EFFECTS OF BACKGROUND PROCEDURES AND PROBIOTIC ADMINISTRATION ON WEIGHT GAIN IN GROWING HEIFERS

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EFFECTS OF BACKGROUND PROCEDURES AND PROBIOTIC ADMINISTRATION

ON WEIGHT GAIN IN GROWING HEIFERS

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ABSTRACT

Angus sired heifers (n=96; initial BW 200 kg) were used to evaluate the effects of background procedures and probiotic administration on weight gain in growing heifers. Heifers were stratified by arrival BW into a 2×2 factorial arrangement where treatments consisted of direct fed microbials (DFM) (yes or no), and High Ruminal Ammonia or Control (HRA or CTR). Heifers were acclimated for 7 d, and treatments were applied for 77 d. Rectal temperatures were taken and any heifer with a temperature >40°C was determined to have pyrexia (fever). Overall, heifers that did not exhibit signs of pyrexia had an ADG of 0.973 kg which translates into a 0.085 kg/d greater ADG ($P < 0.05$). For the first 21 days (Period A), CTR fed heifers experienced higher ADG than the HRA fed heifers. Heifers fed the HRA diet had a higher ADG than those fed the CTR diet for Period B and C.

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INTRODUCTION

During periods of reduced forage availability, calves are often weaned early, prior to reaching a target weight acceptable for placement in a feedlot. In addition, most commercial feedlots would prefer that calves spend a minimum of 90 days on feed before entering the feedlot to improve performance and weight gain. Unfortunately, commercial feeds and forages are expensive; thus, reducing the profit potential for beef cattle producers to implement pen-feeding of early weaned calves.

Feeding hay may reduce the cost of feeding during this time while maintaining adequate growth. Additionally, grain and alternative protein sources may be added to the diet to improve growth and gain. Unfortunately, grain and protein prices may affect ration formulation. If corn is too expensive, corn by-products, such as dry distiller's grains, can be utilized. Due to the high energy and protein content of distiller's grains, producers may be able to feed cattle less and still achieve optimal levels of growth.

Many different supplemental nutrients can be utilized to enhance forage potential for weight gains. Protein can help to stabilize the rumen microbes and must consist of both rumen degradable and undegradable protein. Direct-fed microbials (DFM) may also improve levels of performance and can potentially decrease ruminal acidosis. Interest in DFM has increased in recent years due to consumer concerns regarding the use of growth stimulants and antibiotics in livestock.

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OBJECTIVES

The objective of this study is to characterize the effects of utilizing low cost/low input diets and direct fed microbial administration on weight gain performance of growing heifers.

LITERATURE REVIEW

Systems of growing cattle

A seasonal shortage of pasture in the fall will often cause weaned calves to be grown to heavier body weight (BW) in a drylot until pasture is available in the spring (Beck et al., 2005). Stocker cattle can experience a growth lag for up to 30 d after being switched from a drylot diet to a pasture setting. Fresh forages contain soluble carbohydrates and cause an increased population of rumen microbes. These microbes digest soluble carbohydrates that may be in place already if animals are fed liquid supplements or high-concentrate diets before they are turned out for grazing (Beck et al., 2005). Programmed feeding is a method that utilizes a high-concentrate feed that is based on the amount of net energy (NE) needed to meet prescribed average daily gain (ADG) of growing cattle, and limit feeding intake to be below *ad libitum* levels. Prior to grazing, programmed or limit feeding is a cheaper way to background growing calves than feeding cattle with free choice hay. It has been observed that limit feeding high-concentrate diets in a drylot can be used as an economical alternative to feeding hay without extended adaptation periods prior to pasture turnout (Beck et al., 2005).

Drylotting heifers, prior to breeding to help them achieve ideal prebreeding BW, is a common practice. A drylot is a fenced-in area that is free of vegetation and is used for feeding and fattening of livestock. For successful reproduction, it has previously been recommended that heifers reach roughly 65% of mature BW by the first artificial insemination (Funston and Larson, 2014). Due to increased feed costs, it is important for producers to consider lower-input methods to reach the desired levels of BW before breeding. It is more cost effective, however, to feed heifers to a prebreeding weight of 51-57% of their mature BW rather than 65% and this lower weight is still effective for breeding purposes (Funston and Larson, 2014). Winter grazing in Nebraska was an acceptable substitute to drylot for developing heifers and can significantly reduce cost as well as be more sustainable than drylot development, if abundant forage is available. If forage availability is limited, however, drylotting is proven to have higher prebreeding BW, higher ADG for the complete weaning to breeding phase, and a greater percentage of mature BW at breeding. By limiting the length of drylot feeding by grazing winter forage or corn residue for at least 135 d postweaning, decreased prebreeding feed cost by $42/heifer compared to drylot feeding for the prebreeding period (Funston and Larson, 2014).

