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EFFICIENCY OF EARLY-WEANED BEEF CALVES IS NOT IMPROVED BY RESTRICTING FEED INTAKE DURING AN 84-d GROWING PERIOD

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ABSTRACT: Harvested forages become scarce and expensive during times of drought; moreover, grains typically have lesser unit cost of energy than forages. Our objective was to evaluate the performance and efficiency of light-weight, early-weaned beef calves program fed a dry-rolled sorghum-based diet (15.6% CP, 1.20 Mcal NE_g/kg) with intake levels adjusted to achieve 1 of 3 rates of gain during an 84-d post-weaning growing period: 1) 0.45 kg ADG (**LOGAIN**; 1.5% of BW DMI), 2) 0.91 kg ADG (**MIDGAIN**; 2.0% of BW DMI), and 3) 1.36 kg ADG (**HIGAIN**; 2.5% of BW DMI). Angus × Hereford calves (n = 243; initial BW = 156 ± 31 kg; average age = 113 ± 17 d) were stratified by sex and assigned randomly to treatment (n = 3 pens·treatment^{-1}·sex^{-1}). Daily feed allowances were estimated based on initial BW; feed deliveries were adjusted to meet targeted gains every 28 d based on BW at the end of the preceding period. Carcass characteristics (i.e., 12th-rib fat thickness, longissimus muscle depth, and marbling score) were evaluated ultrasonically at the end of the 84-d growing period. Incidence of undifferentiated fever was not different (P = 0.95) among treatments. Average daily gain increased (P < 0.01) as feed allowance increased; HIGAIN calves were heavier (P < 0.01) than either MIDGAIN or LOGAIN calves at the end of the 84-d experiment. Conversely, targeted ADG were not achieved (0.55, 0.69, and 0.88 kg for LOGAIN, MIDGAIN, and HIGAIN, respectively). Per design of our study, DMI was greater (P < 0.01) for HIGAIN (4.32 kg/hd/d) calves than for MIDGAIN (3.48 kg/hd/d) calves; moreover, DMI of MIDGAIN calves was greater (P < 0.01) than that of LOGAIN (2.65 kg/hd/d) calves. Gain efficiency did not differ (P = 0.83) among treatments. Fat thickness over the 12th rib was greater ($P \leq 0.02$) for HIGAIN than either LOGAIN or MIDGAIN calves. In contrast, there were no differences (P = 0.14) in marbling between treatments. Longissimus muscle depth was less ($P \leq 0.04$) in LOGAIN calves than in MIDGAIN or HIGAIN calves. Under the conditions of this experiment, feed efficiency of early-weaned beef calves was not improved by restricting DMI of a concentrate-based diet during an 84-d growing phase.

Keywords: beef calves, early weaning, intake restriction

Introduction

Early weaning can be used by cow-calf producers to reduce rangeland stocking rates by 20 to 30% during periods of drought (Rasby, 2007). Early-weaned calves can weigh less per day of age than calves weaned at conventional ages; therefore, calf value may be less, even with a positive price slide for lighter calves (Story et al., 2000). To avoid revenue shortfalls, calves can be retained and grown before selling. Feeding grain-based diets to calves less than 125 d of age has been associated with excessive fat accumulation early in the feeding period and decreased carcass weights compared with calves that enter the feedlot after 200 d of age (Schoonmaker et al., 2002). Conversely, growth of early-weaned calves can be highly efficient when compared with calves weaned at conventional ages (Peterson et al., 1987). Marked improvements in feed efficiency have been noted when grain-based finishing diets were limit-fed (Zinn, 1986; Murphy and Loerch, 1994; Schmidt et al., 2005) to early-weaned calves. Thus, high feed costs and early fat deposition may be controlled by limit-feeding a grain-based diet to early-weaned calves. Our goal was to measure performance and efficiency of light-weight, early-weaned, beef calves during an 84-d post-weaning growing period when feed intakes were varied to achieve targeted ADG of 0.45, 0.90, or 1.35 kg / day.

Materials and Methods

Animal care practices used in this study were approved by the Kansas State University Animal Care and Use Committee (protocol no. 3175).

Angus × Hereford calves (n = 243; initial BW = 156 ± 31 kg) originating from the Kansas State University commercial cow-calf herd in Hays, KS were used in this experiment. Calves were weaned at 113 ± 17 d of age. All calves were de-horned and steer calves were castrated prior to 60 d of age. At weaning, calves were weighed individually and assigned randomly to a common diet (Table 1) fed to achieve 1 of 3 rates of gain: 1) 0.45 kg ADG (**LOGAIN**), 2) 0.90 kg ADG (**MIDGAIN**), and 3) 1.35 kg ADG (**HIGAIN**). Growth and health performance were evaluated during an 84-day growing period. Targeted intakes were 1.5 % of BW for the LOGAIN diet, 2.0% of BW for MIDGAIN and 2.5% of BW for HIGAIN.

