1976

Roughage Quality and Protein Supplementation with High-Concentrate Rations for Finishing Cattle

R. N. Gates
South Dakota State University

L. B. Embry

South Dakota State University
Brookings, South Dakota

Department of Animal Science
Agricultural Experiment Station

A.S. Series 76-13

Roughage Quality and Protein Supplementation with High-Concentrate Rations for Finishing Cattle

R. N. Gates and L. B. Embry

Feedlot cattle have been shown to make high rates of gain with low feed requirements when fed all-concentrate rations during finishing periods up to 6 months or more. However, some roughage has frequently been reported to improve weight gain and to reduce digestive problems associated with all-concentrate rations. Roughage levels of 8 to 10% have appeared adequate for these purposes and are considered to be about optimum on basis of weight gain and feed efficiency. Questions are often raised as to the importance of roughage quality when included in rations at these low levels.

It has been shown on several occasions in recent years that many finishing rations for feedlot cattle over 750 lb. do not benefit from protein supplementation. Numerous experiments during past years have been devoted to determining protein requirements for growing and finishing cattle. Requirements appear to have been determined rather accurately, and the amount needed in the ration is determined largely by the amount of various feeds consumed, digestibility and quality of proteins in the feeds, size of cattle and rate of production. These factors should be considered in determining the need for supplemental protein with various types of growing and finishing rations.

The objectives of this experiment were to determine the benefits of low levels of roughage in comparison to all-concentrate rations for finishing cattle, the importance of roughage quality when fed at low levels and the need for supplemental protein under the various conditions of roughage level and quality.

Procedures

Steers for the experiment had been used previously in a growing experiment for 138 days. They were fed corn silage with variations in level and source of supplemental protein. Upon completion of the growing experiment, all steers were fed a ration which consisted of 5 lb. of high-moisture corn grain and a full feed of alfalfa haylage for a period of 6 weeks. Changing over to an all-concentrate ration was then accomplished over a period of 2 weeks by gradual reductions in the alfalfa haylage and increases in corn grain. Following 4 days of feeding all-concentrate rations, the steers (108 Hereford-Angus and 36 Angus) were allotted on the basis of weight and breed group to 24 pens of 6 each.

Dietary treatments were an all-concentrate control, control plus 2 lb. daily of wheat straw for a poor quality roughage and control plus 2 lb. of bromegrass-alfalfa hay for a good quality roughage. Each of these rations was fed with or without supplemental protein, resulting in the six dietary treatments. Each treatment was fed to four pens of steers with high-moisture corn fed to appetite.

The wheat straw contained 4.52% protein, dry basis, and the bromegrass with a light mix of alfalfa contained 12.35% protein, dry basis. Each roughage was chopped with a forage chopper set for the finest cut possible.

The corn grain was purchased as dry corn. It was stored in an oxygen-limiting silo with water added as it was blown into the silo, resulting in an average moisture content as fed of 21.5%. The protein content averaged 11.5%, dry basis, which exceeds NRC requirements for feedlot steers weighing over 770 pounds. The silage blower resulted in considerable cracking of the grain, and no further processing was used. Average protein content of the all-concentrate control ration was 11.3%. The average protein content of the rations over the entire experiment was reduced approximately 0.7 percentage unit by addition of wheat straw and increased 0.1 percentage unit or less by the bromegrass-alfalfa hay. Protein supplementation resulted in an increase of about 0.7 percentage unit.

A soybean meal based supplement (17% protein, dry basis) was fed at 2 lb. per head daily to steers that received supplemental protein. Cattle that received no supplemental protein were fed 2 lb. per head daily of a corn based supplement which provided the same levels of added minerals, vitamin A, vitamin E and chlortetracycline as the soybean meal supplement. The soybean meal supplement was formulated so that the ration with wheat straw and soybean meal supplement would be about equal in protein content to the ration with bromegrass-alfalfa hay and corn supplement. Ingredient composition of the supplements is shown in table 1.