Preconditioning Management Systems

If nutritional strategies that improve calf performance can be identified early in life, this can improve adult production criterion, and provide opportunities to optimize feed resources and thus, improve cattle operation profitability. *Bos Taurus* heifers weaned at roughly 90 d of age and then offered a high-concentrate diet before breeding had greater attainment of puberty at the start of breeding season than suckling heifers traditionally weaned at 7 months (Moriel et al., 2014). Additional observations by Moriel et al. (2014) determined that *Bos indicus* heifers limit fed a high concentrate diet at 3.5% of BW (as fed) in drylots until d 180 were heavier than normally traditionally weaned heifers in addition to heifers grazing ryegrass and Bahiagrass. A similar result was also observed in this study for heifers that were limit fed the same diet through d 90, but then grazed Bahiagrass pastures to d 180. The heifers fed strictly the drylot diet until d 180 reached puberty at the youngest age.

Both groups of drylot fed heifers evaluated in this study exhibited altered BW as compared to normally weaned and managed heifers. It was determined that limit feeding heifers for 90 days and then grazing or limit feeding for 180 days were suitable options for anticipating achievement of puberty in comparison to traditionally weaned and managed heifers.

The impact of feeding programs initiated later in life for replacement heifer development may be determined by the nutritional status of heifers during the early period of their lives. Precocious puberty (<300 d of age) can be achieved in most heifers if they are fed a high-concentrate diet and weaned early. In Gasser et al. (2006), heifers were randomly assigned to receive either a control (30% corn; C) or high-concentrate (60% corn; H) ration during the first phase (average age between 126 and 196 d) and H or C during the second phase (average age between 196 and 402 d), resulting in 4 separate treatments. H treatment group heifers achieved puberty sooner and were heavier. It was concluded increasing dietary energy intake in early-weaned heifers, through feeding a high-concentrate diet during the first phase, decreased puberty age despite the diet fed after an age of 196 d (Gasser et al., 2006). The diet consumed during phase 2 was a less important determinant of age at puberty than the diet consumed during phase 1. Feeding a high-concentrate diet to early-weaned heifers when they are 4 to 6.5 months of age can hasten attainment of puberty similarly to that of heifers that are fed a high-concentrate diet after early weaning continuously.

Feedlot Cattle Diet- Acidosis Potential

Feedlot cattle are routinely adapted from high-forage diets to high-concentrate diets, causing upsets to occur in the ruminal environment, and it takes time for a stable microbial populations to be established (Bevans et al., 2005). When abrupt changes occur from the aforementioned high-forage to high-concentrate diets, acute or subacute acidosis can result. Subacute acidosis is more challenging to identify than acute acidosis. Symptoms may include decreased intake and a reduction in performance. With acute acidosis, as acids and glucose accumulate, osmolarity and ruminal acidity increase considerably; these can cause damage to the ruminal and intestinal wall, lower blood pH, and cause dehydration that can be fatal. Blood pH must fall below 7.35 for clinical diagnosis of acidosis; however, other clinical signs include irregular feed intake, ruminal pH anorexia, diarrhea, and apathy are routine characteristics of acidosis in the feedlot (Owens et al., 1998). Metabolic digestive disturbances are typically attributed to extreme daily shifts in behavior at feeding and variable feed intake by feedlot managers and nutritionists. After a period of feed withdrawal, introduction to a high-concentrate diet can ultimately result in acidosis. Ruminal pH profiles can differ considerably among cattle, even among those experiencing the same conditions and fed the same diet in the same amounts and at the same time. Determinants other than meal size, and feeding procedure determine susceptibility to ruminal upset and can thus influence growth performance. Programmed feeding, delivering feed multiple times a day, and consistent delivery timing are feedlot management procedures that were developed to regulate feeding behavior, and reduce feed intake variations in feedlot cattle. However, variation of intake among individuals is not viewed as much as the intake per pen of animals (Schwartzkopf-Genswein et al., 2003). Cattle feeders traditionally increase dietary concentrate in incremental amounts over 3 to 4 weeks when high concentrations of grain are utilized. If cattle are adapted more rapidly, this would be preferred to increase ADG and gain efficiency, since these generally increase when high-concentrate diets are fed. Acidosis must be prevented in the entire group of cattle, so it is customary that high-grain adaptation programs are implemented in gradual increments, even when some individuals respond appropriately to rapid adaptation (Bevans et al., 2005).

Direct-fed Microbials

Direct fed microbials have been utilized in both humans and livestock based on the potential for advantageous intestinal effects; however, recently, there have been indications of specific bacterial DFM having beneficial effects in the rumen of livestock by reducing the potential for acidosis. Much research has been conducted on DFM, with data indicating there is potential to reduce acidosis in the feedlot and dairy, and improve immune response in cattle experiencing stress (Krehbiel et al., 2003).

