recommendation of 8.1 percent digestible protein may not be adequate for young cattle on moderate to high energy rations. Feed efficiency, rate of gain, and cost of grain were all improved when comparing the variable protein ration to the ration formulated to the NRC recommendation.

Introduction

Protein requirements of feedlot cattle are mainly dependent on the weight and rate of gain of the cattle and on the energy density of the ration. Since feedlot cattle vary in weight and rate of gain through the feeding period, the protein requirements for maximum performance may also vary. Thus, perhaps total feedlot performance can be enhanced by supplying protein at a level necessary to support maximum growth and weight gain at each stage of the feeding period, rather than an average protein level over the entire feeding period.

This experiment trial was conducted to test a ration designed to supply digestible protein at a rate determined by the estimated level of gain of the cattle at 100 lb. weight increments throughout the feeding period. Estimated gain was calculated using probable feed intakes and calculating gain using the net energy equations of Lofgreen and Garrett 1968. The ration digestible protein for the variable protein ration was determined using the equation: total digestible protein, lbs.$=0.0040\ W^{0.75} + G \times 0.40$. In this formula, W is equal to the animal weight in pounds and G is the calculated average daily gain in pounds. This ration was compared to a ration formulated using the 1970 NRC recommendation of 8.1 percent digestible protein.

Materials and Methods

Experimental rations were formulated using the O.S.U. developed linear programming technique. Net Energy gain was held to a constant 57 megcalories Net Energy Gain per hundred weight on all rations. Table 1 shows the composition of the rations and Table 2 shows the composition of the pelleted supplement. The ration compositions are presented in Table 3. All ration compositions are expressed on a zero moisture basis. Care was taken to adjust the zero moisture basis formulas

Table 1. Ration Composition in Percent (Zero Moisture Basis)

Ingredient	NRC	Ration 500	Ration 600	Ration 700	Ration 800	Ration 900
Alfalfa hay	6.52	6.57	6.56	6.55	6.55	6.54
Cottonseed hulls	3.79	3.82	3.81	3.80	3.80	3.80
Fat (Beef tallow)	3.20	3.32	3.29	3.25	3.23	3.21
Rolled Milo	77.18	69.77	72.13	74.62	76.06	77.40
Molasses	4.08	4.07	4.06	4.05	4.05	4.05
Soybean Meal, 44%	.23	7.45	5.15	2.73	1.31	---
Supplement	5.00	5.00	5.00	5.00	5.00	5.00
Total	100.0	100.0	100.0	100.0	100.0	100.0

to the as fed moisture content of the feed commodities to accurately control ration composition. Dry ground milo was the main energy source used in the experimental ration and based on previous net energy trials, it was assigned an energy value of 90 meg. cals. NEm and 60 meg. cals. NEg. This would compare to values of 97 meg. cals. NEm and 64 meg. cals. NEg for the steam flaked milos used in many commercial feedlots.

On the variable protein levels, cattle were started on the 500 level ration and were changed to the 600 level when the animals weighed an estimated 600 lbs., to the 700 level at 700 lbs. etc. When the variable protein lot reached the 900 level, no further reduction of protein was made to simplify feed mixing procedure. The steers on the NRC ration Lot was held on a constant ration with 8.1 percent digestible protein

Table 2. Pelleted Supplement Composition (Zero Moisture Basis)

Ingredient	Percent Composition
Ground Milo	48.665
Urea 45% Nitrogen	13.000
Salt	6.000
Calcium Carbonate	13.000
Stilbesterol 2 gram/lb.	.700
Vitamin A 30,000 IU/gram	.210
Aureomycin 10 gram/lb.	1.425
Soybean meal 44%	17.000
Total	100.00

Table 3. Calculated Composition of Experimental Rations (Zero Moisture Basis)

Component	NRC	Ration 500	Ration 600	Ration 700	Ration 800	Ration 900
Energy, maint. meg-cal/cwt.	88.97	88.98	88.98	88.97	88.97	88.97
Energy, gain meg-cal/cwt.	57.00	57.00	57.00	57.00	57.00	57.00
Crude Protein (total)	11.76	14.88	13.89	12.84	12.22	11.66
Protein from Urea	1.83	1.83	1.83	1.83	1.83	1.83
Digestible Protein	8.10	11.14	10.17	9.15	8.55	8.00
Ether Extract	6.28	6.25	6.25	6.27	6.28	6.29
Crude fiber	6.43	7.22	6.96	6.70	6.54	6.40
Potassium	.69	.82	.78	.73	.71	.68
Calcium	.46	.46	.46	.46	.46	.46
Phosphorus	.34	.34	.34	.34	.34	.34
Total	100.0	100.0	100.0	100.0	100.0	100.0

throughout the trial. Stilbestrol was removed from the supplement for the required 7 day withdrawal before slaughter.

The 69 choice angus steers initially alloted to the experiment were the progeny of eight sires involved in a progeny testing program as a part of the cattle breeding project. In order to maintain valid progeny test comparisons between sires, half of each sire group was randomly alloted to each treatment group. The steers were weaned at an average of 205 days at the Lake Carl Blackwell range where they had been maintained with their dams without creep. At weaning, they were transported to the Fort Reno Livestock Research Station, where they were placed immediately on feed in two adjoining pens that opened to the South from a feeding barn. One steer died during the experiment and only data from the 68 steers completing the experiment were analyzed.

