Effects of Roughage Source and Particle Size on Performance and Carcass Characteristics of Finishing Heifers

C.E. Markham, C.R. Krehbiel, L.O. Burciaga, D.R. Gill, R.E. Peterson, H.A. DePra, and L.J. McBeth

Story in Brief

In Experiment 1, one hundred crossbred heifers were fed to evaluate the effects of roughage source and particle size on feedlot performance and carcass characteristics. In Experiment 2, 4 ruminally cannulated steers were fed to determine the effects of roughage source and particle size on chewing behavior and ruminal pH. Both steers and heifers were fed finishing diets with either cottonseed hulls or alfalfa hay as the roughage source at equal concentrations of NDF (% of DM). Alfalfa hay was included at 12% of diet DM either coarsely chopped or ground through a 1.3-cm screen. Cottonseed hulls were included at 4.5% of diet DM either unprocessed or pelleted. No differences were observed for any of the performance or carcass traits measured in Exp. 1. In Exp. 2, no differences were observed between treatments for chewing time. However, a significant (P=.05) treatment x time interaction was observed for ruminal pH. Steers fed cottonseed hulls had a greater decrease in ruminal pH over time than steers fed alfalfa. These results indicate that different roughages may be substituted at equal levels of NDF without adversely affecting intake or performance. This is supported by chewing response. Additionally, our data suggest that particle size is not a useful measure of roughage value for feedlot diets.

Key Words: Roughage Source, Particle Size, Feedlot Cattle

Introduction

Feedlot cattle are commonly finished on high-concentrate diets to maximize efficiency and minimize cost of gain. Roughages are typically included in finishing rations, at minimal levels, to reduce digestive upset and maintain healthy digestive tract function. Neutral detergent fiber (NDF) has been identified (Welch and Smith, 1970) as the critical component of roughages involved in stimulating chewing and salivation, leading to rumen buffering. Mertens (1997) recognized that NDF alone does not account for all the variation in chewing, and developed a system to account for physical factors that affect roughage value of dairy rations. However, recent research with finishing cattle (Calderon-Cortez and Zinn, 1996, and Shain et al., 1999) indicates that particle size is not an important factor in determining the value of roughages included in feedlot diets. Other research (Defoor et al., 2002) indicates that NDF from roughage may be the most useful roughage index for balancing finishing diets.

Materials and Methods

Animals and Diets - Experiment 1. One hundred crossbred heifers (initial BW=364±10.5 kg) were received at Willard Sparks Beef Cattle Research Center, Stillwater, OK, and placed on feed on May 15, 2002. Upon arrival all heifers were vaccinated for respiratory disease (Bovi-Sheild™ 4), treated for internal and external parasites with Ivomec Plus®, and implanted with Synovex® Plus. Following processing, heifers were offered ad libitum access to a 55% concentrate receiving ration during a 13-d acclimation period. After the acclimation period, the

heifers were blocked by weight and randomly allotted to one of four treatment diets. Treatment diets contained one of two roughage sources (cottonseed hulls or alfalfa hay) at equal concentrations of NDF (Table 1), and two physical forms within each roughage source. Alfalfa hay, from a single source of square bales, was included at 12% of diet DM either coarsely chopped using a Rotomix® bale processor (AC), or finely ground though a hammer mill equipped with a 1.3-cm screen (AF). Cottonseed hulls were included at 4.5% of diet DM, either unprocessed (CSH), or as a 0.64 cm pellet (PCSH). All diets were formulated to be isonitrogenous and isocaloric and meet NRC requirements for growing heifers. Heifers were offered ad libitum access to diets for the entire feeding period (103 d). Following the 103-d feeding period, heifers were harvested at Iowa Beef Packers, Emporia KS, and carcass data were collected by trained personnel from Oklahoma State University.