There are several microbiological criteria that must be met for DFM to be effective; including, survival through sections of the gut, nonpathogenicity, genetic stability, and specificity to host (Krehbiel et al., 2003). If these criteria are met, it has been reported that bacterial DFM modify intestinal microorganism balance, attach to the intestinal membrane and prevent pathogen adherence or activation, affect permeability of the gut, and regulate immune function (Krehbiel et al., 2003). This study also explains that within the first 14 d of the receiving period, the greatest performance response to bacterial DFM generally occurs, and in most studies, feed efficacy, an increase in ADG, and a decrease in death loss was observed in stressed calves.

Beauchemin et al. (2003) explains that although bacterial DFM can improve feed utilization by feedlot cattle, the type of bacterial species is imperative to developing an effective product. Two experiments were conducted to determine if a bacterial DFM by itself or with yeast could reduce the chance of acidosis and improve feed utilization in the feedlot where cattle receive high-concentrate diets. Eight cannulated steers that had been formerly adapted to a high-concentrate diet were utilized. Steers received *ad libitum* access to a ration that featured barley silage, steam-rolled barley, and a protein-mineral supplement. It was concluded that the DFM that included *Enterococcus faecium,* with or without yeast, did not provide any added benefits to feedlot cattle adapted to high-grain rations. However, supplemental *Enterococcus faecium* bacteria may be beneficial to cattle not adapted to high-concentrate diets, such as newly received cattle (Beauchemin et al., 2003).

Bovine Respiratory Disease Potential in Feedlot

In the United States, Bovine respiratory disease (BRD) is the most common and costly disease of feedlot cattle. Bovine respiratory disease is a series of diseases that can be distinguished by many types of infection, which have different causes, symptoms, and economic implications. Shipping and processing calves into the feedlot predisposes them to BRD and increases environmental risk factors. Predisposing causes include stress (comingling, weather, nutritional changes, etc.), age, and their previous immunity. Some environmental factors include ventilation, distance of shipping, temperature, dust, stocking density, and humidity. Infectious period, virulence, microbial agent(s), parasite density dependence, mode of transmission, and latent and carrier periods, are all examples of epidemiological factors (Snowder et al., 2006). Symptoms of BRD in feeder calves generally included more than 1 of the following: coughing, fever, heavy breathing, nasal or eye discharge, dehydration, diarrhea, and lack of appetite (Snowder et al., 2006).

Schneider et al. (2009) used health records and lung lesion scores after slaughter to examine the effects of BRD on economically important production traits. ADG was considered for 3 separate periods of feeding (acclimation, on-test, and overall test) along with final BW. 5,976 cattle were utilized in this study from Midwestern feedlots. The results of this study determined that occurrence of BRD in the feedlot reduced ADG during the acclimation period and the overall test. Reduction in performance and carcass merit perceived were associated with a decrease of ($23.23, $30.15, and $54.01 respectively) in carcass value when cattle never treated, treated once, or more than once. (Schneider et al., 2009).

Low quality forage characteristics

Forage quality can be defined as the respective performance of livestock when herbage is fed *ad libitum*. It is the product of intake potential, nutrient concentration, digestibility, and partitioning of metabolized products within the animal. In addition to the direct response of animals to forage quality, animal performance also is influenced by many non-forage factors such as animal genetics, animal physiological state, and animal environment as well as interactions between forage and animals (Buxton et al., 1996). The diversity of plants growing in a field or ecosystem helps to determine forage quality, depending on the growing and harvesting conditions. Although certain aspects of quality can be modified after harvest, the plant species, growth stage, and condition at harvest generally dictate quality of the forage (Nelson and Moser, 1994).

Warm-season (i.e., C_4) grasses are the foundation of livestock systems in many parts of the world. 85% of the food supply for milk, meat, and fiber production in warm climates is made up of these forages. They are usually grazed, but can be conserved as hay or silage. Quality of C_4 grasses can be quite excellent early in the growing season, but they grow and mature rapidly. Like the C_3 grasses, the quality of C_4 grasses declines with maturity. Unless C_4 grasses are managed properly, they may only meet maintenance requirements for adult animals (Coleman et al., 2004). Generally, the organic matter of warm-season grasses and most other forages is too low in digestibility to fully meet the energy needs of moderate-to high-producing herbivores, especially as forages near maturity. Cell walls, consist of proteins, silica, cutin, polysaccharides, and water, are major limitations to digestibility. Cell contents, consist of soluble carbs and minerals, lipids, proteins, and organic acids, which are all usually readily available and highly digestible (Buxton et al., 1996).

Voluntary intake of forage depends on the quantity of excess feed offered. This increase in intake is caused by two factors, appetite variance from day to day, and sufficient forage availability when appetite is high and intake is not to be depressed by a shortage of forage. The second reason for variation in intake is the increased opportunity for the animal to select the more desirable and usually less fibrous parts of the forage when excess forage is available (Minson, 1990).

