Growth Performance and Health of Steer Calves Adapted to a High-Concentrate, Program-Fed Diet Using Four Methods

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Story in Brief

An experiment was conducted at the Willard Sparks Beef Research Center to evaluate effects of different methods for adapting calves with a high-risk of morbidity to a high-concentrate, program-fed diet during the growing phase. Five hundred thirty-four steer and bull calves were delivered to the Willard Sparks Beef Research Center, Stillwater, OK from auction markets in Florida, Missouri, Oklahoma, and Texas during November and December 2006. Calves were adapted to an 88%-concentrate diet traditionally using three transition diets, were adapted traditionally using these same diets, but for each transition diet, intake was limited to 2.1, 2.3, and 2.5 times the initial maintenance energy requirements, were fed the 64%-concentrate (receiving) diet for 28 days before being transitioned traditionally, or were program fed the final 88%-concentrate diet from day 1 through the end of the experiment. Results suggested that feeding a higher roughage diet for an extended period (28 days) after arrival resulted in the greatest gain during the 60-day growing period. However, when those cattle were adapted to being fed a high-concentrate program-fed diet, they were less efficient than traditional or program-fed steers. A 21-day adaptation period with ad libitum intake or feeding the high-concentrate diet initially resulted in increased morbidity due to bovine respiratory disease. Therefore, extending the period during which a higher roughage diet is fed or limiting the maximum intake during the adaptation period can reduce morbidity in newly received feedlot steers.

Key words: Bovine Respiratory Disease, Diet adaptation, High-Risk Calves, Morbidity, Programmed Feeding, Roughage Levels

Introduction

Programs for growing calves prior to placement on a finishing diet have traditionally included forages as a significant proportion of the diet. This may be pasture, or in the case of drylot programs, hay or a mixed ration including over 30% roughage. However, in a drylot program, roughage is usually the most expensive feed ingredient per unit of energy (Eng, 1995). With the development of the net energy system and equations (NRC, 2000), producers have been able to feed high-concentrate rations at low levels of intake to achieve a desired rate of gain (Galyean, 1999). In most situations, stocker calves are received from unknown sources or pasture settings, and gradually adapting the rumen to a highconcentrate diet is advisable to reduce the incidence of digestive disturbance and death (Brown et al., 2006). The early days and weeks after arrival are also the time when morbidity due to Bovine Respiratory Disease is most prevalent (Galyean and Duff, 2007). In a review of over 20 years of data from one experiment station, Rivera et al. (2005) concluded that while a higher roughage receiving diet results in lower morbidity, the economic impact of reduced growth performance made feeding the higher roughage diet undesirable. The present experiment was conducted in order to evaluate the effects of different methods for adapting calves with a highrisk of morbidity to a high-concentrate, program-fed diet during the growing phase.

Materials and Methods

Cattle Source and Processing. Five hundred thirty-four steer and bull calves (average initial BW = 626 ± 46 lb) were delivered to the Willard Sparks Beef Research Center, Stillwater, OK from auction markets in Florida, Missouri, Oklahoma, and Texas during November and December 2006. Approximately 1 h after arrival, calves were individually weighed and identified with a sequentially numbered ear tag and placed in pens (40 × 100 ft with 40 ft of linear bunk space). Calves were maintained on long-stemmed prairie hay until an adequate number of cattle were received to begin the trial. Initial processing included vaccinating against viral pathogens (Vista 5 SQ, Intervet Inc., Millsboro, DE) and clostridial organisms (Vision 7 with Spur, Intervet, Inc.), deworming (Safeguard, Intervet Inc. and Ivomec Pour-On, Merial, Duluth, GA), and implanting with zeranol (Ralgro, Schering-Plough Animal Health, Kenilworth, NJ). Bulls were castrated and horns were tipped as needed. Processing occurred on November 19 (n=182), November 21 (n=80), December 2 (n=82), December 5 (n=80), and December 8 (n=110). When a sufficient number of steers was received to fill four or eight pens (n=20 to 24 steers/pen) cattle were randomly assigned to pens based on arrival weight and sorted into home pens (d 0). The range of days between arrival and processing was 0 to 5; between processing and initiation of the trial was 0 to 6.. Steers were revaccinated (Vista 5 SQ) on d 11.