Table 1. Composition of the growing diet

Ingredient composition	% of DM
Dry-rolled sorghum grain	52.9
Dried distillers grains	23.8
Sorghum silage	18.0
Supplement*	5.3
Nutrient composition	**Amount**
CP, % of DM	15.6
NE_m, Mcal/kg	1.81
NE_g, Mcal/kg	1.20

*Supplement contained Ca, urea, ammonium sulfate, Na, Rumensin® 80, and Tylan® 40

At weaning, calves were stratified by sex and assigned to 1 of 18 pens (3 pens·sex^{-1}·treatment^{-1}; minimum area = 200 m^2/calf, bunk space = 0.46 m/calf). Animals were fed a common diet once daily at 0800. Diet formulation software predicted calves to gain ~1.35 kg/hd/d at maximal intake; we restricted the intake of the LOGAIN and MIDGAIN calves to a level that decreased their software-predicted ADG to 0.45 kg/hd/d and 0.90 kg/hd/d, respectively.

Calves were weighed individually and given initial vaccinations against respiratory pathogens (Bovi-Shield Gold® 5, Pfizer Animal Health, Exton, PA), clostridial pathogens (Ultrabac® 7, Pfizer Animal Health, Exton, PA), and *H. somnus* (Somubac®, Pfizer Animal Health, Exton, PA) at the time of maternal separation. In addition, all calves were treated for internal and external parasites (Ivomec®, Merial Limited, Atlanta, GA). Booster vaccinations were administered 14 d later. Calves were not implanted during the study.

Calf BW were measured at weaning and every 28 d thereafter for the duration of the study. Initial feed allowances were determined based on weaning BW and targeted rates of gain. Feed deliveries were adjusted every 28 d to match observed rates of gain. Carcass characteristics (12th rib fat thickness, LM depth, and marbling) were determined via ultrasound using an Aloka 500V (Aloka Co., Ltd, Wallingford, CT) B-mode instrument equipped with a 3.5-MHz general purpose transducer array (UST 5021-125 mm window) at the end of the 84-d growing period.

All calves were monitored for symptoms of respiratory disease twice daily during the study by trained personnel. Calves with clinical signs of BRD were removed from pens and evaluated. Calves were assigned a clinical morbidity score (scale: 1 to 4; 1 = normal, 4 = moribund), weighed, and assessed for fever. Calves with a clinical illness score > 1 and a rectal temperature > 40.0 °C were treated with therapeutic antibiotics according to label directions (1st incidence = Baytril®, Bayer Animal Health, Shawnee Mission, KS; 2nd incidence = Nuflor®, Merck Animal Health, Summit, NJ). Cattle were evaluated 72 h post-treatment and re-treated based on observed clinical signs.

Animal performance, intake, and ultrasound data were analyzed as a completely randomized design with pen as the experimental unit (PROC MIXED; SAS Inst. Inc., Cary, NC). No treatment*sex interactions were detected (P > 0.05; thus sex was removed from the final analysis. Pen within treatment was used as the random term. Incidence of undifferentiated fever was analyzed using PROC GLIMMIX (SAS Inst. Inc., Cary, NC). All models included terms for treatment and sex. No treatment*sex interactions were detected (P > 0.05; thus sex was removed from the final analysis. Pen within treatment was used as the random term. When protected by a significant F-test (P < 0.05), least squares treatment means were separated using the method of Least Significant Difference. Treatment differences were discussed when P < 0.05; tendencies were discussed when P > 0.05 and ≤ 0.10.

Results and Discussion

Calf BW increased as feed allowance increased (P < 0.01; Table 2). Feed intake was greater (P < 0.01) for the HIGAIN treatment than for the MIDGAIN treatment; moreover, feed intake of the MIDGAIN treatment was greater (P < 0.01) than for the LOGAIN treatment (Table 2). In addition, ADG increased (P < 0.01) as feed allowance increased.

Gain efficiency did not differ (P = 0.77) among treatments. Among instances where G:F improved when intake was restricted (e.g., Schmidt et al., 2005), diet NE and MP concentrations were held constant across treatments. Other research showed no difference in (Murphy and Loerch, 1994) or a reduction in G:F (Murphy et al., 1994) when intakes of high-concentrate diets were restricted. In this study, a common diet was fed at different intakes, thus a greater proportion of energy intake was used to meet maintenance requirements in cattle fed for lesser rates of gain.

