Effects of dietary forage concentration in finishing diets on growth and carcass characteristics of steers

K.S. Sorensen[1], V.L. Anderson[2], K.R. Maddock-Carlin[1], C.L. Engel[2], C.S. Schauer[3], K. Olsen[4] and R.J. Maddock[1]

The objective of this study was to evaluate the effect of feeding different levels of forage during the finishing phase of beef production. Three different finishing diets of 20, 30 and 40 percent forage were fed to feedlot yearling steers to assess effects on growth and meat quality traits. Feed intake, rate of gain, gain efficiency, carcass traits and cost of gain were not different among treatments. The retail shelf-life display study determined that the high (40 percent) forage diet maintained baseline beef color longer than the low (20 percent) forage diet.

Summary

The objective of this study was to evaluate the effect of feeding different levels of forage during the finishing phase of beef production. Steer performance and meat quality traits were evaluated.

One hundred twenty steers were fed a finishing diet that consisted of a corn and barley combination, with treatments being different forage content of 20 percent (20FOR), 30 percent (30FOR) or 40 percent (40FOR) of the total ration. Body weight gains, average daily gains, dry matter intake and gain:feed were not different among treatments. Hot carcass weight, rib-eye area, 12th rib fat thickness, marbling and final yield grades were not different among treatments. Shelf-life evaluations showed that loin steak redness (a*) was greater from day six to day 10 of the shelf-life display study for the 40 percent forage diet when compared with other treatments. Steak yellowness (b*) had a tendency to be greater for the 40 percent forage diet as well. These results indicate that when compared with 20 and 30 percent forage diets, the 40 percent forage treatment resulted in meat that maintained a fresher appearance longer. The cost of producing a pound of gain was only slightly different among treatments and would have very little impact on overall profits.

Introduction

Because of the increased cost of grain, beef producers are looking for alternative feedstuffs as a way to reduce costs. One way may be to increase forage in a high-concentrate finishing diet. Adding a low percentage of forage to finishing diets helps prevent digestive upsets and, therefore, maximizes energy intake (Gaylean and Defoor, 2003).

Bartle and Preston (1991) found that reducing roughage content during the midfinishing period may improve carcass quality. Willms et al. (1991) fed cattle a finishing diet of 10 or 20 percent forage and determined that 12th rib fat thickness; kidney, pelvic and heart fat; and yield grade were not different between treatments. They did report that rib-eye area tended to be larger in steers fed 10 percent forage than those fed 20 percent forage. They had no explanation for the difference in rib-eye area.

For the present study, we also conducted a shelf-life display study to compare color stability among treatments. Visual appearance is the most important sensory property by which consumers judge meat quality (Kropf et al., 1986). The objective of this study was to evaluate three different diets that contained 20, 30 or 40 percent forage and to assess effects on growth performance and meat quality traits.

Experimental Procedures

This study was conducted at the Carrington Research Extension Center in outside feedlot research pens. The protocol for this study was approved by the NDSU Animal Care and Use Committee.

One hundred twenty steers were stratified by body weight (BW) and then allotted randomly to one of 12 pens (n = 10 head/pen). Dietary treatments were forage level in finishing rations (Table 1). All steers were fed a 40 percent forage diet for the first 28-day period and then assigned to one of three treatments: 1) 40 percent forage (40FOR), 2) 30 percent forage (30FOR) or 3) 30 percent forage for 28 days and then 20 percent forage throughout the remainder of the feeding periods (20FOR). Diets contained 8 percent hay with increasing corn silage (assuming 100 percent forage) in the higher percentage forage treatments.

Steers were weighed approximately every 28 days for a total of

[1]Animal Sciences Department, NDSU
[2]Carrington Research Extension Center, NDSU
[3]Hettinger Research Extension Center, NDSU
[4]Department of Animal Science, South Dakota State University

119 days. Performance data collected included average daily gains, dry-matter intake and gain:feed. Steers were slaughtered on one day at Tyson Fresh Meats in Dakota City, Neb. Hot carcass weights were obtained on slaughter day. The following carcass attributes were measured after a 24-hour chill: 12th rib fat depth; rib-eye area; kidney, pelvic and heart fat (KPH); marbling; and U.S. Department of Agriculture yield grades.

Beef strip loins were obtained from the carcasses, vacuum-packaged and transported to the NDSU Meats Laboratory and aged for 10 days at a temperature of 39 F. At day 10, three steaks (about 1 inch) were cut from the strip loins. Steaks were vacuum-packaged individually and frozen until further evaluation of tenderness or prepared immediately for retail display.

Retail display shelf-life steaks were placed on metal trays, covered with polyvinyl chloride film and placed under continuous fluorescent lighting at 39 F. Steaks were evaluated for color scores with a Minolta chromometer (model CR-410, Konica Minolta, Osaka, Japan) every 24 hours and rotated randomly. Muscle lightness (L*), muscle redness (a*) and muscle yellowness (b*) color scores were recorded for 10 days.

