2009

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Summary

Six ruminally cannulated steers were used in a 6 x 6 Latin square with treatments arranged as a 2 x 3 factorial with alfalfa hay or cornstalks included at a normal, low or zero level on an equal neutral detergent fiber (NDF) basis. The base finishing diet contained 30% wet distillers grains plus solubles (WDGS). No source x level interactions were observed. Roughage source had no effect on nutrient intake, dry matter (DM) and organic matter (OM) digestibility or ruminal pH. Digestibility of NDF tended to be higher for alfalfa hay compared to cornstalks. Ruminal pH, DMI and NDF intake increased linearly while nutrient digestibility decreased linearly as roughage level increased. These data indicate that in finishing diets containing 30% wet distillers grains plus solubles (WDGS) roughages can be exchanged on an equal NDF basis and it is not beneficial to completely eliminate roughage sources from the diet.

Introduction

Roughages have been used to control acidosis in feedlot diets. However, corn-milling byproducts may help manage acidosis, suggesting roughages may be reduced or eliminated. Roughage source and level were evaluated and compared to no roughage inclusion in finishing diets containing 30% (DM basis) WDGS (*2007 Nebraska Beef Report*, pp. 29-32). Higher roughage levels increased DMI and average daily gain (ADG), and elimination of roughage resulted in decreased DMI and ADG. Diets containing no roughage or low levels of cornstalks tended to have the lowest feed-to-gain ratio (F:G). Overall, the previous study indicated that at high roughage levels, sources can be exchanged on an equal NDF basis in diets containing 30% WDGS. The objectives of the current study were to determine the effects of roughage source and level on nutrient digestion and ruminal fermentation characteristics.

Procedure

Six ruminally cannulated steers (BW = 762 lb) were used in a 6 x 6 Latin square to determine the effects of roughage source and level in feedlot diets containing WDGS. Treatments were arranged as a 2 x 3 factorial treatment structure with alfalfa hay included at 0%, 4% or 8% and cornstalks included at 0%, 3% or 6% on a DM basis (Table 1). Alfalfa and cornstalks averaged 57.2% and 78.8% NDF, respectively, and dietary treatments were balanced to provide equal percentages of NDF from roughage at each level. All diets contained a mixture of dry-rolled and high-moisture corn fed at a 1:1 ratio and 30% WDGS (DM basis).

Periods were 14 days in length, including a 9-day adaptation period followed by a 5-day collection period to measure ruminal digestibility, fermentation, pH and DMI. Steers were fed individually in pens during the adaptation period and moved into stanchions on day 9 for the collection period. Steers were fed once daily at 0730, and feed refusals were collected daily if present. Chromic oxide (7.5g/dose) was used as an indigestible marker for estimating fecal output and was dosed intraruminally at 0700 and 1900 daily from day 6 through day 14 of each period. Fecal grab samples were collected three times daily during the collection period at 0, 6 and 12 hours post-feeding. Feed intake patterns and ruminal pH measurements were collected as described in the *1998 Nebraska Beef Report,* pp. 71-75. Feed intake measurements included DMI, number of meals per day, total time spent eating and intake rate. Ruminal pH measurements included average, maximum and minimum pH, magnitude of pH change, pH variance, time spent below pH 5.6 and 5.3, and area of pH below 5.6 and 5.3 (time below x magnitude below). Feed ingredients, feed refusals and

(Continued on next page)

Table 1. Composition of finishing diets.[1]

Roughage Source	Alfalfa			Cornstalks		
Roughage Level[2]:	0	4	8	0	3	6
DRC[3]	32.50	30.50	28.50	32.50	30.98	29.46
HMC[3]	32.50	30.50	28.50	32.50	30.98	26.46
WDGS[3]	30.0	30.0	30.0	30.0	30.0	30.0
Alfalfa hay	—	4.00	8.00	—	—	—
Cornstalks	—	—	—	—	3.04	6.08
Dry supplement[4]	5.0	5.0	5.0	5.0	5.0	5.0
Roughage NDF, %[5]	0.00	2.62	5.25	0.00	2.56	5.11

[1]Values presented on a DM basis.
[2]Percent of diet DM.
[3]DRC = dry-rolled corn; HMC = high-moisture corn; WDGS = wet distillers grains plus solubles.
[4]All diets were formulated to contain a minimum of 0.65 % Ca, 0.60% K, 360 mg/steer daily Rumensin®, 90mg/steer daily Tylan® and 130mg/steer daily thiamine.
[5]NDF supplied from roughage source included in the diet.

Table 2. Main effects of roughage source and level on nutrient intake and digestibility.

	Roughage Source		Roughage Level[1]				*P*-Value[2]		
Item	Alfalfa	Cornstalks	0	3-4	6-8	SEM	Source	Lin.	Quad.
Nutrient Digestibility									
DM									
Intake, lb/day	20.9	20.6	19.4	20.9	21.9	1.4	0.73	0.05	0.83
Digestibility, %	84.4	83.3	86.9	82.7	81.9	0.1	0.30	< 0.01	0.14
OM									
Intake, lb/day	20.5	19.4	19.1	20.5	20.2	0.60	0.23	0.33	0.37
Digestibility, %	85.5	84.5	88.1	84.0	82.9	0.1	0.35	< 0.01	0.18
NDF									
Intake, lb/day	5.04	4.75	4.20	5.04	5.43	0.15	0.19	< 0.01	0.30
Digestibility, %	75.9	72.9	77.3	73.1	72.8	0.1	0.10	0.06	0.31
Intake Patterns									
Meals/day	11.7	12.5	12.1	12.5	11.8	0.7	0.18	0.57	0.37
Time eating/day, minutes	572	573	570	587	561	27	0.93	0.72	0.28
Rate, %/hour	18.9	18.4	18.3	17.3	20.3	1.4	0.77	0.32	0.22

[1]Percent of diet DM.
[2]No differences ($P > 0.20$) due to roughage source x level interaction; Source = main effects of alfalfa versus cornstalks; Lin.= contrast for the linear effect of roughage inclusion level; Quad. = contrast for the quadratic effect of roughage inclusion level.