Table 1. Ingredient Composition of Supplements

Ingredient	SBOM supplement	Corn supplement
	%	%
Corn	44.46	73.03
SBOM (44%)	28.57	---
Limestone	9.93	9.93
Dicalcium phosphate	6.94	6.94
Potassium chloride	6.60	6.60
Trace mineral salt	3.30	3.30
Trace mineral premix	0.20	0.20
Vitamin A premix (30,000 IU/g)	added at rate of 10,000 IU/lb. of supplement	
Vitamin E premix (500 IU/g)	added at rate of 150 IU/lb. of supplement	
Aureomycin-10	added at rate of 35 mg of CTC/lb. of supplement	

Four implant treatments were superimposed over dietary treatments. Implant treatments were balanced with regard to dietary treatments with one pen each of the four serving as nonimplanted controls or implanted with 36 mg diethylstilbestrol (DES), 36 mg zeranol (RAL) or Synovex-S (20 mg estradiol benzoate and 200 mg progesterone).

Feeding was once daily and water was available continuously from automatic waterers. Animals were confined to outside, concrete-paved pens without access to shade or shelter.

Weights were taken at 4-week intervals in early morning before feeding. In addition, initial and final weights were taken following an overnight stand (about 17 hr.) without feed and water. The experiment was terminated after 140 days, animals marketed and carcass data obtained.

Results

There were no apparent interactions between implant treatments and dietary treatments. Therefore, results for dietary treatments presented in the tables were averaged across implant treatments.

Feed Intake

Average daily feed intake accumulated to date by weigh periods is presented in table 2. In all instances, daily feed intake increased with increasing weights and time on the experiment.

Table 2. Cumulative Feed Intake by Weigh Periods as Affected by Roughage Source and Protein Supplement

Roughage	All-concentrate		Wheat straw		Brome hay	
Supplement	Corn	SBOM	Corn	SBOM	Corn	SBOM
No. of animals	24	23[a]	24	24	24	24
Init. shrunk wt., lb.	681	687	677	678	679	679
Final shrunk wt., lb.	1099	1111	1023	1068	1084	1109
Avg. daily feed, lb.						
28 days	14.53	15.05	16.83	16.23	16.21	17.80
56 days	17.92	18.29	19.74	21.23	19.52	21.33
85 days	20.12	20.57	21.84	23.68	22.16	23.76
113 days	21.14	21.52	22.95	24.30	23.41	24.74
140 days	21.65	21.92	23.19	24.73	24.08	25.22
Avg. protein content during expt., %	11.3	12.1	10.7	11.4	11.4	12.1

[a]One loss occurred not believed to be related to experimental diet. Results presented in all tables are averaged for 23 head for this treatment.

Without supplemental protein, steers fed wheat straw consumed an average of 1.5 to 2.3 lb. more feed daily than steers fed the all-concentrate ration. The greatest difference in feed intake between these two groups occurred during the first month of the experiment. After the first month, steers fed wheat straw consumed more total feed but slightly less concentrates (grain and supplement) than those fed the all-concentrate ration.

With supplemental protein, steers fed wheat straw consumed more total concentrates (0.8 to 1.1 lb. daily) than the all-concentrate group at each weigh period except the first one. The data show that supplemental protein had only a minor effect on feed intake with the all-concentrate ration. However, there was a substantial improvement in feed intake from protein supplementation with wheat straw, amounting to 1.3 to 1.8 lb. daily at various periods after the first month.

There was also an improvement in feed intake from feeding of the bromegrass-alfalfa hay in comparison to the all-concentrate rations. The increase over the all-concentrate ration was greater with supplemental protein. Hay was consumed more readily than the straw. However, there were only slight differences in total feed intake between the hay and straw except for a slight advantage for hay near the end of the experiment.

Weight Gain

Weight gains to date by weigh periods are presented in table 3. The 140-day adjusted average daily gain is on basis of the initial shrunk weight and a final weight based on carcass weight, with live weight adjusted to a carcass yield of 62%.

Table 3. Cumulative Weight Gains by Weigh Periods as Affected by Roughage Source and Protein Supplement

Roughage	All-concentrate		Wheat straw		Brome hay	
Supplement	Corn	SBOM	Corn	SBOM	Corn	SBOM
No. of animals	24	23	24	24	24	24
Init. shrunk wt., lb.	681	687	677	678	679	679
Final shrunk wt., lb.	1099	1111	1023	1068	1084	1109
Avg. daily gain, lb.						
28 days	2.22	2.98	2.83	3.16	2.91	3.59
56 days	2.62	3.19	2.64	3.39	2.95	3.40
85 days	2.92	2.98	2.71	3.22	3.00	3.35
113 days	3.02	3.19	2.74	3.06	2.97	3.22
140 days (filled)	3.02	3.08	2.51	2.90	2.95	3.21
140 days (adjusted)	3.08	3.08	2.56	2.95	2.99	3.22

Weight gain during the first month of the experiment when increasing the animals to a full feed was lowest for the all-concentrate ration without supplemental protein. There was considerable improvement for this treatment group after the first month. These cattle had weight gains nearly equal to the all-concentrate group with supplemental protein by end of the third month. There was no advantage for the supplemental protein with all-concentrate rations on the basis of weight gain at the end of the 140-day experiment.

