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Beef Cattle Research

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Cattlemen's Day 2013

Beef Cattle Research

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Nutrition

Biological Variability and Chances of Error

Variability among individual animals in an experiment leads to problems in interpreting the results. Animals on treatment X may have higher average daily gains than those on treatment Y, but variability within treatments may indicate that differences in production between X and Y were not the result of treatment alone. Statistical analysis allows us to calculate the probability that such differences are from treatment rather than chance.

In some of the articles herein, you will see the notation $P < 0.05$. That means the probability of the differences resulting from chance is less than 5%. If two averages are said to be significantly different, the probability is less than 5% that the difference is from chance, or the probability exceeds 95% that the difference resulted from the treatments applied.

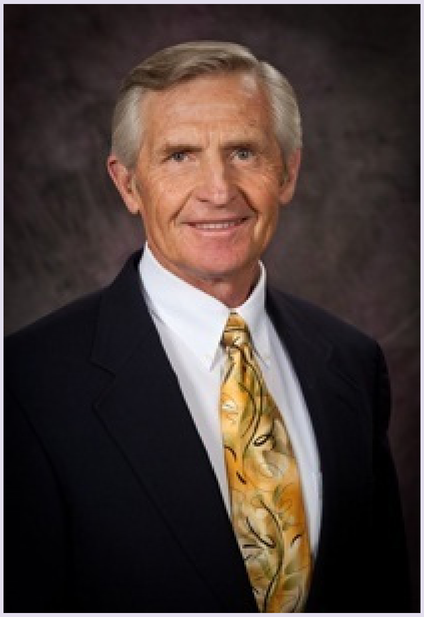
Some papers report correlations or measures of the relationship between traits. The relationship may be positive (both traits tend to get larger or smaller together) or negative (as one trait gets larger, the other gets smaller). A perfect correlation is one (+1 or -1). If there is no relationship, the correlation is zero.

In other papers, you may see an average given as 2.5 ± 0.1. The 2.5 is the average; 0.1 is the standard error. The standard error is calculated to be 68% certain that the real average (with an unlimited number of animals) would fall within one standard error from the average, in this case between 2.4 and 2.6.

Using many animals per treatment, replicating treatments several times, and using uniform animals increase the probability of finding real differences when they exist. Statistical analysis allows more valid interpretation of the results, regardless of the number of animals. In all the research reported herein, statistical analyses are included to increase the confidence you can place in the results.

Celebrating the career and retirement of

Dr. Michael E. Dikeman



Michael earned his bachelor's degree in animal husbandry at Kansas State University in 1966, his master's degree in animal husbandry at Michigan State University in 1968, and his doctoral degree in food science at K-State in 1970. He was hired as faculty in the animal husbandry department at K-State in 1970 with a teaching and research appointment. He has taught 13 different courses. He cooperated on research projects with the U.S. Meat Animal Research Center (ARS, USDA) at Clay Center, NE, for 18 years.

Michael received numerous K-State, regional, and national awards for teaching, research, and advising, including the Distinguished Teaching Award and the Distinguished Research Award from the American Meat Science Association and a National Association of State Universities and Land Grant Colleges (NASULGC) Food and Agricultural Sciences Excellence in College and University Teaching Award. He served as advisor to Block & Bridle (15 years), Ag Student Council (7 years), and Alpha Zeta (2 years). He was selected as the K-State Outstanding Student Club Advisor Award in 2002. He served three years as a K-State Ombudsperson.

Michael's research focused on the interface between beef cattle production/genetics and carcass composition, meat tenderness, and meat cookery. He was co-investigator on an extensive inter-university "Carcass Merit Traits" tenderness project resulting in three cattle breed associations publishing Expected Progeny Differences for tenderness. He and his 37 graduate students published more than 425 journal articles, technical reports, abstracts, and conference papers, and he co-edited the first Meat Science Encyclopedia. He has made invited presentations at international conferences. Michael served as president of the American Meat Science Association, president of the Federation of American Societies of Food Animal Sciences, and secretary of the American Society of Animal Science.

Upon retirement, Michael will continue to enjoy raising Simmental cattle with his Border Collie, Sugar's, help. He will remain active in First Baptist Church and the Gideons and will continue to cheer on the Wildcats.

We thank Michael for his many years of service to our department and university and wish him a long and happy retirement.

Commentary: Increasing Productivity, Meat Yield, and Beef Quality through Genetic Selection, Management, and Technology

M.E. Dikeman

Introduction

The primary purpose of producing beef cattle is to convert grass, forages, and various byproducts, plus human-edible protein and energy, into highly nutritious and tasty beef. To accomplish this, (1) cattle enterprises must be profitable; (2) carcasses should yield a high percentage of meat; (3) beef should be safe, affordable, attractive, nutritious, and highly palatable; and (4) both production and processing systems must be socially and environmentally responsible. The U.S. population has doubled since 1952, but the number of cows in the U.S. is the lowest since the 1950s. At the same time, a rather dramatic increase in beef production has occurred because of improved genetics, management, and technology. Yet, too many cattle breeders and/or breed associations have failed to realize improvements in meat yield, marbling, and palatability through genetic selection for these traits. Consequently, a significant proportion of cattle are fed to excessive fatness with long feeding periods to attain Choice or Prime marbling. Waste fat production is very costly to the industry. An extensive review, evaluation, and interpretation of research literature, technical bulletins, trade articles, and industry trends demonstrates a path forward through improved genetics, improved management, and optimum use of technology to improve production efficiency, meat yield, and meat quality of cattle.

Circumstances

Drought, beef demand, and prices

2011 and 2012 will become historical years in the beef cattle production and processing industries. The effects of severe drought in much of the Midwest likely will be a long-term problem, primarily because of the dramatic decrease in cow numbers, very high feed costs, and the long-lasting negative effects of the drought on grass production. A dramatic reduction in cow numbers and the current high prices of feeder and fed cattle make it more difficult for producers to decide whether to retain more heifers to increase cow numbers. In addition, the drought might not be over in some areas.

Surprisingly, the demand for high-quality beef actually increased during the recent economic recession, which provides potential for significant expansion if more herds were to produce Premium Choice or Prime beef. If producers shrug this off and stick with commodity goals, recovery may only bring the cowherd back from less than 30 million to 31.7 million head by 2017. But if ranchers rebuild with cattle that produce beef for the high-quality markets, there could be close to 34 million beef cows by 2018. That could mean "a 10% increase in overall demand for beef," which could translate into "a long-term expansion of ≈ 6 million cattle."[1] When cow-calf producers can

[1] Brown, S. 2012. Premiums for quality beef continue to grow as packers seek cattle. Department of Agricultural and Applied Economics, College of Agriculture, Food and Natural Resources, University of Missouri, Columbia. Retrieved from http://extension.missouri.edu/news/DisplayStory.aspx?N=1368.

sell calves and yearlings for $1,000 to $1,200 without the risk of retained ownership, however, there is little incentive to select for increased marbling.

