Effects of Dietary Energy Density and Frame Size on Performance and Body Composition of Feedlot Steers

A.S. Leaflet R1830

Claudio C. Ribeiro-Filho, graduate research assistant,
Allen Trenkle, professor of animal science, and
Dan Loy, professor of animal science

Summary

Thirty-six steers were sorted by frame size and individually fed diets containing 2.4, 2.7, or 3.0 Mcal of ME/kg of DM to evaluate the effects of dietary energy density and animal frame size on performance and body composition. Frame size did not have an effect on performance or body composition. Steers fed the 2.4 or 2.7 Mcal/kg diet had a higher feed intake than those fed the 3.0 Mcal/kg diet, but they were less efficient. The results indicated that steers fed the diet with higher energy concentration deposited more fat earlier and had larger ribeye area than steers fed the diets with lower energy concentration. The results also indicated that dietary energy density affects composition of gain more than average daily gain.

Introduction

Forage is one of the most expensive diet ingredients when priced per unit of net energy, but feeding sufficient forage is important to optimize rumen fermentation and to reduce rumen disorders. Recently, research has been conducted to minimize the amount of forage in cattle diets, but also the interest in grass-fed beef has increased in some areas.

During the last few years many studies have been conducted to evaluate the effects of feeding different forage levels on performance and carcass composition of feedlot cattle. The results of previous studies indicated that feeding low-forage concentration diets reduced feed intake, usually did not affect gain, improved feed efficiency, and improved carcass characteristics. However, the extent of the effects on performance and carcass traits is dependent on the quality of forage and energy concentration of the diet. Previous research also indicated that large framed cattle gained faster and were more efficient than were small framed cattle, but small framed steers had higher fat deposition than did large framed steers.

This study was conducted to evaluate the effects of dietary energy density and animal frame size on performance and body composition.

Materials and Methods

Thirty-six black and predominantly Angus steers weighing approximately 325 kg were sorted by frame size. The steers were separated by visual appraisal from an initial group of 120 steers into two groups: small and large frame sizes. The tallest eighteen steers were placed in the large frame size group and the shortest eighteen steers were placed in the small frame size group. Steers were randomly allotted to six pens, with six steers per pen, and electronic individual Calan gates were used to individually feed the steers. The steers were not implanted and ionophores were not fed.

Experimental treatments were diets containing 2.4, 2.7, or 3.0 Mcal of ME/kg of DM (65:35, 37:63, or 12:88 for forage to concentrate ratio, respectively). Dietary treatments are shown in Table 1. Each treatment was fed to 12 steers and the experimental design was a 3 x 2 factorial design, where the treatments were based on diet and frame size. Dry matter intake (DMI), average daily gain (ADG), and feed efficiency (FE) were measured. Ingredients were mixed and fed as total mixed diets. Animals were weighed individually in the mornings before feeding on two consecutive days at the beginning of the study and each 28 days until the end of the experiment. The steers were fed for 196 days from March through October. Ultrasound images of longissimus muscle (ribeye) and subcutaneous fat thickness (backfat) were taken between the 12^{th} and 13^{th} ribs each 28 days. Data were analyzed as two-way ANOVA, using the PROC GLM procedure of SAS, and data were considered statistically significant at $P<.05$.

Results and Discussion

Concentrations of nutrients in the diets are shown in Table 2. The alfalfa hay used in this experiment contained 13.1% crude protein, 52.0% NDF, and 42.5% ADF. Steer performance and body composition are shown in Table 3 and Table 4.

Table 1. Composition of the diets (% of dry matter).

	Diet Mcal ME/kg		
Ingredient	2.4	2.7	3.0
Alfalfa hay	64.99	37.26	11.52
Cracked corn	33.23	58.12	76.81
Cane molasses	1.03	0.89	0.92
Soybean meal	0.00	2.24	8.45
Urea	0.30	1.04	0.62
Premix[a]	0.15	0.15	0.15
Salt	0.30	0.30	0.30
Limestone	0.00	0.00	1.23

[a] Provided trace minerals, sulfur, and vitamin A.

Table 2. Nutrient composition of diets.