Adaptation Treatments. Pens were randomly assigned to one of four methods of adaptation to a high-concentrate diet. During the trial a total of four diets (Table 1) that were formulated to meet or exceed NRC (2000) recommendations and contained increasing levels of concentrate (64 to 88% concentrate) were fed. Treatments were as follows:

Traditional (TRAD) – Steers were initially fed the 64% concentrate diet at 1.5% of body weight (as-fed). When bunks were slick before feeding, feed delivery was increased 2 lb/steer daily until ad libitum consumption was achieved. On d 8 and 15, the concentrate level was increased to 72 and 80%, respectively. On d 22, the final 88% concentrate diet was fed at an intake programmed (NRC, 2000) so the steers would gain 2.5 lb/d.

Receiving (REC) – Steers were initially fed the 64% concentrate diet and bunks were managed as above. However, the initial diet was offered through d 28 before feeding the step-up diets in 7 d intervals from d 29-42. The program feeding period began on d 43.

Limited Maximum Intake (LMI) – The initial diets were fed similarly to TRAD, but the maximum intake was limited to 2.1, 2.3, and 2.5 times the initial maintenance energy requirement (NRC, 20001996) of steers during days 0-7, 8-14, and 15-21, respectively. On d 22, the steers were program-fed as above.

Program-Fed (PF) – On d 0, the 88% concentrate diet was delivered to provide equivalent metabolizable energy as the 64% diet in the previous treatments. Feed delivered was increased 0.5 lb/steer, and the maximum allowable intake was an amount programmed for the steers to gain 2.5 lb/d.

Feed was mixed and delivered twice daily beginning at 0700 and 1000 in an 84 or 184 cubic foot rotary mixer wagon (Rotomix 84-8 or 184-8, Dodge City, KS) depending on relative batch size to optimize overall feedyard efficiency. Steers were individually weighed on d 21, 42, and 60. On days 20 and 41, steers on TRAD, REC, and LMI treatments were only delivered ½ the previous day's feed call in an attempt to equalize gut fill across treatments prior to weighing. For all steers in, or beginning, program-feeding, the programmed intake was adjusted based on the most recent pen average weight. Fecal grab samples were collected from six steers/pen at revaccination and all weigh days. Those samples were immediately used for pH measurement (SympHony SP70P, VWR Scientific, Irving, TX).

Protocol for Treatment for Bovine Respiratory Disease. Each morning, steers were evaluated for signs of Bovine Respiratory Disease (BRD) by trained personnel. Signs of disease included depression, lack of fill compared with pen mates, altered gait, and nasal or ocular discharge. Any calf exhibiting one or more of these signs was assigned a severity score from 1 (mild) to 4 (moribund) and pulled to the chute for further evaluation which included recording rectal temperature (GLA, M-500, GLA Electronics, San Luis Obispo, CA). Steers with a severity score of 1 or 2 were administered antimicrobials only when the rectal temperature was $\geq$ 104.0ºF, and steers with a 3 or 4 were treated regardless of rectal temperature. Steers were treated with antimicrobials according to a standard feedlot protocol which included tulathromycin (1.1 mL/100 lb BW; Draxxin, Pfizer Animal Health, Exton, NY) initially, followed by florfenicol (6.0 mL/100 lb BW; Nuflor, Scherinc-Plough Animal Health, Kenilworth, NJ) for a second pull, and two doses of ceftiofur (2.0 mL/100 lb BW; Excenel, Schering-Plough Animal Health, Kenilworth, NJ) for a third pull.

Statistical Analysis. Performance variables including BW, ADG, DMI, and ratio of ME intake to gain were analyzed as a completely randomized block design with pen as the experimental unit using the MIXED procedure of SAS (SAS Institute, Cary, NC). The model statement contained the fixed effect of adaptation treatment. All pens that began treatments on the same day were classified as a load, and the random statement contained load and weight block within load. Morbidity data including total morbidity, number of second and third treatments, mortality, case fatality rate, and average days on feed to first treatment were transformed to percentages for each pen and analyzed using the model listed above. Fecal pH data was analyzed as repeated measures with steer as the experimental unit using PROC MIXED. Treatment, period, and the treatment×period interaction were included in the model with load and weight block within load in the random statement. Differences were considered significant when P<.05 and as tendencies when P<.10.