Forage digestibility, intake, how much grain is in the diet, and the animal's maturity are all related to the rate of substitution of grain for forage. Ruminants that consume high amounts of forage generally have high substitution rates. This could be due to metabolic mechanisms, which control voluntary intake which reduces intake of forage. Livestock consuming forage of low and medium digestibility often have low substitution rates (Dixon and Stockdale, 1999).

MATERIALS AND METHODS

All methods were approved by the Angelo State University's Institutional Animal Care and Use Committee (15-06). Mention of trade names is provided for description only and does not constitute product endorsement over similar products.

Angus-sired heifers (n=96; initial BW 200 kg) were stratified by initial BW and assigned to treatments in a 2×2 factorial arrangement where treatments consisted of DFM (yes or no), and High Ruminal Ammonia or Control (HRA or CTR). Treatments were assigned to alternating pens and, after a 7 d diet acclimation period, applied for 77 d. Heifers were either limit-fed a concentrate diet (HRA) or Sorghum Sudan hay (round bale) in addition to a dry supplement (CTR). The HRA feed consisted of medium ground corn grain, sorghum sudan hay, HRA hfr concentrate, and cottonseed meal. The supplement was formulated to be isonitrogenous to the concentrate diet and consisted of mineral premix, urea, calcium carbonate, and corn distiller's ethanol. The HRA diet components and percentages are presented in Table 1.

Table 1. Ingredients and Percentages of HRA hfr concentrate feed

Ingredients	% in Ration (As-Fed)
Corn Grain Ground Medium	43.51
Sorghum Sudan Hay MIR	40.70
Cottonseed Meal 42Cp	8.77
HRA hfr concentrate	7.02
Mineral Premix Heifer	25.07
Urea 281 CP	10.30
Calcium Carbonate	9.90
Dried Distillers Grain	54.72

The CTR feed consisted of free choice sorghum sudan hay and CTR hfr supplement. The supplement was composed of mineral premix, cottonseed meal, medium ground corn grain, and corn gluten feed. The CTR diet components and percentages are presented in Table 2.

Table 2. Ingredients and Percentages of CTR hfr feed

Ingredients	% in Ration (As-Fed)
Sorghum Sudan Hay MIR	67.23
CTR hfr Supplement	32.73
Mineral Premix Heifer	4.27
Cottonseed Meal	22.22
Corn Grain Ground Medium	51.28

Additionally, treatments of direct-fed microbial and calcium propionate was imposed on an equal number of individuals within the HRA and CTR diet treatments. Six heifers were selected from each diet treatment pen to receive two randomly chosen boluses of an approximate total net weight of 15g of Probios® (direct-fed microbial). Boluses were administered orally via a bolus gun inserted into the mouth and down the esophagus.

Body weight was collected on day on d 0, 7, 21, 35, 49, 63, 77 of the dry-lot period. Feed was delivered to cattle at approximately 1300 hrs each day. Orts were collected each day before feeding during the first 21 days of the study. Orts were weighed and recorded before fresh feed was delivered. Heifers on the CTR ration received fresh round bales as needed to maintain *ad libitum* access throughout the study. Samples of feed were collected each day for each treatment diet. Each week, a new series of samples were collected. These samples were sent to SDK Laboratories (Hutchinson, KS) for analysis at the completion of the study.

Mixed model procedures of SAS (v. 9.2; SAS inst, Inc., Cary, NC) were used to analyze body weight with a model that includes the fixed effects of Diet (HRA, CTR), Direct Fed Microbial (YES, NO), day (0, 7, 21, 35, 49, 63, 77), Pyrexia (> 40°C) (YES, NO), day 0 weight as a covariate, and two-way interactions. These models were ran as repeated measures with multiple covariance structure options being evaluated prior to final analysis. The first order autoregressive covariance option was selected. Average daily gain measures between the observation days were calculated and analyzed with similar models that excluded the repeated measures statements. In all models, main effects with ($P \geq 0.15$) and interacting terms with ($P \geq 0.25$) were removed from final analysis. The least squares means of each model were separated using / PDIFF option and $P \leq 0.05$ were considered different.

RESULTS AND DISCUSSION

The summary statistics (n=96) of this data is presented in Table 3 to help explain the nature and structure of the response variables of interest.