	Diets (Mcal of ME/kg of DM)		
Variable	2.4	2.7	3.0
Dry matter %	90.2	90.4	90.8
Nutrient as % DM			
Organic matter	96.1	96.3	96.6
Crude protein	12.2	13.9	14.0
Neutral detergent fiber	36.4	24.1	12.8
Acid detergent fiber	28.5	17.5	7.5
Non-fiber carbohydrate	45.7	55.9	67.0
Fat	1.8	2.4	2.8

Dry matter intake, ADG, and FE were not significantly different (P>.05) due to frame size in any phase of the feeding period or the average during the whole experiment. Steers fed diets with 2.4 or 2.7 Mcal of ME/kg of DM had significantly (P<.05) higher DMI than those fed the 3.0 Mcal/kg diet during most of the experiment (Figure 1) and average of the experiment (Table 3). Steers fed the 3.0 Mcal/kg diet had significantly (P<.05) higher ADG than those fed the 2.7 Mcal/kg diet during the late phase of the feeding period and the average during the whole experiment (Figure 2). The steers consuming the 2.7 Mcal/kg diet experienced digestive disorders during the late phase of the experiment, which may have had a negative effect on ADG. The steers fed the 3.0 Mcal/kg diet were significantly (P<.002) more efficient that those fed the diet 2.7 Mcal/kg, and they tended (P<.06) to be more efficient than those fed diet 2.4 Mcal/kg. There was no interaction between frame size and diet for DMI, ADG, FE, FT, and REA.

Fat thickness (FT) and ribeye area (REA) were not significantly different due to frame size during any phase of the feeding period. There was no significant difference on FT among diets at the end of the experiment, but steers fed the 3.0 Mcal/kg diet had larger (P<.05) REA than those fed the other two diets at the end of the trial. The results indicated that steers fed the higher energy density diet deposited more FT during the middle and late phase of the experiment than those fed lower energy density diets (Figure 3). The results also indicated that steers fed the higher energy density diet had greater REA than steers fed the lower energy density diets (Figure 4).

Table 3. Performance and body composition of the whole trial.

	Diets (Mcal of ME/kg of DM)			
Item	2.4	2.7	3.0	LSD[b]
Starting weight (kg)	326.29	321.37	328.63	
Ending weight (kg)	526.55	502.13	553.09	
Average DMI (kg)	10.25	10.04	8.36	1.29
Average ADG (kg)	1.02	0.92	1.14	0.17
Average FE (feed/gain)	10.18	12.18	7.43	2.84
Ribeye area (cm^2) [a]	72.13	72.43	79.05	5.37
Fat thickness (cm) [a]	0.69	0.77	0.84	0.20

[a], Measure at the end of the trial.
[b], Least significant difference at 5%.

Table 4. Performance and body composition of the whole trial.

	Frame Size		
Item	Small	Large	LSD[b]
Starting weight (kg)	302.65	348.21	
Ending weight (kg)	504.20	550.31	
Average DMI (kg/day)	9.29	9.80	1.05
Average ADG (kg)	1.03	1.03	0.14
Average FE (feed/gain)	9.36	10.51	2.32
Ribeye area (cm^2) [a]	74.19	74.88	4.38
Fat thickness (cm) [a]	0.82	0.72	0.17

[a], Measure at the end of the trial.
[b], Least significant difference at 5%.

Implications

The results indicated that steers fed a higher energy density diet consumed less feed, had similar gains, and were more efficient than those fed lower energy density diets. Feed intake was reduced when cattle fed high-concentrate diet progressed in the feeding period. Steers fed the higher energy diet deposited more fat earlier and had larger ribeye area than those fed the lower energy diet. The gain between the highest and the lowest energy density diet was not significantly different over the whole trial, but fat thickness was different after 84 days on feed. The results suggested that dietary energy density affected composition of gain and body composition rather than rate of gain.

