K-STATE Research and Extension

CATTLEMEN'S DAY 2021

KANSAS STATE UNIVERSITY CATTLEMEN'S DAY

Limit-Fed, High-Energy Diets Can Achieve Improved Feed Conversion Rates Without Compromising Rate of Gain When Compared to Conventional High Roughage Diets

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Abstract

Recent research suggests that limit feeding a high-energy diet to growing cattle improves performance, with no increased incidence of morbidity and mortality. The objective of this study was to compare the performance impacts of limit feeding a high-energy diet to a traditional high roughage diet fed ad libitum. Crossbred heifer calves (n = 418) were used in an 84-day growing and receiving study at the Kansas State University Beef Stocker Unit with two treatment diets, including a high-energy, limit-fed treatment consisting primarily of dry-rolled corn and Sweet Bran (Cargill Animal Nutrition, Blair, NE), and a high roughage, ad libitum treatment. Pen performance statistics were measured throughout the study. Compared to the high roughage, ad libitum treatment, the high-energy, limit-fed cattle gained 14.7% more ($P < 0.01$) with 25.5% less dry matter consumption ($P < 0.01$). According to ultrasound scanning data, high-energy, limit-fed cattle showed a greater extent of muscle depth over the ribs and more marbling in the ribeye ($P < 0.02$).

Introduction

Previous research conducted at the Kansas State Beef Stocker Unit has demonstrated the possible benefits of limit feeding high-energy diets based on dry-rolled corn and corn co-products for newly received growing cattle. This study was conducted to further explore subsequent feedlot performance and carcass merit implications. During the receiving and growing phase of production, roughage-based diets are commonplace in the industry. However, in times of drought, or when forage prices are high, producers often seek alternative, yet readily available feedstuffs such as corn, distiller's grains,

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or wet corn gluten feed. Coupled with limit feeding, the use of high-energy feeds is a powerful means to achieve comparable, or even improved performance in young growing cattle prior to feedlot entry.

Experimental Procedures

A total of 418 weaned, crossbred heifers (body weight = 615 ± 53 lb) were purchased at auction markets in Texas and New Mexico, assembled at two different farms approximately 90 miles southwest of Amarillo, TX, then shipped 570 miles to the Kansas State University Beef Stocker Unit, Manhattan, KS, on May 28, 2019. The heifers were used in a completely randomized block design, 84-day receiving and growing study to evaluate the impact of a high-energy, limit-fed diet containing dry-rolled corn and Sweet Bran (Cargill Animal Nutrition, Blair, NE) to a high roughage diet fed ad libitum on animal performance. Cattle were randomized by arrival weight and assigned to pens, each containing 13 or 14 heifers. Additionally, each pen was randomly assigned to one of two treatments in a "treatment pair" (one high-energy, limit-fed pen, and one high roughage, ad libitum pen). There was a total of 32 pens. The high roughage and high-energy diets were formulated to provide either 45 or 60 Mcal of net energy for gain/100 lb of dry matter, respectively. Feed intakes of the high-energy, limit-fed groups were initially set at 85% of the feed intakes of the high roughage, ad libitum groups. However, this percentage was reduced when it became apparent that 85% of the high roughage, ad libitum intakes resulting in ad libitum intakes for the high-energy, limit-fed treatment. Both diets were formulated to contain 40% Sweet Bran on a dry matter basis (Table 1).

At the time of arrival, all calves were evaluated for disease and lameness. Each animal was individually weighed, given a visual identification ear tag, and was vaccinated for typical respiratory diseases. Cattle were fed once daily, and each pen was weighed once per week. A 24-hour shrunk weight was measured at the end of the study to calculate pen performance statistics. Pen was the experimental unit. On day 84, ultrasound was performed on all cattle to determine muscling and fat differences by a technician from the Cattle Performance Enhancement Company, and preliminary carcass data were obtained.

Results and Discussion

Performance and growth results are provided in Table 2 for each treatment group. Ultrasound data are shown in Table 3. Overall, the high-energy, limit-fed cattle outgained the high roughage, ad libitum cattle ($P < 0.01$). Inherently, dry matter intakes were considerably lower for the high-energy, limit-fed cattle; their efficiency was also markedly better, with gain-to-feed and feed-to-gain ratios better than the high roughage, ad libitum treatment ($P < 0.01$). Body weight was not different between treatments ($P = 0.22$) on day 84. Initially, the high-energy, limit-fed feed intake was set at 85% of the feed intakes of the high roughage, ad libitum treatment. However, the high roughage, ad libitum cattle consumed more dry matter than expected. Consequently, over subsequent weeks, each high-energy, limit-fed pen's intake was decreased to maintain limit-fed conditions according to each adjacent high roughage, ad libitum contemporary pen. Although 85% may work for some groups of cattle, this percentage is highly variable and depends on several factors such as breed type, age, weight, weather

conditions, and eating experience. In practical producer settings, it would be more economical and convenient to base limit-fed cattle intakes on a fixed percentage of body weight to achieve a targeted rate of gain. In ultrasound scans, high-energy, limit-fed cattle showed greater muscle depth ($P < 0.01$) and marbling in the ribeye ($P = 0.02$). Furthermore, this treatment group also deposited more backfat ($P < 0.01$). These outcomes may allow for shorter times on feed to achieve desired carcass indices.