Strip loin steaks used for the tenderness evaluation were thawed for 24 hours at 39 F. Warner-Bratzler shear force analysis was conducted according to American Meat Science Association guidelines (AMSA, 1995). The steaks were weighed and cooked on clamshell-style grills to an internal temperature of 160 F. Steaks were cooled to room temperature and weighed to determine cooking loss.

Six 0.5-inch cores from each steak were removed parallel to the muscle fibers and were sheared using a Warner-Bratzler shear force machine. The mean of the six cores per steak was used for analysis. Data were analyzed statistically using SAS GLM procedures (SAS Inc., Crary, N.C.). Pen was the experimental unit.

Table 1. Finishing rations for steers fed different levels of forages.

	Diet Treatments		
Feeds	**40FOR**	**30FOR**	**20FOR**
	Percent, Dry-matter basis		
Prairie hay	8.0	8.0	8.0
Corn silage	32.0	22.0	12.0
Corn #2	18.5	23.5	28.5
Barley	18.5	23.5	28.5
Modified distillers grains	20.0	20.0	20.0
Calcium carbonate	1.0	1.0	1.0
Supplement			
Rumatec Sup – 1/3 lb.	2.0	2.0	2.0
Nutrients			
Dry matter, %	53.7	59.1	65.7
Net energy gain, Mcal/lb.	56.9	59.0	61.1
Crude protein, %	13.2	13.4	13.2
Calcium, %	0.71	0.69	0.67
Phosphorous, %	0.31	0.32	0.34
Potassium, %	0.72	0.67	0.61

Results and Discussion

Feedlot Performance and Carcass Traits

Measures of growth performance (Table 2) were not different among treatments ($P \geq 0.14$). The feed cost per pound of gain was

Table 2. Performance of yearling steers fed different levels of forages as part of finishing rations.

	Treatments				
Item	**40FOR**	**30FOR**	**20FOR**	**StErr**	***P*-Value**
Number of pens	4	4	4		
Number of animals	40	40	40		
Body weight, lbs.					
Initial wt., Oct. 8	861	865	862	21	0.98
Final wt., Feb. 22	1383	1399	1393	28	0.92
Avg. daily gain, lbs.	4.08	4.25	4.26	0.10	0.39
Dry-matter intake, lbs./head/day	27.5	27.7	28.1	0.57	0.71
Gain:feed, (DM)	0.14	0.14	0.13	0.003	0.14
Feed costs/lb. gain	$0.70	$0.69	$0.71		

very similar across all treatments. This indicated the cost among the diets would have very little impact on overall profit. These results agree with Bartle et al. (1994), who found average daily gains were not affected as forage level increased from 10 to 20 percent.

Hot carcass weights, rib-eye area, 12th rib fat thickness, kidney-pelvic-heart fat, marbling score and USDA yield grade were all similar among treatments ($P \geq 0.61$). Previous studies have shown similar results (Arnett et al., 2012; Willms et al., 1991). Warner-Bratzler shear force and cook loss also were not different ($P \geq 0.26$) among treatments (Table 3).

Shelf-life Display

During shelf-life display, steak lightness (L*) was similar among treatments for the 10-day study (Figure 1). Steak redness (a*) was significantly higher for the 40 percent forage diet after day six (Figure 2). This indicates the higher forage diet resulted in meat that stayed redder longer. Steak yellowness (b*) had a tendency to be higher for the 40 percent forage diet when compared with the other treatments (Figure 3).

A study done by Arnett et al. (2012) found similar results when feeding steers a finishing diet of 12 or 24 percent forage. Their results showed that during retail shelf display, steaks from steers fed 12 percent forage were less red and yellow than steaks from steers fed a 24 percent forage diet. These results could be due to forages being rich in antioxidants, which can contribute to the delay of oxymyoglobin and lipid oxidation in meat, resulting in extended color stability for beef (Liu et al., 1995). We did not measure dietary antioxidant concentrations.

This study indicates that finishing diets with greater amounts of forage do not influence body weights, carcass composition, meat quality or tenderness, and did not decrease cost of gains. However, meat color attributes were improved.

Table 3. Carcass traits of steers fed different levels of forages as part of finishing rations.

	Treatments				
	40FOR	30FOR	20FOR	St Err	*P*-Value
Hot carcass wt., lb.	817.41	831.75	825.20	37.8	0.87
Rib-eye area, sq. in.	13.44	13.69	13.71	0.67	0.82
Backfat thickness, in.	0.45	0.45	0.43	0.05	0.90
KPH, %	2.42	2.44	2.52	0.20	0.74
Marbling score[a]	350	340	354	20	0.61
Yield grade[b]	2.91	2.89	2.84	0.18	0.86
WBSF, lbs.	6.50	5.82	6.48	0.29	0.26
Cook loss, %	19.47	18.30	17.94	3.43	0.89

[a]Based on scores 300-399 = small and USDA low Choice quality grade
[b]Yield grade is composite calculation of fat to lean yield in a carcass based on a relationship of hot carcass wt., rib-eye area, fat thickness and KPH, low values = lean carcasses