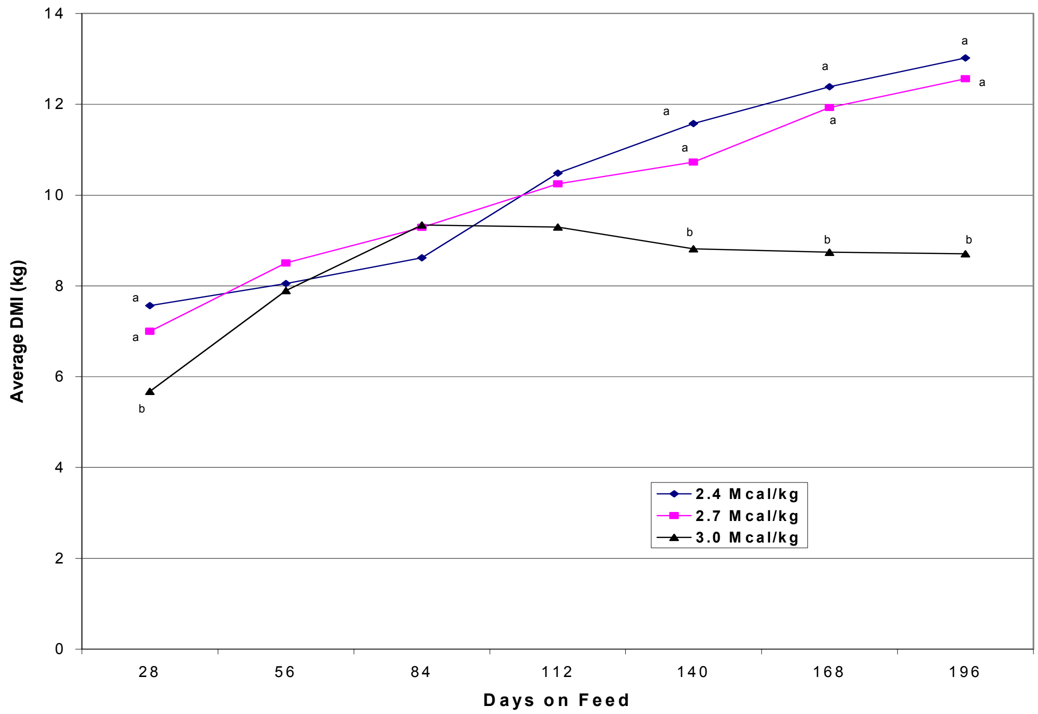

Figure 1. Effects of dietary treatment on dry matter intake. [a,b] **Averages with different superscripts differ (P<.05).**

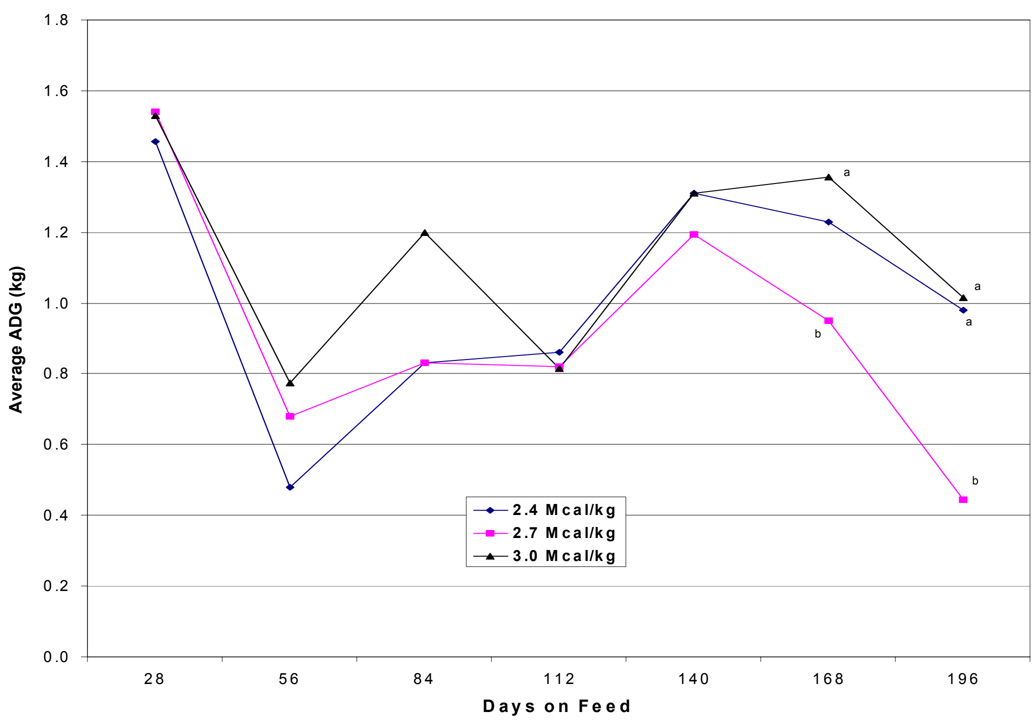

Figure 2. Effects of dietary treatment on average daily gain. [a,b] **Averages with different superscripts differ (P<.05).**