Results and Discussion

Performance. Growth performance for cattle in the study is listed in Table 2. Steers on the four adaptation treatments had similar BW (P=.55) and ADG (P=.41) on d 21. However, from d 22 to 42, REC steers gained faster (P>.001) and therefore weighed more (P<.001). Even though steers that were being fed ad libitum had feed removed on the day prior to weighing, a portion of the advantage of REC steers on d 42 can probably be contributed to gastrointestinal fill since on d 60, after all steers had been program-fed a common diet for 18 d, the range between REC (BW=772 lb) over PF steers (BW=760 lb) was numerically less than on d 42. However, REC steers still had the greatest (P=.06) BW and PF the least with TRAD and LMI intermediate.

Over the entire growing period, ADG was greatest (P=.02) for REC, intermediate for TRAD and LMI, and least for PF. Figure 1 illustrates cumulative dry matter intake for steers in the experiment. As intended, REC steers consumed more feed (P<.05) and PF the least. However, no differences could be separated between TRAD and LMI steers, even though LMI steers were restricted to some extent during the first 21 d and TRAD were fed ad libitum. Using yearling cattle, Bartle and Preston (1992) reported that LMI steers consumed less feed during the adaptation period than steers fed ad libitum, but noticed no difference in BW of feed efficiency. When using steer calves, Choat et al. (2002) reported similar results to the present study with decreased DMI and ADG of calves limit-fed the finishing diet compared with traditional adaptation using multiple diets with intermediate levels of concentrate. This effect was consistant throughout the 173-d feeding period. In another experiment in the same report, yearling steers limit-fed consumed and gained less during the initial 28 d, but gain was similar for the entire 70-d finishing period. The authors indicated that there was a difference in calves vs steers when using restricted levels of a high-concentrate diet for adaptation.

Due to the design of the experiment with dietary restriction and ad libitum intake treatments occurring at the same time, we chose to report the efficiency of metabolizable energy intake to gain (calculated as average daily ME intake/ADG) rather than efficiency of DMI to ADG. Over the 60-d growing period, REC steers consumed the greatest ME/d (P<.001), but tended to be least (P=.06) efficient in converting that energy to gain. No differences due to treatment or the treatment×period interaction (P>.10) occurred for fecal pH (Figure 2). However, pH was lower on d 42 and 60 than on d 11 and 21 (P<.01). This may be expected with all steers eating a greater amount of a high-concentrate diet on those days.

Morbidity. In all the reports previously mentioned, no indication of morbidity due to BRD was reported. In the case of Bartle and Preston (1992) and Choat et al. (2002; experiment one), yearling cattle with presumably low risk of BRD were used. Therefore, one of our goals was to obtain cattle with a relatively high risk for BRD and use pens with adequate population numbers to give a robust indication of incidence of BRD on the various dietary treatments. BRD morbidity was relatively high with 38.7% of calves being treated at least once for BRD. Total BRD morbidity was greater (P=.02) for TRAD and PF steers compared with REC and LMI (Table 3). The number of steers treated three times for BRD (chronics) was greatest (P=.03) for PF, intermediate for TRAD, and least for REC and LMI. These results are consistent with those reviewed by Rivera et al. (2005). The reasons for increased morbidity with increasing dietary percent concentrate are not known. While the fecal pH results in this study and metabolism data (Choat et al,, 2002) did not indicate digestive upset, one postulated reason for this is that a higher concentrate diet resulted in more cases of sub-clinical ruminal acidosis that are diagnosed incorrectly as BRD. Though not significant, steers on the LMI and PF treatments were initially pulled 1 to 5 days earlier on average than TRAD and REC steers. A possibility exists that reduced gastrointestinal fill in these restricted steers changed the perception of the steers to the personnel pulling the steers and allowed BRD events to be detected earlier than they would have been otherwise.

Conclusion

In the current experiment, feeding a higher roughage diet for an extended period (28 d) after arrival resulted in the greatest gain during the 60-d growing period. However, when those cattle were adapted to being fed a high-concentrate program-fed diet, they were less efficient. A 21-d adaptation period with ad libitum intake or feeding the high-concentrate diet initially resulted in increased morbidity due to BRD. Therefore, extending the period during which a higher roughage diet is fed or limiting the maximum intake during the adaptation period can reduce morbidity in newly received feedlot steers.