Table 1. Composition of diets, DM basis

	Treatment	
Ingredients, %	Cottonseed hulls[a]	Alfalfa[b]
Rolled Corn	80	80
Roughage	4.5	12.0
Fat	3.0	3.0
Supplement	12.5	5.0
Nutrient Composition, DM basis		
NEm, Mcal/kg	2.20	2.20
NEg, Mcal/kg	1.42	1.42
Crude protein, %	13.1	13.1
NDF, %	11.2	12.0
Ca, %	.52	.50
P, %	.33	.29
K, %	.65	.64

[a]Rations containing cottonseed hulls as the roughage source
[b]Rations containing alfalfa hay as the roughage source

Experiment 2. Four ruminally cannulated steers were allotted to a 4x4 Latin square design using the same treatments described in experiment 1. Each period was 28 d, consisting of a 21-d adaptation period and a 7-d collection period. Chewing behavior was observed on d 0 of the collection period. Steers were observed every 5 min over a 24-h period and a behavior score was

recorded. On d 6 of the collection period, ruminal samples were collected at 3-h intervals over a 24-h period, and pH was recorded for each sample.

Statistical Analysis. All data in Exp. 1 were analyzed as a randomized complete block design using the GLM procedure of SAS. Pen served as the experimental unit and the model included feed treatment and weight block. The data in Exp. 2 were analyzed using the MIXED model procedure of SAS. The class variable for chewing response was feed treatment, and the class variable for ruminal pH included feed treatment and collection time.

Results and Discussion

Feedlot Performance. No differences ($p<.05$) were observed for any performance traits measured, as shown in Table 2. These results agree with previous research (Calderon-Cortez and Zinn, 1996, and Shain et al., 1999) indicating that physical form of roughage does not affect feedlot performance. Additionally these data support the findings of Defoor et al. (2002) suggesting NDF from roughage as a useful index for balancing feedlot diets.

Table 2. Least squares means for heifer feedlot performance

	Treatment[a]					
Item	CSH	PCSH	AF	AC	SEM[b]	P>F
Pens	5	5	5	5	---	---
Heifers	20	20	20	20	---	---
Weight, kg						
Initial	364	365	363	362	2.1	.74
Final	510	514	524	515	6.1	.39
Daily Gain, kg/d						
d0-end	1.41	1.45	1.56	1.48	.05	.24
DMI, kg/d						
d0-end	9.2	9.5	9.2	9.6	.30	.67
ADG:DMI						
d0-end	.161	.155	.164	.154	.005	.37

[a]CSH = unprocessed cottonseed hulls; PCSH = pelleted cottonseed hulls; AF = alfalfa hay ground through hammer mill; AC = coarsely chopped alfalfa
[b]Standard error of the least squares means

Carcass Characteristics. No differences ($p<.05$) were observed for any measured carcass traits,

as shown in Table 3. These results are in agreement with the previously discussed data indicating that neither roughage source nor physical form affects carcass characteristics when rations are formulated for equal NDF from roughage.

Table 3. Least squares means for carcass characteristics

	Treatment					
Item	CSH	PCSH	AF	AC	SEM[a]	P>F
Hot carcass wt, kg	323	326	332	325	3.9	.40
Ribeye area, cm2	95.2	92.0	95.0	94.0	2.8	.84
Yield Grade	1.95	2.22	2.18	2.22	.18	.66
Marbling Score[b]	443	451	443	460	12.1	.70
Fat thickness, cm	1.13	1.21	1.27	1.30	.09	.58
KPH, %	1.74	1.68	1.76	1.80	.05	.48

[a]Standard error of the least squares means
[b]200-299 = Traces; 300-399 = Slight; 400-499 = Small; 500-599 = Modest

Chewing Response. No differences ($p<.05$) were observed for chewing responses, in support of the data from experiment 1.