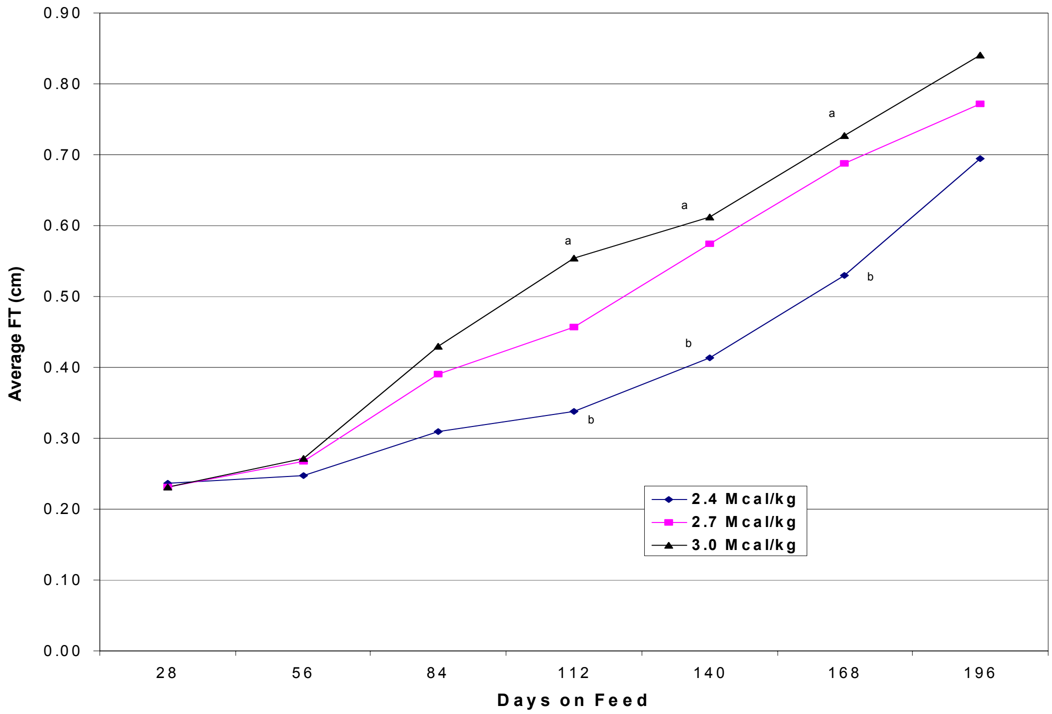

Figure 3. Effects of dietary treatment on fat thickness. [a,b,] **Averages with different superscripts differ (P<.05).**

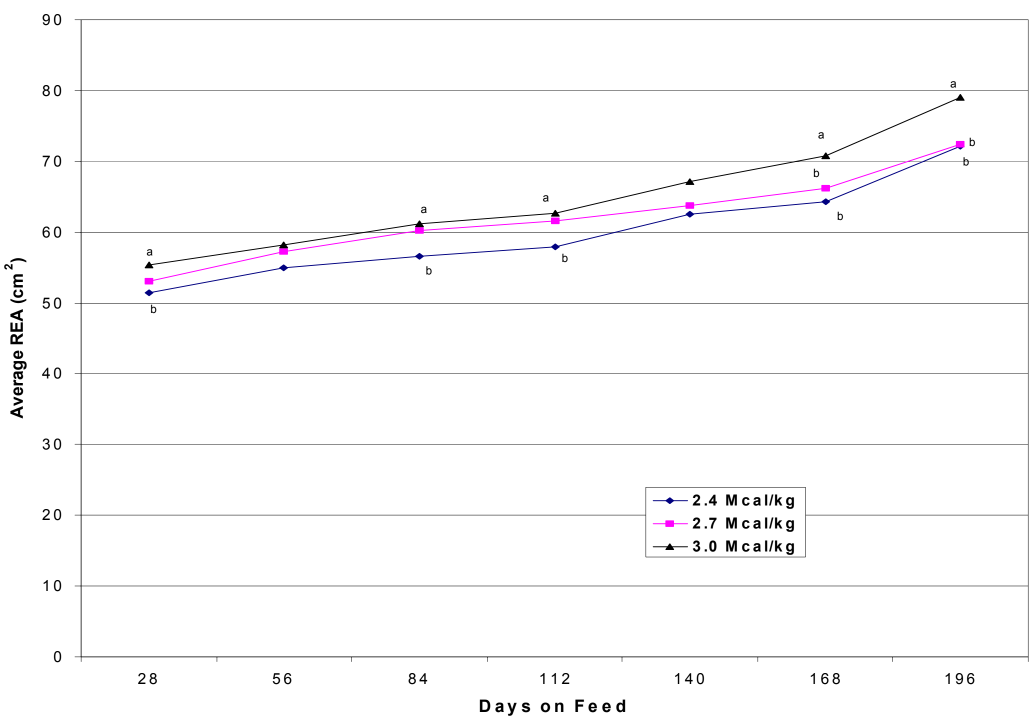

Figure 4. Effects of dietary treatment on ribeye area. [a,b,] **Averages with different superscripts differ (P<.05).**