The actual weaning weights obtained at the Blackwell Range were used as the initial test weights even though the average shrink to the feeding site in previous years averaged about nine percent. The cattle were trucked to the feeding site and placed immediately on feed in the two feed pens in order to avoid some of the problems which frequently result when cattle are held off feed and water for extended periods of time. The test rations were diluted with a decreasing amount of cotton hulls such that they were on full feed on the experimental ration in about ten days. Rations were fed using self feeders.

Results and Discussion

Both pens of steers started on feed without any digestive or health problems. As indicated by the 43 and 79 day weights, the lot on the variable protein ration gained significantly faster during the first part of the test. The feedlot performance and carcass data are presented in Table 4. Steers were slaughtered at 191 and 216 days on test in order to slaughter the steers as they reached the choice grade. An equal number of the fattest steers were selected from each of the two lots for the 191 day kill and the remainder were killed at 216 days. Statistical analysis of the data showed no interaction between the kill date and the experimental treatments, even though the cattle selected for the first kill gained much more rapidly than did the remainder. Data were pooled over the two slaughter periods for presentation on the results.

The steers on the variable protein ration significantly outgained the steers on the NRC constant protein ration by 0.17 lbs. per day ($P<.05$). Most of this increased rate of gain occurred during the first half of the feeding period as evidenced by 21 and 37 lbs. more gain by the variable protein steers during the first 43 and 79 days on test, respectively. Although the daily feed consumptions were similar for the two rations,

Table 4. Feedlot Performance and Carcass Data

Trait	Feedlot Ration		Pooled Std. Deviation
	NRC	Variable Protein	
Number of steers	35	33	
Feedlot Data:			
Initial weight, lbs.	487	490	47.1
First 43 day gain, lbs.	92	113*	30.7
First 79 day gain, lbs.	214	251*	34.4
Average daily gain, lbs.	2.77	2.94*	0.323
Final weight,[1] lbs.	1014	1050	84.4
Avg. daily feed,[2] lbs.	19.5	19.9	
Feed conversion,[2] lbs. feed/lb. gain	7.05	6.79	
Feed cost per lb. of gain (cents)	17.12	16.88	
Carcass Data:			
Carcass weight, lbs.	640	655	54.3
Dressing percent, %	63.1	62.4	
Kidney, heart and pelvic fat, %	3.2	3.3*	0.46
Carcass grade[3]	10.5	10.5	3.57
Ribeye area, sq. in.	12.2	11.9	1.03
Ribeye area/cwt., carcass wt.	1.91	1.81*	0.193
Marbling score[4]	5.60	5.67	1.02
Fat thickness, in.	0.91	1.07**	0.227
Cutability (%)[5]	49.2	48.0**	1.72

[1] Final weight shrunk 4%.
[2] Expressed on an as fed basis.
[3] USDA carcass grades converted to the following numberical designations: high choice 12; ave. choice 11; low choice 10; high good 9.
[4] Marbling score equivalents: modest=6; small=5; slight=4.
[5] Estimated percentage boneless retail cuts from round loin rib and chuck.
*Means significantly different at the 0.05 probability level.
**Means significantly different at the 0.01 probability level.

the variable protein steers gained sufficiently more rapidly to reduce the amount of feed required per lb. of gain by 0.26 lbs. The steers on the variable protein ration had 0.16 in. more fat cover ($P<.01$) and 0.1 percent more kidney, heart and pelvic fat ($P<.01$). In spite of this increased external fat, there was no difference in the marbling score for the two groups of steers. Thus, there was not any difference in carcass grade. The increased fat cover did, however, result in a 1.2 percent reduction in estimated cutability ($P<.01$) for the variable protein ration steers.

Steers fed the variable protein ration consumed more soybean than did the steers on the NRC ration. (See Table 1) In total, they consumed an average of 76 lbs. per head more of soybean meal than did the NRC lot. At the time this experiment was conducted, soybean meal cost $4.50 per Cwt. and ground milo ready to feed cost $2.25 per Cwt. thus the substitution of soybean meal for milo in these rations cost $1.71 per head for the duration of the test.

Feed only costs including shrinkage and processing were $17.12 per Cwt. on the NRC ration and $16.88 per Cwt. on the variable protein ration[1]. Cattle on the variable protein ration made more rapid gains, had a slightly better feed conversion ration 6.79 vs. 7.05 on an as fed basis and a lower cost than the steers on the NRC ration. Because the gain defferences were largest early in the test, and, because the variable protein cattle were fatter at slaughter time they might have exhibited even larger advantage in terms of rate and efficiency of gain had they been killed at an equal slaughter weight with the NRC cattle.

All rations contained 0.65 percent feed grade urea. Rations 500, 600, and 700, with soybean meal may have failed to have had sufficient urea fermentation potential for good utilization of the urea nitrogen based on the formula proposed by Burroughs et al 1972. Additional investigation will be required to resolve the question of this possibility.

The results of the trial suggest that additional protein above the NRC recommendation may be desirable for young light weight cattle during the first part of the feeding period when using high energy rations.

[1] Ration cost per hundred (dry)

NRC -	$2.43
500	2.60
600	2.55
700	2.49
800	2.45
900	2.42

References

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