Table 4. Least squares means for chewing behavior

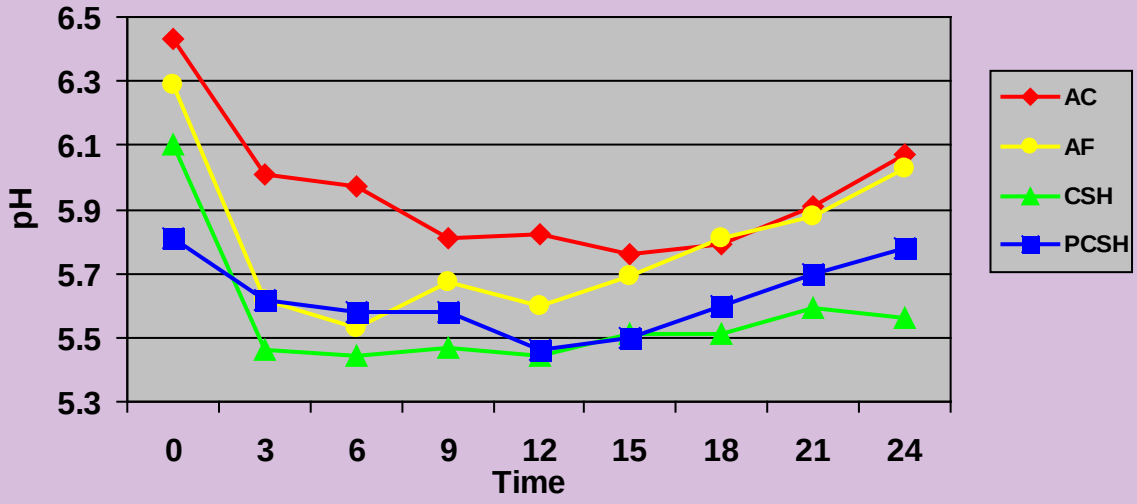
Item	AC	AF	CSH	PCSH	SEM[a]	P>F
DMI, kg	10.2	8.9	9.3	9.5	.6	.36
Eating						
Min/d	174.5	140.3	138.0	150.5	17.9	.43
Min/kg NDF	102.5	94.8	84.7	84.1	13.9	.73
Ruminating						
Min/d	265.1	168.8	133.8	142.6	44.1	.16
Min/kg NDF	155.9	114.1	82.1	79.7	28.5	.19

TCT[b]						
Min/d	439.1	309.1	271.6	292.9	48.8	.12
Min/kg NDF	258.4	208.9	166.6	163.6	33.3	.17

[a]Standard error of the least squares means
[b]Total chewing time (Eating + ruminating)

Ruminal pH. A significant (p=.05) treatment x time interaction was observed for ruminal pH. Steers fed cottonseed hulls had a greater decrease in ruminal pH over time than steers fed alfalfa. However this is inconsequential since no differences were observed for performance.

Figure 1. Ruminal pH



Implications

These data, along with previous research indicate that physical form or particle size of roughages are most likely not an important consideration when formulating feedlot diets. Additionally, these data implicate NDF supplied from the roughage source as a useful index for substituting roughages in finishing diets.

Literature Cited

Calderon-Cortes and Zinn. 1996. J. Anim. Sci. 74:2310.

Defoor et al. 2002. J. Anim. Sci. 80:1395.

Mertens. 1997. J. Dairy Sci. 80:1463.

Shain et al. 1999. J. Anim. Sci. 77:1082.

Welch and Smith. 1970. J. Dairy Sci. 53:797.

Acknowledgements

The authors thank the personnel at the Willard Sparks Beef Cattle Research Center and Steve Welty at the N&P Research Center for their assistance with this experiment. The authors also thank Mark Wyatt for providing the cattle and feed used in the experiment.

Authors

Markham, C.E. – Graduate Assistant

Krehbiel, C.R. – Assistant Professor

Burciaga, L.O. – Graduate Student

Gill, D.R. – Regents Professor

Peterson, R.E – Graduate Assistant

DePra, H.A. – Graduate Assistant

McBeth, L.J. – Graduate Assistant