Table 1. Composition of Experimental Diets (DM Basis)

	Percent Concentrate			
Item[a]	64	72	80	88
Dry Rolled Corn	43.55	50.45	57.35	64.25
Corn DDGS	15.70	15.80	15.90	16.00
Liquid Supplement[b]	1.00	2.00	3.00	4.00
Dry Supplement[c]	3.75	3.75	3.75	3.75
Ground Alfalfa Hay	18.00	14.00	10.00	6.00
Prairie Hay	18.00	14.00	10.00	6.00
Dry Matter, %	84.06	83.95	86.18	84.54
ME, mcal/kg	1.21	1.26	1.32	1.38
NEm, mcal/kg	.81	.85	.89	.94
NEg, mcal/kg	.50	.54	.57	.60
Crude Protein, %	14.02	14.04	14.06	14.08
Crude Fat, %	4.37	4.73	5.10	5.46
ADF, %	19.44	16.39	13.34	10.29
NDF, %	31.16	27.34	23.53	19.71

[a]All items except dry matter on a dry matter basis.

[b]Synergy 19-14 (Westway Feed Products, Catoosa, OK).

[c]Contained monensin (775 g/ton) and tylosin (210 g/ton).

Table 2. Performance of steers on four different programs for adaptation to a high-concentrate diet.

	Treatment				
Item	TRAD	REC	LMI	PF	*P* > F[†]
BW, kg					
Initial	624	622	626	624	.55
d 21	675	674	670	666	.58
d 42	730[a]	761[b]	728[a]	721[a]	.001
d 60	772[ab]	776[a]	765[bc]	761[c]	.055
ADG, kg/d					
d 0 - 21	2.34	2.38	1.98	1.92	.41
d 22 - 42	2.54[a]	4.06[b]	2.78[a]	2.60[a]	.001
d 43 - 60	2.54[b]	.90[a]	2.18[b]	2.38[b]	.001
d 0 - 60	2.49[bc]	2.58[c]	2.34[b]	2.29[a]	.017
ME intake, Mcal/d					
d 0 - 21	16.18[a]	16.02[a]	16.77[a]	13.26[b]	.003
d 22 - 42	18.41[b]	23.99[a]	18.47[b]	18.73[b]	.001
d 43 - 60	19.0[1b]	19.54a	18.99b	18.97b	.002
d 0 - 60	17.67[bc]	19.75[a]	17.93[b]	16.72[c]	.001
ME:Gain, Mcal/kg					
d 0 - 21	9.15	7.45	8.81	7.25	.481
d 22 - 42	9.73	5.97	7.29	2.41	.101
d 43 - 60	8.52[b]	21.50[a]	11.68[b]	8.76[b]	.003
d 0 - 60	7.37	7.81	7.79	7.39	.057

[†] Probability of overall F test.

[abcd] Means within a row without a common superscript differ ($P < 0.05$).

Table 3. Morbidity of steers on four different programs for adaptation to a high-concentrate diet.

	Treatment				
Item	TRAD	REC	LMI	PF	P > F†
Total Morbidity	45.94[a]	33.97[bc]	29.64[c]	43.56[ab]	.021
Second Treatments	22.95	15.18	18.52	28.38	.107
Third Treatments	4.48[ab]	1.45[a]	2.24[a]	7.98[bc]	.032
Total Mortality	4.48	.72	1.48	.69	.138
Case fatality rate	7.66[d]	1.52[c]	0[a]	1.39[b]	.034
DOF to 1st Treatment	10.91	12.79	7.21	9.28	.124

† Probability of overall F test.

abcd Means within a row without a common superscript differ (P < 0.05).