High prices for feeder cattle and fed cattle have been great for cow-calf producers, but not for feedlots and beef processing companies. A significant proportion of feedlots are running at 62–75% capacity, which is not sustainable. It is conceivable that 1 to 2 beef processing plants could close as a result of dwindling cattle numbers. The retail price of beef reached a record high of $5.09/lb in January of 2012, and this could have both short-term and long-term effects on the demand for beef. High unemployment, the recession, and higher food prices have strained consumers' budgets. A significant proportion of consumers have or will shift away from beef, particularly rib and loin cuts, because of high retail prices, and they are likely to be slow to come back to beef.[2]

Global food issues and resources

On a global basis, more than 900 million people in the world are estimated to be starving or suffering from malnutrition. Even more will be pushed into extreme poverty by high food costs. Yet, livestock production is critical to food security and livelihood of the world's population. Globally, the livestock sector employs 1.3 billion people, either directly or indirectly, and is responsible for up to 50% of global agriculture GDP (Bureau of Food Security, U.S. AID). But to sustainably feed a world population expected to grow to 10–11 billion people by 2100, the resources used to rear livestock — water, fossil fuel and grain — must be used more efficiently. The global land area available for grazing livestock is close to its biological limit for production under the prevailing climatic and soil fertility conditions, putting pastoral systems under pressure. Improving efficiency and reducing waste in livestock production will make important contributions to ensuring the supply and accessibility of livestock sources of food.[3]

Grades, marbling, and genetics

In the late 1970s, the NCA (now NCBA) adopted the goal of "winning the war on fat," but the war has not been won nearly 35 years later. Carcasses with a high yield grade 3 average 24% fat trim, depending on trim level. Major "Premium Choice" beef programs now allow yield grade 4 carcasses (≈ 28% fat trim) to be used to secure an adequate supply of product. Too many beef cattle breeders and/or breeds have failed to make genetic improvements in meat yield and marbling; consequently, a significant proportion of cattle are fed to excessive fatness with long feeding periods to attain Choice or Prime marbling. Genetic improvement in marbling is an important alternative to feeding cattle to excessive fatness. Using two breed associations as examples, the American Simmental Association publishes expected progeny differences (EPDs) for marbling, ribeye area, fat thickness, and tenderness (Warner-Bratzler shear force). For example, two Simmental bulls in two major AI studs have EPDs in the top 1% for marbling, the top 5% for ribeye area and indexes, and the top 10% for tenderness. Some Angus AI sires are available that simultaneously excel in marbling, ribeye area, and fat thickness EPDs. These examples demonstrate that, even though ribeye area and/or meat yield are antagonists to marbling, some cattle defy the antagonisms. In addition, genetic progress can be made in selecting for tenderness because of its moderately high heritability of

[2] Sands, M. 2012. Dealing with declining inventories amid excess feeding and packing capacity. Presentation at Kansas State University Cattlemen's Day. Kansas State University, Manhattan, KS.

[3] FAO. 2011. World Livestock 2011: Livestock in Food Security. Retrieved from http://www.fao.org/docrep/014/i2373e/i2373e00.htm.

0.40. Although DNA tests can be used for tenderness prediction, they are really most valuable only when the DNA data are incorporated into EPDs. Most breed associations do not yet have that capability. The most recent national Beef Quality Audit shows that cow-calf producers, in particular, and even some seedstock producers, are still producing "commodity" beef rather than focusing on improving carcass and meat quality traits. Cow-calf producers in particular, and even some seedstock breeders, have not focused on producing for a specific quality target such at Lite/Lean, Retail, or White Tablecloth.

Implants and supplements

In terms of production efficiency, implants are one of the most economically viable technologies to increase meat yield and carcass value, but improper use can cause meat quality problems. Implanting five or more times has a negative effect on both marbling and tenderness, and using the more "aggressive" implants within 70 to 80 days of harvest has the same negative effect. Some research shows that delaying implanting until 2 to 3 weeks after cattle are started on feed improves marbling. The industry needs to capitalize on the benefits of implants without causing significant negative effects on marbling and tenderness.

Supplementation of finishing diets with Zilmax for 20 days will significantly improve feed efficiency and increase dressing percentage and meat yield percentage with minimal negative effects on marbling and tenderness when beef is aged for at least 21 days. Shorter aging times will result in decreased tenderness, particularly in the top sirloin of heifers, but feedlots and beef processors have no control over the aging time employed by retailers. Supplementation with Optaflexx (Elanco Animal Health, Greenfield, IN) or other β-agonists is a cost-effective way to increase live weight gain, provide for some increase in meat yield, and have minimal effects on marbling and tenderness if used properly.

Yield Grade Pricing vs. Meat Yield Pricing

Feeding cattle to high yield grade 3 and 4 endpoints is not an efficient method to improve beef cattle productivity. With instrument grading, percentage meat yield can be accurately predicted, but that information usually is not transparent in that it is not communicated to producers, and premiums and discounts are not tied to this information. Instead, the industry continues to use a crude yield grade pricing system and includes "token" premiums of only $1 to $2 per 100 lb carcass weight for yield grade 2 over 3 and yield grade 1 over 2 carcasses. Yet, there can be a difference of up to $16/cwt between a typical yield grade 2 and 3 carcass when carcasses are priced at $180/cwt (which assumes 3 1/2% closely trimmed meat yield difference between these two yield grades). For 850-lb carcasses of the same quality grade, that equates to a $136 difference in total value. It would be a milestone in the beef industry if premiums and discounts were to be paid for *meat yield percentage* differences rather than only token premiums with the yield grade pricing system. The pork industry has utilized percentage of fat-free lean for premiums and discounts for nearly two decades, and the beef industry could do the same thing. Even if only half of the meat yield value difference between yield grades was used for premiums or discounts, it would provide a major catalyst for the industry to reduce waste fat production.

In U.S. Meat Animal Research Center Cycle IV data involving different biological types of cattle in a "calf-fed" program, feeding an additional 30 days beyond a target endpoint of 426 days of age resulted in a net decrease of 2% retail product yield because of increased fat trim and only an 8% increase in percentage Choice from 62 to 70% for all breeds combined. The increase in percentage Choice for Hereford, Angus, and Shorthorn sired cattle was 10% (from 76 to 86%), and the increase in percentage fat trim was 49%, whereas percentage retail product increased 42% over the additional 30 days. If cattle gain 100 lb during an additional 30 days and the percentage of that gain is 75% carcass, the 49% gain of fat would be approximately 37 lb, and the 42% gain of retail product would be 31 lb. In a March 2012 survey of feedlots in Kansas, the cost of gain for more than 60,000 steers and heifers was $114/100 lb (feed, yardage, interest) over the entire feeding period. Assuming that the cost of gain for the extra 30 days for the Cycle IV MARC cattle was 10% higher than for the cumulative cost of gain prior to 426 days, the feed cost for the 100-lb gain would be $125. The 31 lb of meat would be worth about $87 (using a carcass price of $180/cwt and average meat yield percentage of 65%), and the fat would be worth about $17 as choice white grease, for a total of $104. So, the extra days resulted in a loss of $21/head for the whole pen [$125 – ($87 + $17)]. Assuming the percentage Choice was increased by 10% and the Choice-Select spread was $10/cwt, the increase in value of the 10% more Choice carcasses = $85/carcass for eight 850-lb carcasses. The $21/head loss for 100 cattle represent a loss of $2,100, and the increase in value of the extra 10% Choice carcasses is $850, resulting in a net loss of $1,250 for the pen of 100 cattle.