Implications

Limit feeding a high-energy diet, as compared to feeding a traditional high roughage diet ad libitum in growing cattle can result in comparable, or even improved, feed conversion without negatively affecting rate of gain. Moreover, limit feeding the higher energy diet also increases muscling depth and fat deposition.

Acknowledgments

National Cattlemen's Beef Association
Kansas Corn Commission

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Table 1. Composition of experimental diets fed in the backgrounding phase

	Diet[1]	
Item	**High roughage, ad libitum**	**High-energy, limit-fed**
Ingredient, % dry matter inclusion		
Alfalfa	22.50	6.50
Dry rolled corn	8.57	38.82
Prairie hay	22.50	6.50
Sweet Bran[2]	40.00	40.00
Supplement	6.43	8.18

1 Diets were formulated to contain 45 or 60 Mcal net energy for gain/100 lb dry matter, respectively.
2 Cargill Animal Nutrition, Blair, NE.

Table 2. Performance data collected from heifers in an 84-day backgrounding study

Item	Diet[1]		Standard error of the least square means	*P*-value
	High roughage, ad libitum	High-energy, limit-fed		
Number of pens	16	16		
Number of animals	205	204		
Body weight, lb				
Day 0	618	615	13.5	0.89
Day 42	753	748	14.2	0.81
Day 84	811	837	14.6	0.22
Average daily gain, lb/day				
Day 0–84	2.30	2.64	0.04	< 0.01
Dry matter intake, lb/day				
Day 0–84	23.26	17.32	0.4	< 0.01
Feed to gain, lb/lb				
Day 0–84	10.15	6.55	0.2	< 0.01
Gain to feed, lb/lb				
Day 0–84	0.100	0.153	0.002	< 0.01

[1] Diets were formulated to contain 45 or 60 Mcal net energy for gain/100 lb dry matter, respectively, and were fed to each pen once/day. Weekly pen weights were measured, and feed intakes were adjusted accordingly.

Table 3. Ultrasound scanning data from heifers in the backgrounding phase and predicted carcass traits

Item	Diet[1]		Standard error of the least square means[2]	*P*-value
	High roughage, ad libitum	High-energy, limit-fed		
Carcass quality traits in backgrounding phase[3]				
Backfat, in	0.20[a]	0.22[b]	0.01	< 0.01
Muscle depth, in[4]	2.11[a]	2.25[b]	0.02	< 0.01
Marbling score[5]	4.78[a]	4.92[b]	0.04	0.02
Predicted carcass quality traits upon slaughter[6]				
Days on feed	139.0[a]	126.0[b]	3.6	0.02
Pay weight, lb	1246.0	1229.7	8.1	0.16
Hot carcass weight, lb	787.1	775.1	5.8	0.15
Backfat, in	0.57	0.58	0.01	0.19
Marbling score	6.93	6.92	0.06	0.93
Probability of final yield grade[7]				
Yield grade 2, %	29.6	27.5	0.01	0.16
Yield grade 3, %	62.3	63.7	0.01	0.21
Yield grade 4, %	6.6[a]	7.5[b]	0.01	0.03

[ab] Least square means with different superscripts are different ($P < 0.05$).

[1] Diets were formulated to contain 45 or 60 Mcal net energy for gain/100 lb of dry matter, respectively, and were fed to each pen once/day in the 84-day backgrounding phase.

[2] Standard error (largest) of the least square means.

[3] Carcass quality traits observed by ultrasound scanning on day 84.

[4] Measured by the Cattle Performance Enhancement Company software program from the bottom backfat line to the rib bones.

[5] A number between 4.00–4.99 indicates "select" marbling, and 5.00–5.99 indicates "low choice" marbling.

[6] Predicted carcass quality traits for cattle upon slaughter, based on day 84 ultrasound scan data and prediction equations from the Cattle Performance Enhancement Company.

[7] Probability (from 0–100%) that the final yield grade of a carcass will be 2, 3, or 4 upon slaughter, based on U.S. Department of Agriculture standards.