Table 3. Summary Statistics of Variables Measured

Variable	Mean	Minimum	Maximum	Standard Deviation	Coeff. of Variation
Period-A ADG, (d0 - d21)	0.997	0.281	1.555	0.285	0.286
Period-B ADG, (d21 - d49)	1.002	0.389	1.588	0.267	0.267
Period-C ADG, (d49 - d77)	0.855	0.324	1.393	0.197	0.231
Overall ADG, (d0 - d77)	0.947	0.424	1.414	0.173	0.183
Day 0 Weight, in kgs	215.288	148.780	270.344	25.241	0.117
Day 7 Weight, in kgs	225.027	156.491	283.952	26.888	0.119
Day 21 Weight, in kgs	236.215	162.841	293.024	27.517	0.116
Day 35 Weight, in kgs	250.504	178.264	313.889	28.745	0.115
Day 49 Weight, in kgs	264.268	185.975	331.126	30.597	0.116
Day 63 Weight, in kgs	277.639	195.047	350.177	31.959	0.115
Day 77 Weight, in kgs	288.214	201.397	359.249	33.165	0.115

While much variation exists, differences were not observed in all variables in the present study. Specifically, d 0 weight was used for stratification purposes and no inherited differences associated with diet ($P = 0.85$), Direct Fed Microbials (DFM) ($P = 0.65$), or Diet × DFM interaction ($P = 0.61$) were observed.

The rate of weight gain was a primary interest in this project and ADG was calculated from d 0 – 21 (Period A), and every 28 days thereafter through d 77; d21 – 49 (Period B), d49 – 77 (Period C). Adapting feedlot cattle from a high-forage to high-concentrate diet can cause significant changes in the environment of the rumen, which leads to delays in re-establishing stable microbial populations. Introducing rapidly fermentable carbohydrates can result in a substantial reduction of fibrolytic bacteria, accelerated production of amylolytic bacteria, and a reduction in ruminal pH (Bevans et al., 2005). Quickly adapting cattle to grain, however, improves ADG and gain efficiency when high-concentrate rations are consumed. In these data, the main effect of diet treatment was a source of variation for ADG in all calculated ADG periods, however Period A displays a contrasting pattern of growth performance as compared to the following periods seen in Table 4.

Table 4. Least squares means of ADG by diet (HRA, Control), Direct Fed Microbial (Yes, No), and Pyrexia Status (Yes, No)

	Diet			
	CTR	HRA	SEM	*P*
Period A ADG	1.06	0.86	0.06	< 0.01
Period B ADG	0.85	1.14	0.05	< 0.01
Period C ADG	0.78	0.92	0.04	< 0.01
Overall ADG	0.88	0.98	0.03	< 0.01
	Direct Fed Microbial			
	YES	NO	SEM	*P*
Period A ADG	0.95	0.97	0.06	0.63
Period B ADG	1.00	0.99	0.05	0.81
Period C ADG	0.81	0.88	0.04	0.07
Overall ADG	0.92	0.95	0.03	0.36
	Pyrexia Status			
	YES	NO	SEM	*P*
Period A ADG	0.87	1.05	0.06	< 0.01
Period B ADG	0.96	1.02	0.05	0.24
Period C ADG	0.83	0.87	0.04	0.30
Overall ADG	0.89	0.97	0.03	0.01

Heifers consuming the CTR treatment gained 0.195 kg more daily than did HRA treatment ration fed heifers during Period A ($P < 0.05$). But the ADG of the HRA consuming heifers was 0.29 kg/d greater than the CTR diet heifers for Period B ($P < 0.05$). While daily dry matter intake was beyond the scope of this trial setting, differences in these growth patterns is likely due to nutrient density availability and ruminal changes allowing for added soluble carbohydrate adaptation and absorption.

Leupp et al. (2009) concluded that dry distillers grains (DDG) can be fed up to 1.2% of BW daily to cattle eating moderate-quality brome hay without negative effects on ruminal fermentation or forage digestion. Producers can potentially feed less forage and increase stocking rates by supplementing DDG, which decreases hay intake. Cattle ingesting moderate-quality forage diets can be limited in RDP (ruminally degraded protein); however, DDG have more RUP (ruminally undegraded protein), and may incidentally supply RDP through the urea cycle. These attributes make DDG an appealing supplement for ruminants fed moderate-quality forage based diets (Leupp et al., 2009). The HRA diet in the current study contains 40.70% Sorghum Sudan Hay mixed within the feedstuffs. However, based on analysis, this hay is designated as low quality. This lower quality forage has reduced RDP compared to moderate-quality forage. The efficient ruminal fermentation function to maintain additional growth rate advantage was observed through Period C.

Heifers consuming the HRA feed ration had 18.28% higher ADG than the CTR treatment during Period C ($P < 0.05$). In this study, the HRA hfr concentrate in the HRA diet concentrate contained 54.72% DDG. Observations by Morris et al. (2005) used high and low quality forage sources to determine the effects of five different levels of DDG on intake of forage. Dried distillers grains were determined to be an economical supplement for cattle fed either low or high quality forage diets. The main effect of diet treatment was a source of variation, ($P < 0.05$), for ADG for Period A, B, & C combined as well (Table 4).