On the other hand, if those 100 cattle gain the same 100 lb live weight in 30 days and have genetics for the same percentage of Choice and increased genetics for muscle (meat) growth without depositing the 37 lb of fat trim, the increase in efficiency would be dramatic. Based on the efficiency of energy utilization for lipid deposition and for protein deposition, cattle could have 1.72 times more muscle deposition with the energy that it takes to deposit excess fat. The calories used to deposit 37 lb of fat could be used to deposit 63 lb (1.72 × 37) of muscle (closely trimmed retail product). Using a 65% meat yield and $180.00/cwt carcass as a base, this equates to $277/cwt of closely trimmed retail product ($180 ÷ 0.65). Adding 63 lb of retail product instead of fat adds $175 value per carcass (61 × $1.77). After subtracting a feed cost of $114/cwt, the net increase in value from shifting 37 lb of fat to 63 lb of retail product would be $61/carcass, or $6,100 for the pen of 100 cattle. Production of "waste fat" is very costly. The beef industry needs to focus on feed efficiency of retail product produced that is of consumer-acceptable quality.

Tenderness

Interest is growing in guaranteeing acceptable tenderness of beef to U.S. beef consumers. The USDA Agriculture Marketing Service has drafted a "Standard Practice for Verifying Tenderness Marketing Claims for Beef Cuts" with marketing claims that can be used by all parties interested in highlighting production and marketing practices for tender beef. Because a significant proportion of beef is marketed by beef processors before near maximum tenderization occurs, retail stores, restaurants, and food service operations will need to further age beef to meet the marketing claims criteria before it is sold to consumers. Therefore, measurements at packaging need to be reinforced by time and temperature monitoring. Marination and mechanical tenderization are considered non-inherent processes and are precluded from use to meet tenderness requirements. Beef can be USDA Certified Tender when WBSF is ≤4.4 kg or slice shear force (SSF) is ≤20.0 kg, or USDA Certified Very Tender when WBSF is ≤3.9 kg or SSF is ≤15.3 kg. This system is anticipated to be used extensively and to decrease the emphasis on marbling to assure consumer acceptability.[4]

Beef is often characterized as the "celebration" meat because of its excellent flavor; however, the most common complaint by consumers when they are not satisfied with beef's palatability is because it is not acceptable in tenderness. Tenderness can be improved both genetically and by proper aging. The recent National Beef Tenderness Survey (2010–2011) shows that tenderness of the longissimus muscle (ribeye, top loin, T-bone, and Porterhouse steaks) scored from 5.9 to 6.3 and the top sirloin scored only 5.6 on a 10-point scale. These results suggest that tenderness of beef needs to improve. Part of the reason for the modest scores by consumers for tenderness was because 35.7% of beef was aged less than 14 days, which was nearly double the time from the 2005–2006 survey. Why can cattle be fed an additional 15–30 days, but the retail and food service industry cannot age beef for the proper amount of time? The retail and food service industries should adopt the policy of the old E. J. Gallo winery advertisement and "sell no beef before its time." The industry should not feel good about earning a modest score for tenderness of only 6 out of 10.

Implications

For beef cattle production to be sustainable and profitable, production must be economically efficient, protect the environment, and be socially responsible. This will require the use of byproducts and a reduction of waste fat production while providing carcasses with high meat yield, sufficient marbling, and guaranteed tenderness that is highly acceptable to consumers. There is great opportunity for the beef cattle industry in the coming years if greater attention is given to improving production efficiency and providing high-quality beef through genetic selection without feeding cattle to excessive levels of fatness.

[4] ASTM Standard F2925-11, "Standard Specification for Tenderness Marketing Claims Associated with Meat Cuts Derived from Beef," ASTM International, West Conshohocken, PA, 2011, DOI: 10.1520/F2925-11, www.astm.org.

Insecticide Ear Tags Numerically Improve Grazing Cattle Performance

S.E. Hill, C.I. Vahl, B.E. Oleen, W.R. Hollenbeck, and D.A. Blasi

Introduction

Stocker cattle grazing pastures during the summer months face challenges due to horn flies, which can result in reduced weight gains and less efficient use of forages. One strategy for controlling horn flies is insecticide-impregnated ear tags. The use of pesticide ear tags may be an effective management practice to improve overall productivity during a grazing season. The objective of this study was to evaluate the efficacy of insecticide ear tags as a means of improving growth of stocker calves grazing native pastures in the Flint Hills region of Kansas.

Experimental Procedures

A 77-day grazing study was conducted at the Kansas State University Beef Stocker Unit, starting in April of 2012, to determine the efficacy of insecticide ear tags for managing growth of stocker calves grazing native grass pastures in the Flint Hills region of Kansas. All steers used in this study (267 head) were previously involved in a receiving study and were of sound health at the time the grazing study was initiated. Off-test weights collected at the conclusion of the receiving study were used to randomly assign each animal to grazing treatments. Steers were assigned to three treatments with four pasture replicates per treatment. The treatment groups included a control (no ear tags applied; Control), one insecticide ear tag per calf (One), or two insecticide ear tags per calf (Two). All paddocks were stocked at 253 lb beef/acre.

All calves were injected with 2 mL of Bovi-Shield Gold 5 (Pfizer Animal Health, Whitehouse Station, NJ) and were poured with UltraBoss insecticide (20 mL; Merck Animal Health, Summit, NJ). Corathon (15% Coumaphos, 35% Diazinon; Bayer Animal Health, Shawnee Mission, KS) insecticide ear tags were administered when cattle were placed on pasture on April 24, 2012. Paddocks were randomly assigned to treatment and served as the experimental unit. Individual weights were taken at initial processing prior to placement on pasture and at the completion of the grazing period. Because of drought conditions, all calves were removed from pastures on July 10, 2012.

Results and Discussion

No significant differences were observed among the three treatment groups ($P > 0.83$; Table 1). This result is likely due to insufficient replicates and a shortened grazing season because of drought conditions. The prevalence of pinkeye was limited in this study; one paddock (Trt = Two) had 5 calves treated for this malady.

Implications

Using insecticide ear tags yielded substantial improvements in gain over the 77-day grazing season, but these improvements were not statistically significant.

Table 1. Performance of grazing cattle tagged with 0 (Control), one, or two insecticide-impregnated ear tags

Treatment	Control	One	Two
Initial weight, lb	679	679	679
Final weight, lb	789	798	801
Average daily gain, lb/day	1.45 ± 0.14	1.53 ± 0.14	1.58 ± 0.14
Added gain relative to control group, lb	-	9	12
Value of added gain, $/head[1]	-	$13.05	$17.40
Value of added gain less cost of ear tags, $/head[2]	-	$11.05	$13.40

[1]Assumes a value of $1.45/lb live weight.