Wheat straw resulted in a marked increase in weight gain during the first month on experiment in comparison to the all-concentrate ration when fed without supplemental protein. After this time, wheat straw without supplemental protein resulted in reduced weight gains.

Wheat straw with protein supplementation resulted in higher weight gains than the comparable all-concentrate ration during the first 3 months of the experiment. Thereafter, these cattle gained at a lower rate than the all-concentrate group with supplemental protein.

There was also a substantial improvement in weight gain from bromegrass-alfalfa hay in comparison to the all-concentrate ration fed without supplemental protein during the first month of the experiment. These cattle fed hay gained at a rather uniform rate throughout the experiment rather than showing a later increase as did the all-concentrate group. After the second month there appeared to be essentially no advantage for the hay on the basis of weight gain.

Supplemental protein with the hay appeared to provide about as much benefit as with the all-concentrate ration during the first 2 months of the experiment. The initial advantage in total gain from supplemental protein with hay was slightly improved during the experiment in contrast to a loss of the initial advantage after about 3 months with the all-concentrate ration.

In direct comparisons between rations with straw or hay, straw was inferior to hay. The difference between rations with straw or hay was less with supplemental protein. Rations with straw and supplemental protein resulted in slightly higher rates of gain during the first 3 months of the experiment than did rations with the hay and no supplemental protein. These rations were approximately equal in total protein content. Over the 140-day experiment, similar weight gains were obtained with these two rations.

Feed Efficiency

Data on feed efficiency are presented in table 4. Feed required per unit of gain increased with increasing time on experiment and weight of the cattle. As would be expected from data presented on feed intake and weight gain, feed to gain ratios were improved by roughage additions during the early part of the experiment. After the first or second month, total feed requirements were higher for rations with roughages. Requirements were increased more with straw than with hay.

Table 4. Cumulative Feed Efficiency by Weigh Periods as Affected by Roughage Source and Protein Supplement

Roughage	All-concentrate		Wheat straw		Brome hay	
Supplement	Corn	SBOM	Corn	SBOM	Corn	SBOM
No. of animals	24	23	24	24	24	24
Init. shrunk wt., lb.	681	687	677	678	679	679
Final shrunk wt., lb.	1099	1111	1023	1068	1084	1109
Feed/gain ratio						
28 days	6.81	5.25	6.09	5.16	5.57	5.01
56 days	6.93	5.74	7.51	6.27	6.67	6.29
85 days	6.89	6.92	8.07	7.37	7.41	7.08
113 days	7.00	6.75	8.39	7.96	7.91	7.69
140 days (filled)	7.16	7.12	9.25	8.50	8.19	7.83
140 days (adjusted)	7.05	7.13	9.08	8.42	8.09	7.84

Protein supplementation improved feed efficiency with all rations during the first 2 months of the experiment. After this time, there was essentially no improvement in feed efficiency from protein supplementation of the all-concentrate ration. Protein supplementation of rations with straw or hay improved feed efficiency with the effect being more pronounced with straw than with hay.

Feed to gain ratios shown by components of the rations for the entire experiment are shown in table 5. Without protein supplementation, requirements for concentrates were increased by feeding straw or hay. This increase was greater for straw than for hay. Feed requirements as concentrates were also increased by feeding straw or hay when rations contained the soybean meal supplement. The increase was less than for rations without supplemental protein but again greater for rations with wheat straw.