Overall (d 0 – 77), heifers that received the HRA diet had an ADG of 0.982 kg and the CTR diet had an ADG of 0.878 kg. This would agree with Ceconi et al. (2015) which reported the effect of increasing dietary DIP (degradable intake protein) through the addition of urea on total tract digestibility, feedlot performance, carcass characteristics, ruminal fermentation, and purine derivatives-to-creatinine (PDC) index. Carcass-adjusted ADG was higher ($P \leq 0.04$) for the high urea ration in comparison to the low urea and control rations. Carcass-adjusted gain: feed was higher ($P = 0.03$) for the high urea ration compared with the low urea ration, and tended ($P = 0.09$) to be higher compared with the control diet.

Rate of gain differences in this trial due to diet treatment would imply that limit feeding low quality forage and including DDG in conjunction with urea in confined fed growing heifers appears to be advantageous through decreases in forage costs and increased selling weights. In production scenarios where forage availability is limited, it could also be economically advantageous to supplement DDG with urea to potentially offset forage intake and extend standing forage surplus, however these benefits are increased when combined with low quality forage supplies.

Probios® bolus capsules were administered at d 0 as an additional treatment variable to determine the effects of direct fed microbial (DFM) on ADG. No differences were observed in Period A or Period B, but the DFM treatment effect was a significant source of variation for Period C ADG. Heifers that received a DFM bolus had an ADG of 0.811 kg and the heifers that did not receive DFM had an ADG of 0.885 kg ($P < 0.05$). It should also be noted that fourteen heifers receiving DFM were identified with symptoms of morbidity, had elevated rectal temperatures over 40^{o} C and were therefore treated with florfenicol (Nuflor®) at d 7 of the trial. Due to the commonly known effects of morbidity in pen fed cattle, rectal temperature status was recorded and florfenicol treatments were administered to all heifers that were over 40^{o} C at d 7. Consequently, rectal temperatures above 40^{o} C (YES or NO), were added as terms in the final analysis, but no DFM × rectal temperature status interaction was detected. These results are in agreement with Zinn et al. (1999) observation of the influence of yeast culture for 28 d on performance and health on crossbred calves (190 kg), (n = 112) experiencing shipping stress during a 56-d receiving period. Yeast supplementation was examined in 2 programs (calves were started on chopped forage for the first 7 d and then given a 72% concentrate receiving diet compared to beginning calves on the 72% concentrate diet directly) in a 2×2 factorial arrangement. It was observed that yeast did not influence feed efficiency or ADG ($P > 0.10$). Yeast, however, did reduce ($P < 0.05$) morbidity.

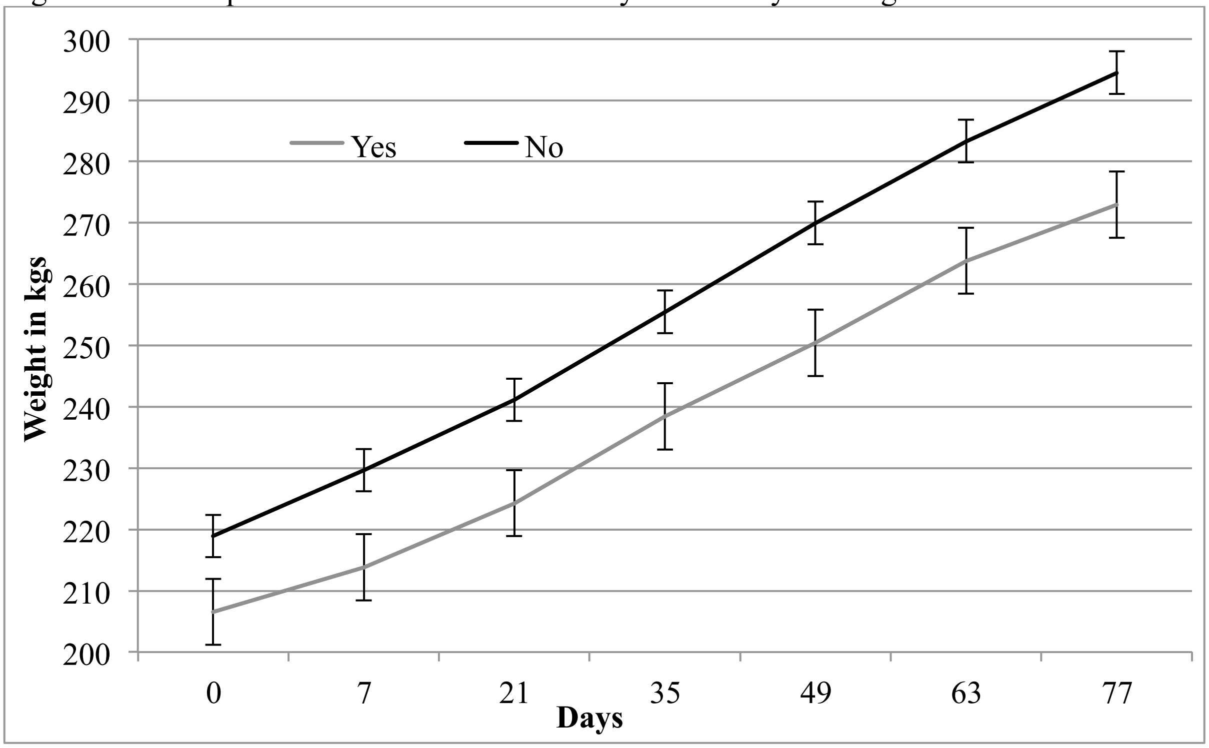
Cole et al. (1992) reports slightly conflicting observations in a series of four experiments that were conducted to determine the influence of yeast culture; three of which pertained to cattle. The first experiment considered the influence on the health and performance of feeder calves and the second examined the influence on the reaction of feeder cattle to an infectious bovine rhinotracheitis virus (IBRV) infection. In experiment 2, cattle were shipped from Austin, TX to Bushland, TX and received diets containing 0, 0.75, 1.125, or 1.5% yeast culture. Yeast culture did not significantly affect the performance level or health of cattle in these experiments, although morbid cattle given yeast culture needed fewer days of antibiotics in experiment 2 ($P < 0.05$). In experiment 3, diets containing 0 or 0.75% yeast culture were fed to feeder steers and then steers were challenged intranasally with IBRV. Higher DMI and heavier weights were maintained during IBRV infection by calves fed yeast compared to the control calves.