[2]Assumes a cost of $2.00/ear tag.

Effects of Weaning on Body Condition Recovery and Calf Performance in Previously Nutritionally Restricted Cow-Calf Pairs

M.A. Ward[1] and S.K. Johnson

Introduction

Drought, defined as less than 75% of normal rainfall, occurs once every 5 to 7 years in Northwest Kansas. Record widespread drought conditions throughout the Midwest and Western United States in 2012 resulted in an early reduction in forage quality and availability. In these situations, cow-calf producers are faced with deciding how to adapt to the conditions. Some producers may be unprepared for the speed at which cows can lose body condition in the face of declining pasture conditions and how much it takes to regain body condition.

Early weaning is one option that can improve a cow's nutritional status, conserve forage, and delay the need for supplementation. The price slide between lightweight early weaned calves and heavier calves is an important factor in the economic outcome of that decision. Feed use and cow and calf performance data are needed to evaluate production and economic differences between early and normal weaning scenarios. The objective of this study was to quantify intake differences between dry and lactating cows that had previously been nutritionally restricted and measure feed consumed by calves still nursing dams.

Experimental Procedures

A combination of 36 primiparous and multiparous cows, primarily Angus and South Devon crosses, were blocked by age and randomly allotted to 1 of 2 treatments, early weaned and normal weaned. All cows were fitted with electronic identification tags and placed in a drylot pen that was equipped with a GrowSafe 6000 digital intake monitoring system (GrowSafe, Ltd., Alberta, Canada). The cows were offered a free-choice ration designed to meet the nutritional requirements of a cow at 120-plus days of lactation. The ration was composed of ground Conservation Reserve Program (CRP) hay (70.2%), wet distillers grains (28.3%), and a mineral package (1.5%), all dry matter basis, and was delivered 3 times per day. Consecutive weights were taken on the first, middle, and last 2 days of the feeding period. Body condition scores (1 = thin; 9 = very fat) were assigned by 2 individuals on day 0 and 77 of the trial. Statistical models used to evaluate the effects of treatment on weight and condition change included starting weight and starting body condition score as covariates.

The early weaned calves were weaned at an average of 150 days of age on the first day of the feeding period. During the trial, the normal weaned calves were given access to the same diet as the cows through a creep gate system. Calves had experience eating from a bunk prior to the start of the trial. The normal weaned calves were weaned at the conclusion of the trial at 228 days of age. Calf weights were taken at day 0 and 77 of the trial.

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[1] Beef Program director, Colby Community College, Colby, KS.

Results and Discussion

At the start of the feeding period, primiparous cows had lower ($P < 0.01$) body condition scores (3.3 ± 0.2) than multiparous cows (4.0 ± 0.1); however, no significant differences were present in cow body weight or condition between treatments at the initiation of the study (Table 1). Cows in both treatments gained weight during the feeding period, but gain was greater ($P < 0.01$) for early weaned than normal weaned cows, at 137 lb and 93 lb, respectively. Starting body condition was a significant ($P < 0.03$) factor in explaining cow weight gain.

At the end of the feeding period, end weight was higher ($P < 0.01$) for early weaned than normal weaned cows. Final cow body condition score and body condition change tended ($P < 0.08$) to be greater in early weaned than normal weaned cows. Compared with mature cows, 2-year-old cows had lower final condition scores, 4.9 ± 0.1 vs. 4.3 ± 0.1, respectively. The improvement in body condition was greater ($P < 0.01$) in mature cows (1.2 ± 0.1) than in 2-year-old cows (0.5 ± 0.1). Since shortly after calving, the 2-year-old cows had been managed with the mature cows, which likely played a role in their inability to maintain the same condition as mature cows.

Average dry matter intake was 20.4 and 25.6 lb for early weaned and normal weaned cows, respectively, which is somewhat higher than National Research Council–predicted values. The bulky diet presented some challenges in the GrowSafe feeders. The variability in recorded intake likely prevented statistical differences in intake being noted between treatments.

Weaning occurred for normal weaned calves on day 77, at which point calves had gained an average of 2.1 lb per day. Total weight gain during the feeding period was less ($P < 0.01$) for calves born to 2-year-old dams (141 ± 8 lb) than for calves born to mature cows (166 ± 5 lb).

Feed delivered directly to the calf creep bunk averaged 3.6 lb per head per day (dry matter basis). This is an underestimate of feed use, because some of the larger calves would eat from the GrowSafe bunks when cows were finished.

Differences in cow dry matter intake, pen intake for calf creep, and calf weights were used to develop a partial budget comparing the two weaning options. Calf prices were based on a 5-year average of Kansas weighted prices in August and October. Observations were limited for August in some years. Wet distillers grain price was taken from a 5-year average of United States Department of Agriculture weekly Nebraska distillers grain reports. A sound historical price series for CRP hay was lacking, so Kansas weekly hay reports for good grass hay were used as an alternative. Net income was higher for the normal weaned calves when calculated using long-term average prices and including the cost of additional feed for lactating cows and creep feeding calves (Table 2). Using this year's actual feed cost and average calf prices of $188.66/cwt and $162.96/cwt, respectively; the early weaned calves returned a $16 advantage compared with normal weaned calves.

Implications

When calves are weaned earlier than normal, forage is conserved from both the cow and calf. When cows become thin due to nutritional restriction, considerable time and a high-quality diet are needed to regain condition. First-calf heifers, however, still lag in recovery time compared with mature cows. Young cows that remain thin postweaning may experience reduced longevity and profitability.

Table 1. Weight and condition change for early and normal weaned cows and calves during a 77-day feeding period

Trait	Early weaned[1]	Normal weaned[1]	
Number	18	18	
Day 0			
Cow age (year)	4.3 ± 0.6	4.6 ± 0.6	
Julian calving date	57 ± 3	60 ± 3	
Calf weight, lb	351 ± 13	367 ± 13	
Cow weight, lb	1023 ± 39	1072 ± 38	
Cow body condition score	3.6 ± 0.2	3.9 ± 0.2	
Day 77			
Cow weight, lbs	1182 ± 10	1137 ± 10	**
Cow body condition score	4.7 ± 0.1	4.5 ± 0.1	†
Cow weight change, lb	137 ± 10	93 ± 10	**
Cow condition change	0.9 ± 0.1	0.7 ± 0.1	†
Cow dry matter intake/day, lb	20.4 ± 3.0	25.5 ± 3.0	
Final calf weight, lb		518 ± 6	
Calf weight change, lb		159 ± 6	

[1] Mean ± standard error.
** $P < 0.01$; † $P = 0.08$.

Table 2. Cost analysis of early weaned versus normal weaned calves

	Early weaned	Normal weaned
Weaning weight, lb	351	518
Income per calf	$552.61[1]	$643.10[1]
Feed cost, cow[2]		$26.74
Creep feed, calf		$32.67
Net income per calf	$552.61	$583.70

[1] 5-year Kansas weight average price: 350-lb calves in August, $157.44/cwt; 550-lb calves in October, $124.15/cwt.
[2] 7.8 lb more was fed normal weaned than early weaned × 77 days × $0.045/lb feed; creep feed normal weaned 9.53 lb/day.