Table 5. Feed to Gain Ratio After 140 Days

Roughage	All-concentrate		Wheat straw		Brome hay	
Supplement	Corn	SBOM	Corn	SBOM	Corn	SBOM
Final shrunk wt., lb.	1099	1111	1023	1068	1084	1109
Adjusted avg. daily gain, lb.	3.08	3.08	2.56	2.95	2.99	3.22
Feed to gain ratio						
Corn grain	6.41	6.49	7.53	7.08	6.76	6.63
Supplement	0.64	0.64	0.77	0.67	0.66	0.61
Wheat straw or brome hay	---	---	0.77	0.67	0.67	0.62
Total	7.05	7.13	9.07	8.42	8.09	7.86

The value of straw in comparison to the hay can be estimated from the feed requirement data (table 5). Without protein supplementation, 100 lb. of wheat straw plus 114 lb. of concentrates (corn and corn supplement) were equal to 87 lb. of the hay. It is evident that wheat straw would not be an economical substitute for hay of the quality used under these conditions. With protein supplementation, 100 lb. of the straw plus 67 lb. of corn and 9 lb. of the supplement were equal to 93 lb. of the hay. While more favorable for straw under this condition than without protein supplementation, wheat straw would not likely be an economical substitute for hay of the quality used under conditions as in this experiment. The value of the wheat straw ration might have been improved by a higher level of protein supplementation. Under such conditions, straw would have to be enough cheaper than hay to justify the cost of the additional protein supplementation.

Carcass Data

Carcass data are shown in table 6. Carcasses were graded under the system in use during the fall of 1975. All treatment groups had carcasses grading within the range of low to average Choice. While there were some small differences in carcass characteristics measured, there appeared to be no consistent effects from roughage treatments or protein supplementation other than those associated with weight gain and carcass weight.

Table 6. Carcass Data

Roughage	All-concentrate		Wheat straw		Brome hay	
Supplement	Corn	SBOM	Corn	SBOM	Corn	SBOM
Hot carcass wt., lb.	689	693	641	676	680	700
Marbling[a]	5.7	6.3	5.9	6.5	6.2	6.0
Carcass grade[b]	19.4	19.8	19.6	20.0	19.7	19.6
Percent kidney fat	2.2	2.4	2.7	2.7	2.4	2.3
Rib eye area, sq. in.	11.45	11.47	11.28	10.92	11.15	11.52
Fat thickness, in.	0.71	0.72	0.62	0.74	0.67	0.74

[a]Moderate = 7, modest = 6, small = 5.
[b]Prime = 23, Choice = 20, Good = 17. Graded to one-third grade.

Summary

One hundred forty-four steers averaging about 680 lb. initially were fed for 140 days to determine the benefits of a low level of roughage in comparison to all-concentrate rations, the importance of the quality of roughage when fed at low levels and the need for protein supplementation under the various conditions of roughage level and quality. All-concentrate rations were compared to those with 2 lb. of wheat straw for the low quality roughage and 2 lb. of bromegrass-alfalfa hay for the good quality roughage. All rations were fed with and without supplemental protein. Average protein contents for the entire

experiment were 11.3, 10.7 and 11.4%, respectively, for all-concentrate, wheat straw and hay rations fed without supplemental protein and 12.1, 11.4 and 12.1% when fed with supplemental protein.

Roughage additions and protein supplementation improved feed intake, weight gain and feed efficiency during the first 1 or 2 months of the experiment. Only with wheat straw did there appear to be an advantage for supplemental protein throughout the experiment. Cattle fed all-concentrate rations with or without supplemental protein had the same weight gain and about the same feed efficiency over the entire experiment. The apparent advantage for the supplemental protein for cattle fed the hay could be attributed largely to the improved performance during the early part of the experiment.

Feeding wheat straw without protein supplementation reduced weight gains and increased feed requirements. While performance was improved with supplemental protein, weight gains were slightly lower than for cattle fed the all-concentrate ration and total concentrate requirements were higher.

Feeding bromegrass-alfalfa hay without supplemental protein resulted in no improvement in weight gains over the all-concentrate ration for the entire experiment with a higher requirement for concentrates. While overall weight gains were higher with protein supplementation, there was no reduction in requirement for total concentrates by feeding hay.

In direct comparisons between straw and hay, straw was inferior to the hay. Cattle performance was improved more by protein supplementation with straw than with hay. There were only small differences between cattle fed straw with supplemental protein and cattle fed the hay without supplemental protein. Under such conditions, straw could be an economical substitute for hay if the price was enough lower than for hay to justify the additional supplemental protein.

Dietary treatments appeared to have no consistent effect on carcass characteristics measured except as influenced by weight gain and carcass weight.