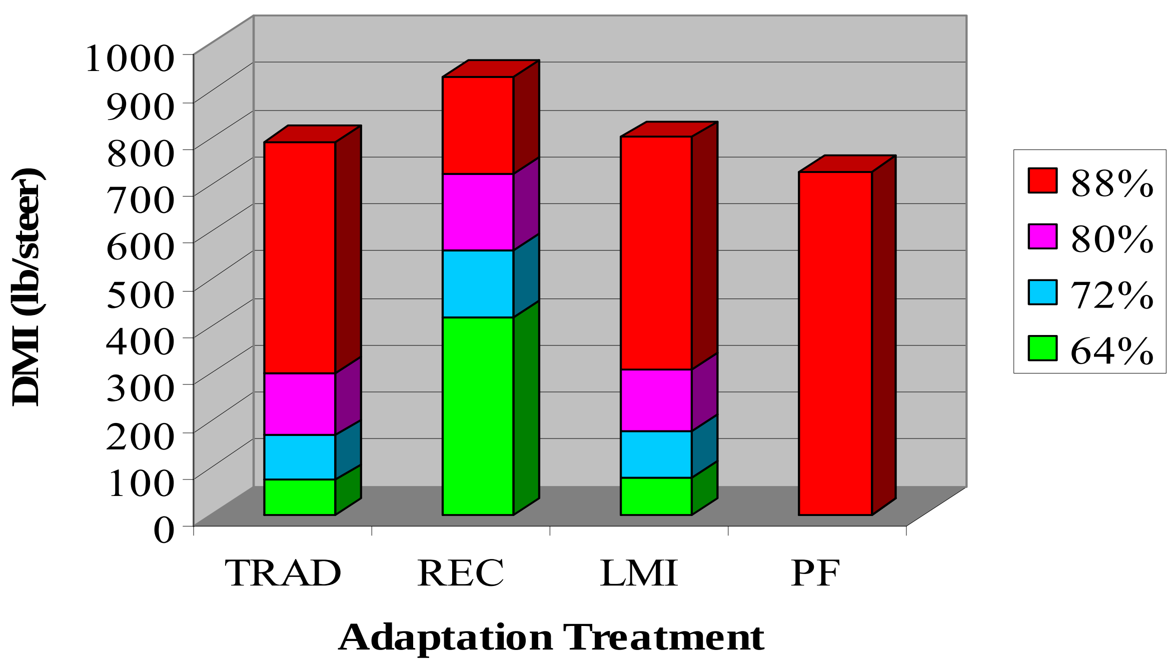

Figure 1. Total dry matter intake of steers on four different programs for adaptation to a high-concentrate diet (*P*<.05).

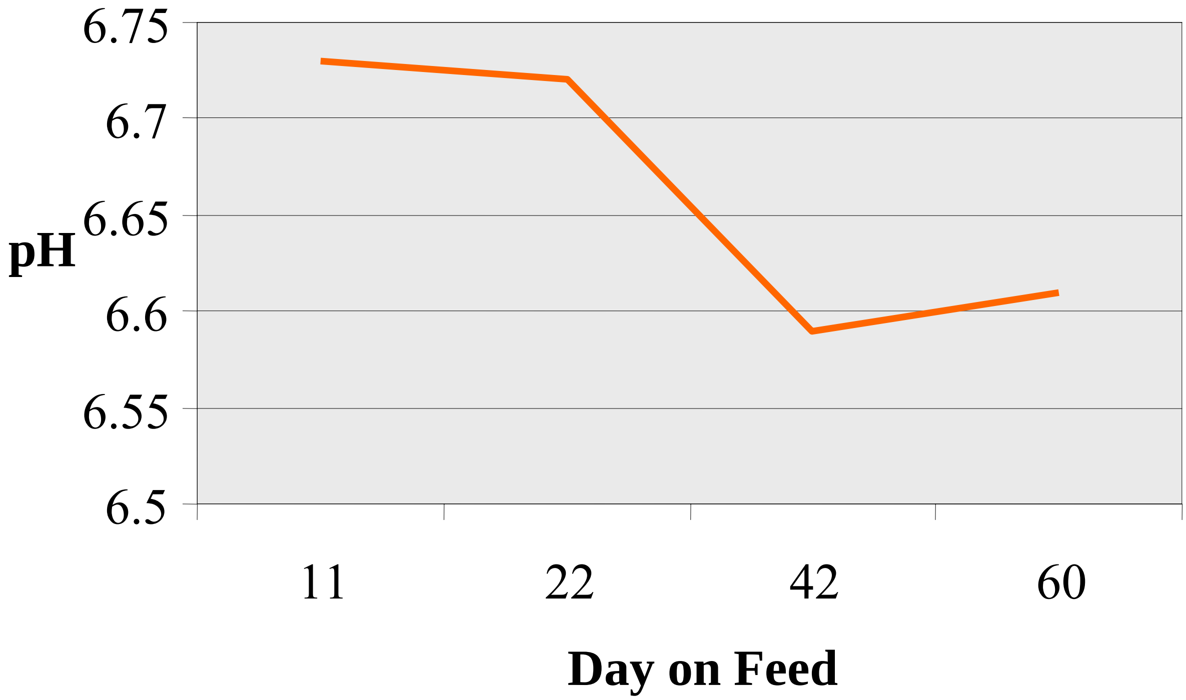

Figure 2. Average fecal pH of steers on four different programs for adaptation to a high-concentrate diet (Treatment *P*=.66; DOF *P*<.01; Treatment×DOF *P*=.10).

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