Dosing with Lactipro Decreases Forage Intake and Manure Output

K.A. Miller, C.L. Van Bibber-Krueger, C.C. Aperce, C.A. Alvarado, and J.S. Drouillard

Introduction

High-concentrate diets consisting of cereal grains and grain byproducts have high energy density compared with forage-based diets. To avoid digestive disorders, cattle must be adapted to concentrates, which often entails feeding a series of step-up diets that contain progressively less roughage over a 2- to 3-week period. This allows the microbial population to adapt to fermentation of the starches and sugars that are present in high-concentrate diets. If cattle are not properly adapted to concentrate-based diets, lactic acid, which is produced by opportunistic starch-fermenting bacteria like *Streptococcus bovis*, can accumulate, predisposing the animal to acidosis. Diets used during the adaptation phase are by nature less digestible than the final finishing diet, which results in increased manure output and suboptimal performance during the adaptation period.

Lactipro, a relatively new probiotic drench containing the lactate-utilizing bacteria *Megasphaera elsdenii,* has been utilized effectively to accelerate the adaptation of cattle from roughages to concentrate-based diets. Our objective was to determine the impact on diet digestibility and manure output in cattle dosed with Lactipro (MS Biotech, Inc., Wamego, KS) and placed directly onto high-concentrate diets without prior adaptation.

Experimental Methods

Ninety crossbred steers were utilized in a randomized complete block design to determine the impact of dosing cattle with Lactipro and placing them directly onto a finishing diet on total tract diet digestibility. Upon arrival at the Kansas State University Beef Cattle Research Center, steers were placed into feedlot pens and offered free-choice access to moderate-quality brome hay. Approximately 24 hours after arrival, the steers were weighed, given uniquely numbered ear tags, vaccinated against common viral and clostridia diseases, treated for internal and external parasites, and implanted with Revalor XS (Intervet Inc., Millsboro, DE). Steers on the traditional step-up program (Control) were fed a series of three step-up diets for 6 days each followed by the final finishing diet for the duration of the study (Table 1). Steers in the Lactipro treatment were orally dosed with 100 mL of Lactipro at processing and placed directly onto a finishing diet. Steers were assigned to treatment based on order through the chute at processing, resulting in 6 pens for each treatment with 7 or 8 steers/pen. Diets were based on steam-flaked corn, wet corn gluten feed, and corn silage (Table 2).

Steers were housed in partially covered pens with concrete surfaces. Before placing steers into their respective pens, the surface of each pen was thoroughly cleaned to remove residual dirt and manure. Manure was removed each day for 24 days and weighed, thoroughly mixed, and sampled, then dried for analysis of dry matter, protein, neutral detergent fiber (NDF), starch, and phosphorus. The amount of feed delivered to each pen was recorded daily, and the weight of unconsumed feed also was recorded daily for each pen. Samples of the diets and unconsumed feed were weighed daily and analyzed for concentrations of dry matter, protein, NDF, starch, and phosphorus. Feed and manure samples from each 6-day period (corresponding to each of the diets fed to the control group) were composited for analysis, making it possible to determine diet digestibility for each period. This resulted in one value per pen for days 1–6, 7–12, 13–18, and 19–24.

Results and Discussion

Control steers had greater dry matter intake ($P < 0.01$) and fecal output ($P < 0.01$) than Lactipro steers during the step-up period (Table 3). Lower fecal output by steers in the Lactipro group can be partially attributed to lower feed intake. Diet digestibility for the 24-day trial also tended to be greater for cattle on the Lactipro treatment ($P = 0.11$). Decreasing manure output without compromising cattle performance generally is positive, because it represents an improvement in utilization of feed resources. Additionally, the costs incurred by commercial feedlots for handling, storage, and transport of manure can be substantial, and technologies that make it possible to decrease manure output can have a favorable impact on cost of production.

Digestibility of NDF was greater ($P < 0.01$) for Control steers than Lactipro steers. This was most pronounced during the first 6-day period, during which digestibility of NDF actually was negative for steers in the Lactipro treatment. Steers were allowed free access to brome hay on arrival, and we speculate that the abrupt switch of Lactipro cattle to the finishing diet may have decreased digestion of the hay, delaying its passage through the gastrointestinal tract. Digestion of concentrates generally results in low ruminal pH, which can have adverse effects on the activity of fiber-digesting bacteria, potentially decreasing fiber digestion. Delayed passage of hay from the rumen (and high rumen fill) could explain the relatively low feed intakes observed for cattle in the Lactipro group during the first several days on feed. The bunk management protocol used for this study limited increases in daily dry matter feed deliveries to no more than 1 lb per animal. The substantially lower feed intakes of Lactipro cattle compared with the Control early in the study created a large differential in feed deliveries that remained for much of the trial period as a result of our bunk management protocol. Cattle were monitored closely for indications of digestive disturbances, but there were no visual indications of acidosis in either group during this time. This led us to speculate that a more aggressive bunk management protocol may be more suitable for cattle dosed with Lactipro and subsequently placed directly onto high-concentrate diets. Crude protein digestibility was greater ($P = 0.05$) for Lactipro steers than for Control steers, which is consistent with the proteolytic activity of *Megasphaera elsdenii*.

Implications

Hay consumption can be decreased substantially during the step-up period when cattle are dosed with Lactipro, which leads to decreased manure output and improved diet digestibility.

Table 1. Step-up regimes for the Control and Lactipro treatment groups

Days on feed	Control	Lactipro
0–6	Step 1	Finisher
7–12	Step 2	Finisher
13–18	Step 3	Finisher
19–115	Finisher	Finisher

Table 2. Composition of experimental diets on a 100% dry matter (DM) basis

	Step-up diets			
Ingredient, % of DM	Step 1	Step 2	Step 3	Finisher
Steam-flaked corn	30.2	40.2	50.2	60.2
Wet corn gluten feed	25.0	25.0	25.0	25.0
Corn silage	40.0	30.0	20.0	10.0
Supplement[1]	2.64	2.64	2.64	2.64
Feed additive premix[2]	2.16	2.16	2.16	2.16
Nutrient analyses, %				
DM	53.9	58.0	62.7	68.3
Crude protein	13.5	13.7	13.8	14.0
Neutral detergent fiber	25.0	22.4	19.9	17.4
Crude fat	3.3	3.4	3.6	3.7
Calcium	0.77	0.75	0.72	0.70
Phosphorus	0.44	0.45	0.45	0.45
Potassium	0.92	0.85	0.77	0.70

[1] Formulated to provide 0.3% salt, 0.1 ppm cobalt, 10 ppm copper, 0.6 ppm iodine, 60 ppm manganese, 0.25 ppm selenium, 60 ppm zinc, 1,000 IU/lb vitamin A, and 10 IU/lb vitamin E on a dry matter basis.
[2] Formulated to provide 300 mg Rumensin and 90 mg Tylan (Elanco Animal Health, Greenfield, IN) per steer daily.