Table 3. Main effects of roughage source and level on ruminal pH.

	Roughage Source		Roughage Level[1]				*P*-Value[2]		
Item	Alfalfa	Cornstalks	0	3-4	6-8	SEM	Source	Lin.	Quad.
Average pH	5.48	5.52	5.31	5.49	5.70	0.12	0.74	0.01	0.93
Maximum pH	6.14	6.19	5.93	6.11	6.45	0.13	0.73	0.01	0.57
Minimum pH	4.82	4.94	4.47	5.10	5.08	0.22	0.59	0.05	0.17
pH change	1.31	1.24	1.45	1.01	1.37	0.25	0.87	0.80	0.16
pH variance	0.068	0.079	0.064	0.054	0.102	0.025	0.70	0.27	0.33
Time < 5.6, min/day	907	884	1116	919	652	168	0.89	0.02	0.81
Area < 5.6, min/day[3]	331	351	486	343	195	122	0.80	0.01	0.98
Time < 5.3, min/day	511	519	741	519	285	215	0.95	0.01	0.97
Area < 5.3, min/day[3]	119	139	208	123	56	67	0.65	0.02	0.84

[1]Percent of diet DM.
[2]No differences ($P > 0.26$) due to roughage source x level interaction; Source = main effects of alfalfa versus cornstalks; Lin.= contrast for the linear effect of roughage inclusion level; Quad. = contrast for the quadratic effect of roughage inclusion level.
[3]Area below pH of 5.6 or 5.3 is calculated as time below x magnitude below.

fecal samples were freeze-dried for analysis to calculate nutrient digestibility.

Data were analyzed as a 2 x 3 factorial treatment arrangement and Latin square experimental design using the MIXED procedure of SAS. Period was included in the model as a fixed effect, and the random effect was steer. Orthogonal contrasts were used to detect linear and quadratic relationship for the main effect of roughage level if no interaction was detected. If an interaction occurred, only simple effects were tested.

Results

There were no effects on nutrient intake or digestibility due to roughage source x level interactions ($P > 0.20$); therefore, all nutrient intake and digestibility data are presented showing only main effects of roughage source and level (Table 2). There were no differences ($P > 0.18$) for nutrient intake and digestibility between alfalfa hay and cornstalks except for NDF digestibility, which tended to be higher ($P = 0.10$) for alfalfa hay (75.9%) compared to cornstalks (72.9%). Increasing roughage level resulted in a linear increase ($P = 0.05$) in DMI (19.4 lb to 21.9 lb) and NDF intake (1.91 lb to 2.47 lb). Organic matter intake was similar among roughage levels. As roughage level increased, there was a linear decrease in DM (86.9% to 81.9%), OM (88.1% to 82.9%) and NDF (77.3% to 72.8%) digestibility. There were no effects on intake patterns due to roughage source, roughage level or roughage source x level interaction. For alfalfa hay and cornstalks, intake rate was 18.9% and 18.4%, respectively. Intake rate was 18.3%, 17.3% and 20.3% for zero, low and high roughage inclusion levels, respectively.

There were no effects of roughage source or roughage source x level interaction on ruminal pH, so only main effects of roughage source and roughage level are presented in Table 3. For alfalfa hay and cornstalks, ruminal pH averaged 5.48 and 5.52, respectively. Ruminal pH ranged from 4.82 to 6.14 for alfalfa hay and from 4.94 to 6.19 for cornstalks. Average, maximum and minimum ruminal

pH increased linearly ($P = 0.01$) due to increasing roughage levels. The pH change or the difference between maximum and minimum pH, as well as pH variance remained fairly constant across roughage levels. Time spent below pH 5.6 or 5.3 and area below 5.6 and 5.3 both decreased linearly ($P < 0.03$) due to increasing roughage levels. A ruminal pH below 5.6 is defined as subacute acidosis. For steers consuming diets containing 0% roughage, ruminal pH was below 5.6 for 1116 minutes/day and below 5.3 for 731 minutes/day. That corresponds to over 18 hours a day that these steers experienced subacute acidosis, and over 12 hours a day were spent at a pH of less than 5.3. When roughage levels were increased to 3-4% and 6-8%, time spent below pH 5.6 was reduced 18% and 42%, respectively.

In conclusion, roughage source did not affect ruminal metabolism or intake patterns. These results agree with observations made in the previous finishing trial and indicate roughages can be exchanged on an equal NDF basis in finishing diets containing 30% WDGS. Nutrient intake and ruminal pH increased linearly due to increasing roughage levels while nutrient digestibility decreased linearly. When 0% roughage was included in the diet, DMI and ruminal pH were markedly reduced, compared to diets containing 3-8% roughage, which is in agreement with observations made in the previous finishing trial. These results further support the finding that it is not beneficial to completely eliminate roughage sources from a finishing diet containing 30% WDGS (DM basis).

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