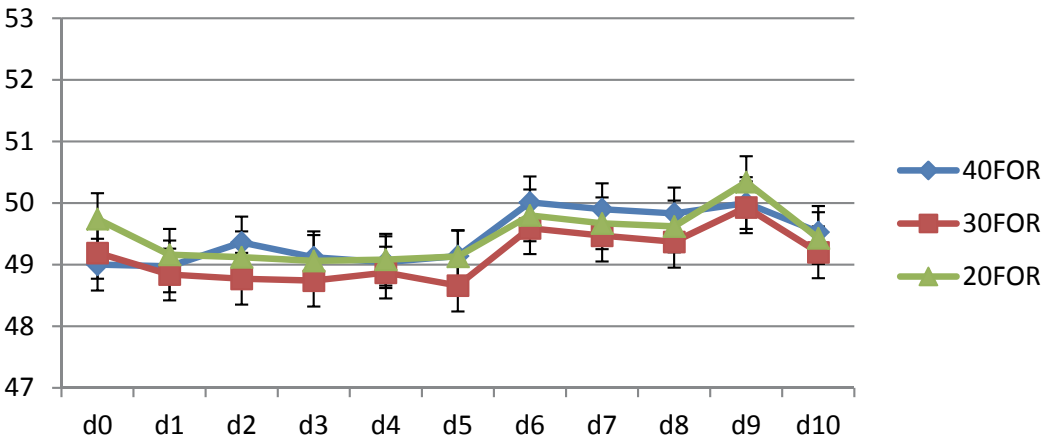

Figure 1. L* color measurements over 10d period from strip steaks from steers fed different forage levels as part of finishing rations.

*Means between 40FOR and 30FOR or 20FOR are different ($P < 0.05$)

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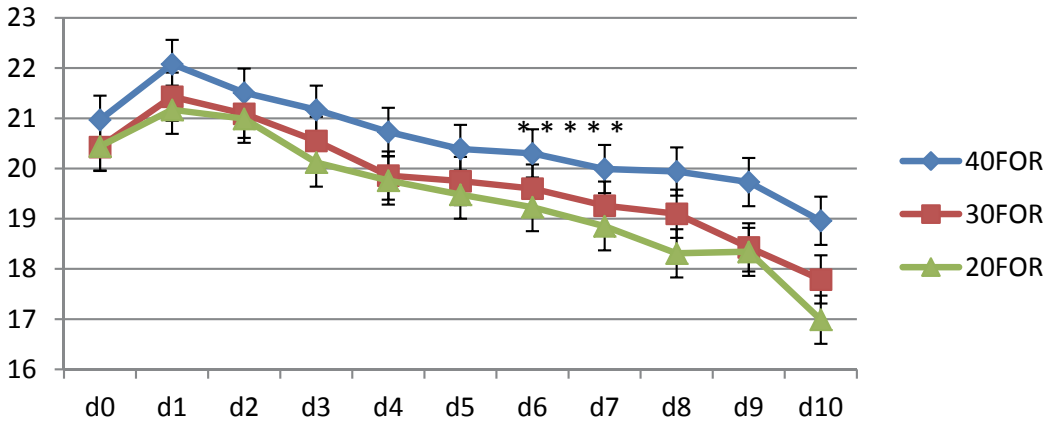

Figure 2. a* color measurements over 10d period from strip steaks from steers fed different forage levels as part of finishing rations.

*Means between 40FOR and 30FOR or 20FOR are different ($P < 0.05$)

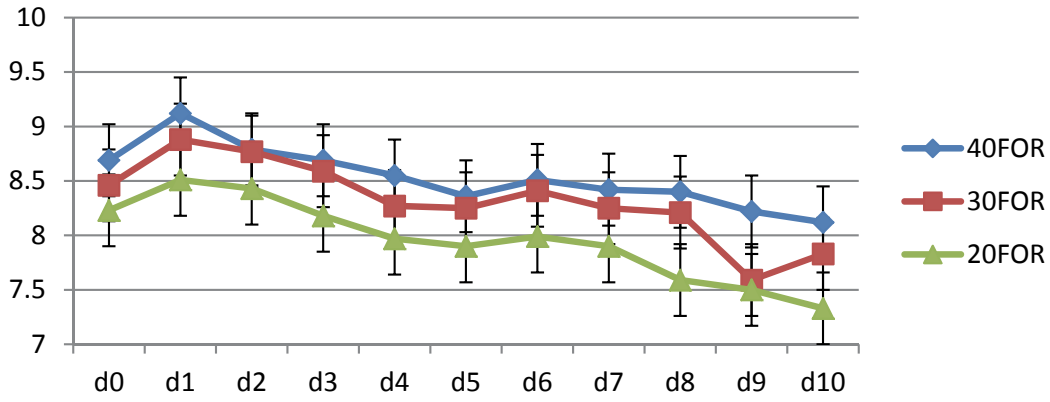

Figure 3. b* color measurements over 10d period from strip steaks from steers fed different forage levels as part of finishing rations.

*Means between 40FOR and 30FOR or 20FOR are different ($P < 0.05$)