Table 3. Apparent total tract digestibility during the first 24 days on feed for steers fed a traditional step-up regimen (Control) and steers dosed with Lactipro at initial processing and placed directly on to a finishing diet (Lactipro)

Item	Control	Lactipro	SEM	*P*-value
Days 0–6				
Dry matter intake, lb/day	11.5	8.2	0.66	<0.01
Fecal output, lb/day	4.2	3.3	0.22	<0.01
Digestibility, %				
Dry matter	63.0	56.6	1.41	0.11
Crude protein	65.8	62.9	1.29	0.05
Neutral detergent fiber	28.0	-24.5	4.92	<0.01
Starch	99.9	99.8	0.08	0.31
Phosphorus	30.3	14.7	5.58	0.06
Days 7–12				
Dry matter intake, lb/day	18.1	14.3	0.66	<0.01
Fecal output, lb/day	4.2	2.6	0.22	<0.01
Digestibility, %				
Dry matter	76.8	81.9	1.41	0.01
Crude protein	75.0	80.4	1.29	<0.01
Neutral detergent fiber	56.3	56.4	4.92	0.99
Starch	99.8	99.8	0.08	0.61
Phosphorus	27.6	54.7	5.58	< 0.01
Days 13–18				
Dry matter intake, lb/day	22.9	21.4	0.66	0.12
Fecal output, lb/day	6.0	4.4	0.22	<0.01
Digestibility, %				
Dry matter	74.3	79.6	1.41	0.01
Crude protein	70.0	72.8	1.29	0.12
Neutral detergent fiber	49.2	56.2	4.92	0.30
Starch	99.9	99.8	0.08	0.26
Phosphorus	36.9	46.4	5.58	0.24
Days 19–24				
Dry matter intake, lb/day	26.5	23.6	0.66	<0.01
Fecal output, lb/day	6.0	4.9	0.22	<0.01
Digestibility, %				
Dry matter	77.6	80.0	1.41	0.25
Crude protein	69.2	71.3	1.29	0.24
Neutral detergent fiber	49.8	55.3	4.92	0.41
Starch	99.8	99.8	0.08	0.99
Phosphorus	35.8	44.9	5.58	0.26

Dosing High-Risk Calves at Processing with Lactipro Decreases the Number of Calves Treated For Bovine Respiratory Disease

K.A. Miller, C.L. Van Bibber-Krueger, and J.S. Drouillard

Introduction

Bovine respiratory disease is the leading cause of cattle mortalities in U.S. feedlots. In addition to costs associated with death loss and medical treatments, cattle affected by respiratory disease typically have suboptimal performance. Lightweight calves coming into the feedlot are at high risk for respiratory disease due to the stress associated with weaning, transportation, feed and water deprivation, commingling, castration, and other factors. Calves often have no experience eating from feed bunks and may be unfamiliar with the types of feeds used in feedlots. At the same time, the cattle are susceptible to acidosis due to the concentrate-based diets that are fed, which also can have unfavorable effects on feed intake and performance. Moreover, symptoms of acute acidosis, which include poor appetite, increased respiration rate, lethargy, depression, loss of muscle tone, nasal and ocular discharge, and diarrhea, can be difficult to distinguish from clinical symptoms of respiratory disease. Therapies designed to address respiratory disease are generally ineffective for treating acidosis, inevitably leading to the perception that antibiotic treatments have only limited efficacy. Moreover, acidosis can increase susceptibility of cattle to respiratory disease. Acidosis is most logically dealt with through preventive measures. We hypothesized that Lactipro (MS Biotec; Wamego, KS), a source of the lactate-utilizing bacterium *Megasphaera elsdenii*, could decrease the incidence of feedlot acidosis in newly arrived feedlot calves. By preventing acidosis, we speculated that clinical symptoms similar to those associated with respiratory disease would be less prevalent, thus decreasing the number of animals inappropriately diagnosed and treated for respiratory disease. Our objective was to determine if dosing cattle with Lactipro at processing would decrease morbidity and mortality in lightweight calves after arrival at the feedlot.

Experimental Procedures

Crossbred calves (504 bulls, 141 steers; initial body weight = 443 ± 11 lb) were received from Texas over a 2-week period in January (two loads per day on the January 14, 19, and 26). Cattle were given brome hay on arrival, and within 24 hours were weighed, vaccinated against common viral and clostridial diseases; dewormed, castrated (banded), treated with Micotil (Elanco Animal Health, Greenfield, IN), and given uniquely numbered ear tags. Cattle were randomly assigned to 1 of 2 treatments based on order through the processing chute. Our experimental treatments consisted of a negative control group (Control) and a group given a 100-mL oral dose of Lactipro at processing (Lactipro). Cattle were blocked by arrival date and randomly assigned to 24 pens with 25 to 30 calves per pen. All calves received a common diet throughout the 64-day receiving period (Table 1). Cattle were monitored daily for clinical signs of illness, and animals determined to be sick were removed from their pen, taken to the processing area, and treated according to Kansas State University Beef Cattle Research Center standard operating procedures. Calves were categorized as sick if they exhibited signs of depression, decreased appetite, increased respiration rate, nasal and ocular discharge, and diarrhea. Therapeutic treatments for respiratory disease included Micotil for first-time antibiotic therapy, Baytril (Bayer Animal Health, Shawnee Mission, KS) for second-time antibiotic therapy, and LA-200 (Pfizer Animal Health, Whitehouse Station, NJ) for third-time antibiotic therapy.

Results and Discussion

Health and performance are summarized in Table 2. Dosing calves with Lactipro at processing reduced the incidence of first-time antibiotic therapy by 31% ($P = 0.02$) and reduced the number of calves that required a second antibiotic therapy by 34% ($P = 0.03$). The number of animals requiring a third antibiotic therapy for bovine respiratory disease did not differ between control and Lactipro groups ($P = 0.36$). Death loss also did not differ ($P = 0.50$) between treatments but was numerically lower for calves that received Lactipro. The decrease in antibiotic usage associated with Lactipro usage resulted in a 13.4% reduction ($P = 0.01$) in the cost of therapeutic treatments compared with the Control calves. Dosing calves with Lactipro improved dry matter intake ($P = 0.01$), average daily gain ($P = 0.02$), and feed efficiency ($P = 0.05$).

Our contention is that the decreased incidence of respiratory disease associated with use of Lactipro likely is the result of avoiding ruminal acidosis, which can present clinical signs that are difficult to distinguish from bovine respiratory disease. As a result, misdiagnosis and unnecessary therapeutic treatments with antibiotics are less likely to occur. In addition, one of the important contributing causes of respiratory disease (i.e., acidosis) is less severe and less prevalent, ultimately decreasing the incidence of respiratory disease. Improved feed consumption in calves given Lactipro also may support greater immune function, thus allowing calves to cope with disease challenges more effectively. In this study, Lactipro provided an effective means of reducing the number of animals that required antibiotic treatment. We view this as positive, given the increased scrutiny relative to use of antibiotics in livestock production.

Implications

A single oral dose of Lactipro at initial processing was an effective means of improving performance of high-risk calves as well as decreasing the number of calves that were treated for bovine respiratory disease after introduction into the feedlot.