The performance-based NE content of the diet used in this study was calculated using the equations of Zinn and Shen (1998). Calves fed to gain 0.45 kg/hd/d had greater (P < 0.01) apparent dietary NEm and NEg concentrations than either calves fed to gain 0.90 or 1.35 kg/hd/d. Murphy and Loerch (1994) also noted no differences in gain efficiency but a difference in performance-based diet NE concentrations of calves that were limit-fed compared with counterparts that were fed more aggressively. They attributed differences in performance-based NE concentrations to differences in diet digestibility, as intake and digestibility are inversely related (Tyrrell and Moe, 1975). Another potential explanation is that calves with greater DMI may have had increased visceral organ weights compared with limit-fed calves, a condition which has been associated with elevated maintenance energy requirements per unit of metabolic body weight (Hersom et al., 2004).

Backfat over the 12th rib was greater in the HIGAIN calves than either the LOGAIN (P < 0.01; Table 3) or the MIDGAIN (P = 0.02) calves. In contrast, there were no differences (P = 0.14) in marbling score among treatments. Longissimus muscle depth was lesser in the LOGAIN calves than either the MIDGAIN (P = 0.04) or HIGAIN (P < 0.01) calves. Early-weaned calves offered *ad libitum* access to a high-concentrate diet after weaning had poorer performance during finishing and achieved a predetermined backfat end point at lighter BW than calves weaned at conventional ages (Schoonmaker et al., 2004). These authors reported that early-weaned cattle reached physiological maturity at a lighter-than-expected BW. Other work noted increased marbling scores in early-weaned calves limit-fed concentrates during the growing phase (Meyer et al., 2005) but calves were fed to a common-age end point in that study. Thus, the criteria used to determine harvest date may strongly influence carcass measurements.

If the harvest decision is based on ultrasonic measurement of carcass composition, early-weaned cattle may be smaller potentially and potentially produce less kg of beef per carcass than conventionally-weaned contemporaries. This may reduce beef production potential of early-weaned calves. One of the goals of this trial was to utilize restricted feeding to overcome this phenomenon, while minimizing the amount of forage fed. Meyer et al. (2005) noted increased HCW and marbling score in calves weaned 112 d before conventional weaning age and subsequently finished in a calf-fed system.

Incidence of undifferentiated fever was not different among treatments ($P = 0.95$) and was relatively mild overall (< 6%). Previous research found no differences in the health of early-weaned calves compared to calves weaned at conventional ages (Myers et al., 1999; Arthington et al., 2005; Arthington et al., 2008). Calves in the aforementioned studies were kept on pasture for a period of time after early weaning. Studies in which early-weaned calves were placed in a feedlot after weaning did not report health data (Schoonmaker et al., 2002; Schoonmaker et al., 2004). Other studies involving limit-fed, early-weaned calves also did not report health data (Murphy and Loerch, 1994; Schoonmaker et al., 2003). Based on our results, it appeared that limit-feeding early weaned calves in a feedlot did not affect subsequent health performance during an 84-d growing period.

Implications

Light-weight, early-weaned calves fed a grain-based diet at restricted rates did not exhibit improved efficiency relative to full-fed counterparts. In addition, there appeared to be limitations associated with predicting feed intake and performance of light-weight, early-weaned calves fed a grain-based diet. Our treatments influenced body composition, which may have an impact on finishing performance.

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Table 2. Growth performance of early-weaned beef calves fed a common diet to achieve 1 of 3 targeted weight gains during an 84-d growing period

	Targeted ADG			
Item,	0.45 kg/d	0.90 kg/d	1.35 kg/d	SEM
Weaning weight, kg	155	155	157	7.7
Weight at end of 84-d, kg	201[a]	213[a]	231[b]	5.8
ADG, kg/d	0.55[a]	0.69[b]	0.88[c]	0.043
DMI, kg/d	2.65[a]	3.48[b]	4.32[c]	0.001
Gain:feed	0.208	0.199	0.205	0.0138
Performance-based NE calculations[1]				
NE_m, (units; Mcal/kg)	1.93[a]	1.65[b]	1.59[b]	0.052
NE_g, (units; Mcal/kg)	1.28[a]	1.03[b]	0.98[b]	0.044

[a, b] Means within rows without common superscripts differ ($P \leq 0.05$)

[1] Calculations based on the equations of Zinn and Shen (1998)

Table 3. Carcass and health characteristics of early-weaned beef calves fed a common diet to achieve 1 of 3 targeted weight gains during an 84-d growing period

	Targeted ADG			
Item,	1 lb/d	2 lb/d	3 lb/d	SEM
Backfat over the 12th rib, mm	3.36[a]	3.55[a]	4.13[b]	0.218
Marbling, % of LM area	4.75	4.68	4.56	0.092
Muscle depth over the 12th rib, mm	38.71[a]	40.24[b]	41.45[b]	0.527
Incidence of undifferentiated fever, %	4.89	6.05	5.85	3.046

[a, b] Means within rows without common superscripts differ ($P < 0.05$)