Because multiple high rectal temperatures were recorded, pyrexia status was observed to be a source of significant variation for growth. Heifers that exhibited pyrexia during the feeding Period A had lower ADG than those that did not exhibit Pyrexia, (0.869 kg/d and 1.049 kg/d) respectively, regardless of diet treatment or DFM treatment arrangement ($P < 0.05$). This pattern was also observed in the overall ADG analysis (Table 4).

Overall, heifers that did not exhibit signs of pyrexia had an ADG of 0.973 kg which translates into a 0.085 kg/d greater ADG ($P < 0.05$). The difference in ADG between calves that remain healthy and calves that suffer from respiratory disease can be substantial. During 28-d receiving periods, Smith (1996) reported that ADG was .23 kg less, and Bateman et al. (1990) reported ADG being.14 kg less for cattle that became ill. In a 90-d Canadian feeding trial, calves that experienced only one episode of respiratory disease had .18 kg lower ADG than cattle that did not experience morbidity. Multiple morbidity observations can also delay or hinder growth as (Morck et al., 1993) report with a .33 kg lower ADG for animals with more than 1 morbidity occurrence. This illustrates the negative effect of relapses on subsequent performance and absence of a "compensatory gain" response (Smith, 1998).

It is very possible that the effect of pyrexia was due to heifers being immunologically challenged prior to arrival for this trial. Because the pyrexia status was determined d 0 through d 7, the retrospective analysis reveals that those identified as not being morbid were heavier on all weight collection days.

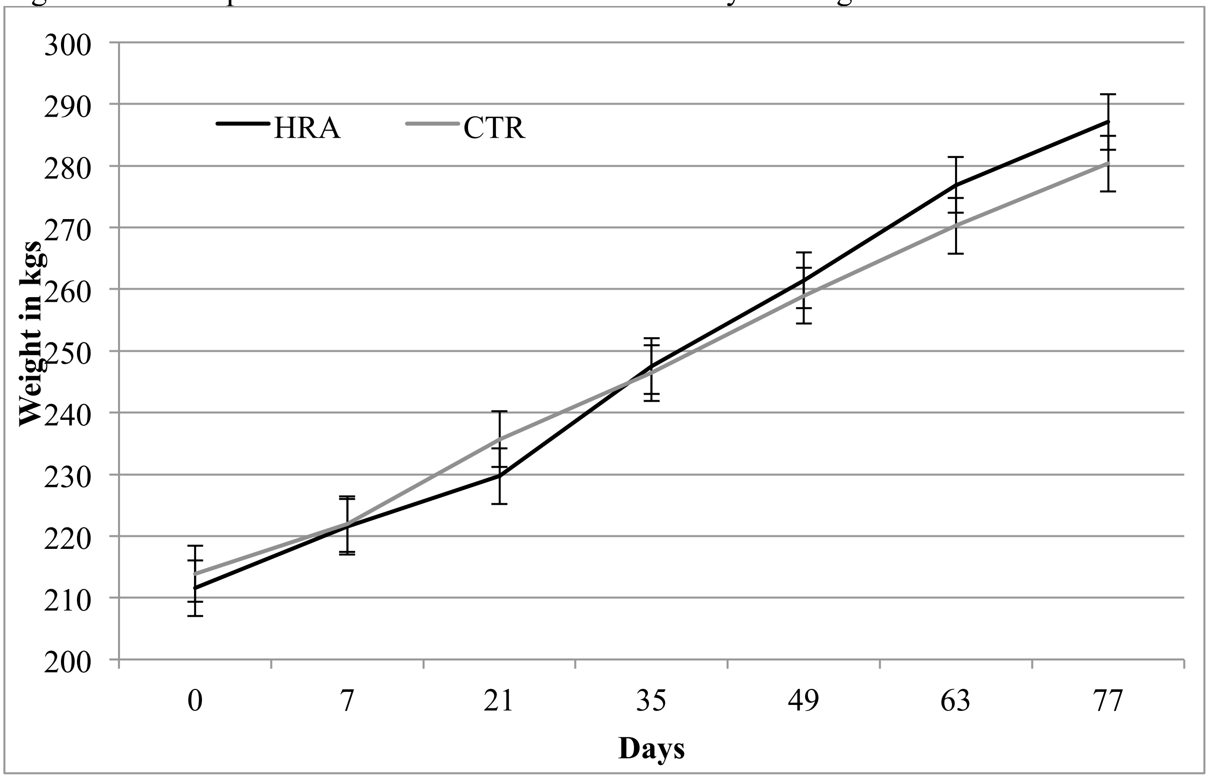
Figure 1. Least square means of the Effects of Pyrexia × Day on weight