Table 1. Composition of diet on a 100% dry matter basis

Ingredient, % of dry matter	Receiving diet
Steam-flaked corn	36.32
Corn silage	45.00
Wet corn gluten feed	15.00
Supplement[1]	2.24
Feed additive premix[2]	1.44
Nutrient composition, %	
Dry matter	53.5
Crude protein	12.0
Neutral detergent fiber	23.8
Calcium	0.70
Phosphorus	0.38

[1] Formulated to provide 0.3% salt, 0.1 ppm Co, 10 ppm copper, 0.6 ppm iodine, 60 ppm manganese, 0.25 ppm selenium, 60 ppm zinc, 1,000 IU/lb vitamin A, and 10 IU/lb vitamin E in the total diet on a 100% dry matter basis.

[2] Formulated to provide 200 mg Rumensin (Elanco Animal Health, Greenfield, IN) per animal daily.

Table 2. Receiving performance and health of high-risk calves orally drenched with Lactipro[1] at initial processing

Item	Control	Lactipro	SEM	*P*-value
Initial weight, lb	440	446	10.8	0.23
Final weight, lb	557.5	579.1	9.3	<0.01
Average daily gain, lb	1.42	1.76	0.16	0.02
Dry matter intake, lb/day	9.53	10.16	0.37	0.01
Feed:gain, lb/lb	6.80	5.75	0.59	0.05
Total morbidity, % of cattle	37.7	26.4	4.81	0.02
Treatment for bovine respiratory disease, % of cattle				
First-time treatment (Micotil[2])	32.0	22.0	4.13	0.02
Second-time treatment (Baytril[3])	17.4	11.5	2.09	0.03
Third-time treatment (LA-200[4])	5.9	4.4	1.22	0.36
Death loss, %	4.9	3.8	1.13	0.50
Medication cost, $/calf	19.70	17.06	0.98	0.01

[1] MS Biotec, Wamego, KS.

[2] Elanco Animal Health, Greenfield, IN.

[3] Bayer Animal Health, Shawnee Mission, KS.

[4] Pfizer Animal Health, Whitehouse Station, NJ.

Ultrasound Technology has Limited Ability to Predict Carcass Yield Grade of Lightweight, Short-Fed Stocker Cattle

S.J. Lawrence, S.E. Kreider, J.J. Higgins, D.A. Blasi, L. Allen, M.E. Dikeman, M.P. Epp[1], and P. Ritter

Introduction

The majority of cattle fed in commercial feedlots are processed and placed into pens without sorting into groups of uniform size and body condition. As a result of the variability in weight and condition, this management practice may lead to some cattle being fed beyond their optimal harvest point, whereas others are underconditioned and harvested prematurely, and thus fail to reach desired weight or quality grade necessary to attract available carcass premiums. Our objective was to determine if ultrasound technology could be utilized with lightweight calves as a means of predicting carcass fat thickness and yield grade outcomes. If successful, ultrasound could be a useful means of sorting cattle into uniforms groups to improve marketing.

Experimental Procedures

Crossbred steers (n = 550; body weight = 450 lb) from the southeast region of the United States were used for this study. The dataset consisted of two separate groups that were received at the Kansas State University Beef Stocker Unit. Calf weight and gender were recorded upon arrival. All calves also were assigned a breed code based on hide color. Black and red, white-faced calves were assigned breed code 1 and were assumed to represent the Angus and Hereford breed derivative. Gray, yellow, and brindle calves were assigned breed code 2 to represent multiple breed crosses, and solid red and white calves were coded 3 to represent continental breeds such as Charolais and Limousin.

The first groups consisted of 274 head and were fed a backgrounding ration for 42 days before the first ultrasound measurement was taken and ending weight was recorded. They were then placed on native grass pastures for 97 days before being transported to a commercial feedlot. The second group consisted of 276 head that were fed a backgrounding ration for 55 days before the first ultrasound measurement and ending weight was recorded. They were then shipped directly to a commercial feedlot. Descriptive information for each group is shown in Table 1. At approximately 60 days post-arrival in the feedlot, both groups were ultrasounded a second time, weighed, and sorted into groups with common projected slaughter dates using the Cattle Performance Enhancement Company (CPEC, Oakley, KS) ultrasound software program. When cattle were harvested, individual carcass data including hot carcass weight, marbling score, ribeye area, fat thickness, quality grade, and yield grade were collected.

Ultrasound measurements were obtained using an Aloka 500 console equipped with a 3.5 MHz probe (Hitachi Aoloka America, Wallington, CT) with a sagittal orientation.

[1] Cattle Performance Enhancement Company, Oakley, KS.

The location of the scan was approximately 2.5 inches distal from the midline and over the first two lumbar or over the last rib and the first lumbar vertebrae.

To estimate marbling using the CPEC system, a predetermined Region of Interest (ROI) box was placed inside the ribeye muscle between the bottom of the backfat and the rib bone at the bottom of the ribeye muscle. Marbling deposits are not registered directly on the ultrasound image; instead, acoustic interactions with the sound wave result in echographic patterns that correspond to marbling. The three specific items that were scored to describe echographic texture included overall echogenicity, pattern homogeneity, and visual assessment of ultrasonic attenuation using echogenicity and contrast of the rib bone as reference points. Muscle depth measures from the bottom of the backfat to the top of the rib bone on the bottom of the ribeye muscle. This location is approximately the same that graders in the plant would use to measure ribeye muscle depth on the carcass. This measurement is not a true measurement of the ribeye muscle size because it measures only one dimension of the ribeye muscle; rather, it is used more as an indicator of ribeye size. Fat thickness is a measurement of the layer of fat underneath the skin and above the muscle.

The initial fat thickness scan and estimated breed composition were used as variables in a regression model to estimate carcass fat thickness and yield grade. The predicted root mean square error from the regression model was then used to estimate the probabilities of the various yield grades based on the initial scan.

Results and Discussion

Figure 1 shows the relationship between initial ultrasound fat thickness and carcass fat thicknness measurements. Although the relationship between initial fat thickness and carcass fat thickness was statistically significant ($P < 0.01$), correlation between the two measurements was low ($r = 0.201$), suggesting that ultrasound measurements have limited value as a predictor of carcass fat thickness at harvest.

Implications

Correlation between initial ultrasound measurements of fat thickness and carcass fat thickness measurements at harvest is low, indicating that ultrasound measurements have limited value as a predictor of carcass fatness.