All heifers in this trial were procured from a single collaborating university source with progressive weaning and vaccine protocols with skilled animal health surveillance personnel. Therefore, it is not unreasonable that any symptoms of illness, prior to arrival, were likely subclinical and undetected. Timsit et al. (2011) described the importance of undetected fever episodes to an animal's performance in the feedlot. Fever episodes not detected visually by feedlot personnel can be identified by monitoring body temperature after cattle are newly arrived in the feedlot. Describing the occurrence and duration of undetected fever episodes and the impact on ADG was the objective of this research study. Every animal was given an oral reticulo-rumen bolus, on d 1, which continuously recorded internal temperature of the reticulo-rumen. On d 1 and d 40, animal's weights were recorded. Bulls were observed twice a day and those that appeared sick were determined to have a rectal temperature ≥39.7°C, and exhibited symptoms consistent with BRD were administered antibiotics. In medicated animals, fever episodes started 4 to 177 h (mean = 50 h) before BRD therapy began. The duration of undetected fever was associated ($P = 0.002$) with a reduced ADG (d 1 to 40): −33 g/d for daily fever duration. These results demonstrate that undetected fever occurred frequently during the first few weeks after entry into the feedlot and can last up to 11 d. The impact observed on ADG designated a possible benefit of administering treatment to affected cattle, specifically those with undetected fever over long periods of time.

Because no weight differences due to diet treatment were detected within each day of the current study, it appears that the variance in weight of heifers that exhibited rectal temperatures > 40^{o}C was balanced across treatments and therefore accounted for in the stratification strategy.

Figure 2. Least squares means of the Effects of diet × day on weight



For each weigh period recorded, the diet by day interaction shows that for the first 21 days (Period A) CTR fed heifers were experiencing a higher ADG than the HRA fed heifers. After the conclusion of Period A, and throughout the following Period B and C, heifers fed the HRA diet had a higher ADG than those fed the CTR diet. This can be explained by the adaptation period theory where an animal's digestive system must adapt to a novel feed source before they can extract weight gain benefits from it. The diet adaptation period is considered a crucial period in which nutritional practices can either impair or promote subsequent health and performance.

IMPLICATIONS

It has been well established that livestock require an adaptation period to novel feed types. This adaptation thus allows for an increase in ADG beyond that of a diet made up primarily of forage. DDG can be utilized as a substitute in a feedlot ration for growing cattle. While the scope of this study was not the economic implications of feeding HRA rations, if heifers can be fed this type of lower input/cost ration during their growing period, they can reach puberty at a more efficient pace than grazing them out on pasture. This would also allow them to gain faster at a lower price than that of feeding them a corn based ration when forage grazing is unavailable.

Although it was not initially in the scope of this study, pyrexia proved to be a significant growth inhibitor. Heifers that exhibited pyrexia during the course of the feeding trial subsequently had lower ADG than those that did not. Since pyrexia was established shortly after arrival, this leads us to believe that the stress of shipping and environmental changes led some cattle to exhibit signs of BRD upon arrival. Since these heifers arrived from a reputable university with skilled health personnel, it can be assumed that these heifers may have exhibited undetected symptoms prior to arrival. It is unknown whether or not these heifers received a vaccination prior to being shipped; this may have reduced the loss of production caused by BRD symptoms such as pyrexia.

The results of this study indicate that DFM did not have significant differences in ADG during the first 48 days of feeding. During the last feeding period, however, cattle that received DFM had a lower ADG than those that did not receive Probios® boluses. Since fourteen of the heifers that received the DFM also exhibited pyrexia during the feeding trial, and the effects of a single dose DFM may not maintain beyond 14 d following treatment, it cannot be clearly interpreted as to whether the benefits of the single dose DFM had beneficial effects in these data.

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