Table 1. Group characteristics of cattle used in the experiment

Traits	Group 1	Group 2
Number of animals	276	274
Stocker unit		
Starting weight, lb	448	450
Ending weight, lb	583	614
Average daily gain, lb/day	3.21	2.98
Days on feed	42	55
Breed composition, %		
Angus/Hereford	59	63
Cross	25	19
Continental	16	18
Mean		
Fat thickness, mm	3.19	3.66
Muscle depth, mm	42.24	42.5
Marbling score	4.24	4.6
Grass		
Days on pasture	97	0
Feedlot		
Weight at scan, lb	1000	949
Fat thickness, mm	5.33	6.35
Muscle depth, mm	57.51	54.02
Marbling score	4.04	4.45
Carcass		
Hot carcass weight, lb	864	811
Fat thickness, mm	10.66	11.68
Ribeye area, sq. in.	13.7	13.04
Marbling score	5.54	5.57
Yield grade 1, %	5	5
Yield grade 2, %	41	39
Yield grade 3, %	46	48
Yield grade 4, %	8	7
USDA Choice, %	73	70

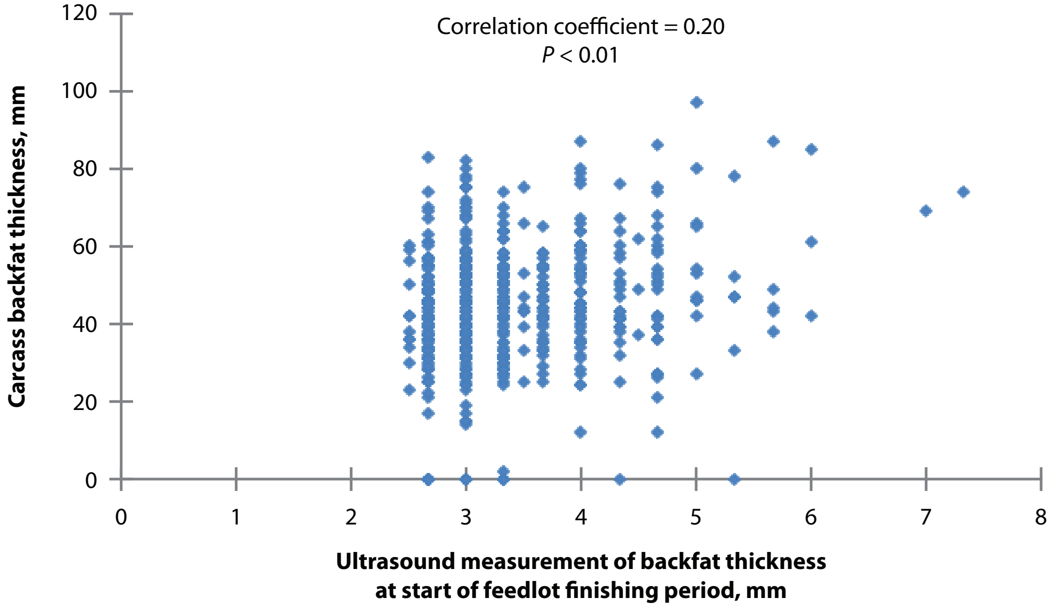

Figure 1. Relationship between initial ultrasound scanned fat thickness and carcass fat thickness at harvest.

Evidence of Estrus Before CIDR Insertion Does Not Influence Pregnancy Rate to Fixed-Timed Artificial Insemination in Beef Heifers

S.K. Johnson, M.A. Ward[1], O.L. Swanson[2], and G.A. Perry[2]

Introduction

Protocols used for fixed-timed artificial insemination strive to synchronize growth of follicular waves and commonly do so by administration of gonadotropin-releasing hormone (GnRH) at the beginning of the treatment. The stage of the cycle at the time of GnRH injection influences the proportion of animals that respond, and cows respond more consistently than heifers. Variability in response to GnRH has been offered as an explanation for why why short-term fixed-timed insemination protocols tend to be less effective in heifers than cows. The dairy industry has used prostaglandin (PG) to "pre-synchronize" cow ovulation before a protocol to improve the proportion of cows that initiate a new wave of follicular growth. Because of the additional cost in time and product, the beef industry has been reluctant to explore this approach.

South Dakota State University research has indicated that variability in onset of estrus was reduced when PG was given 3 days before a controlled internal drug release (CIDR) protocol. A reduction in variability of the onset of estrus may improve response to fixed-time artificial insemination. The objective of this study was to determine if the onset of estrus prior to a PG 6-day CIDR protocol would improve pregnancy rates to fixed-time artificial insemination in beef heifers.

Experimental Procedures

Ovulation was synchronized in 94 Angus and Angus crossbred heifers at 2 locations with a PG 6-day CIDR protocol (Figure 1). Body condition scores (1 = thin; 9 = very fat) were assigned at the start of the treatments. Heifers received 2 mL of Cystorelin (100 ug GnRH, Merial, Duluth, GA) and a CIDR (Pfizer Animal Health, Whitehouse Station, NJ) insert on day −6. On day 0, CIDR inserts were removed and 25 mg of PG (5 mL Lutalyse, Pfizer Animal Health) was administered intramuscularly. A single fixed-timed insemination occurred 66 hours after CIDR insert removal. On day −9, all heifers received a heat-detection patch (Estrotect, Western Point, Inc., Apple Valley, MN) and 5 mL Lutalyse. On day −6, Estrotect patches were scored as activated, partially activated, or non-activated (Figure 2). On day 0, missing or activated patches were replaced, and scoring occurred again at the time of artificial insemination. Serum concentrations of progesterone were determined in samples collected on day −9 and day −6. Serum samples with concentrations of progesterone ≥1 ng/ml were classified as high, and those with <1 ng/ml were classified as low. Heat detection and artificial insemination continued (location 1) or bulls were turned in 10 days after fixed-timed artificial insemination (location 2). Pregnancy to artificial insemination was determined 34 to 36 days after fixed-time artificial insemination via transrectal ultrasonography.

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[1] Beef Program director, Colby Community College, Colby, KS.

[2] South Dakota State University, Brookings, SD.

Results and Discussion

Heifers averaged a body condition score of 6.0 and weighed 890 lb at the start of treatments (Table 1). Starting weight was greater ($P < 0.01$) for heifers in location 1 than location 2, but a similar proportion (91%) had at least 1 sample with concentrations of progesterone >1 ng/mL.

On day −6 at the time of CIDR insertion, 30, 8, and 58 heifers had patches that were activated, partially activated, or non-activated, respectively (Figure 3). Pregnancy rate to artificial insemination was similar regardless of patch activation at the time of CIDR insertion. Response to the first prostaglandin injection by day −6 was 40% (activated or partially activated patches), which is within a normal range when a high proportion of animals are cycling at the time of injection.

At the time of artificial insemination, 60, 23, and 14 heifers had patches that were activated, partially activated, or non-activated, respectively (Figure 3). Pregnancy rate to artificial insemination was similar between heifers that had a fully activated patch and those with non-activated patches. Heifers with partially activated patches had numerically lower pregnancy rates to artificial insemination but were not significantly different from the other groups.

Implications

The onset of estrus as measured by patch activation prior to CIDR insertion did not result in higher pregnancy rates to fixed-timed artificial insemination compared with heifers with non-activated patches. Heifers that did not have activated heat detection patches at the time of fixed-timed artificial insemination conceived to timed artificial insemination as well as those with activated patches.

Table 1. Starting weight and body condition of beef heifers prior to synchronization of ovulation

	No. of cows	Body condition score	Weight, lb
Location 1	78	6.0 ± 0.1	900 ± 8
Location 2	16	5.8 ± 0.1	843 ± 19

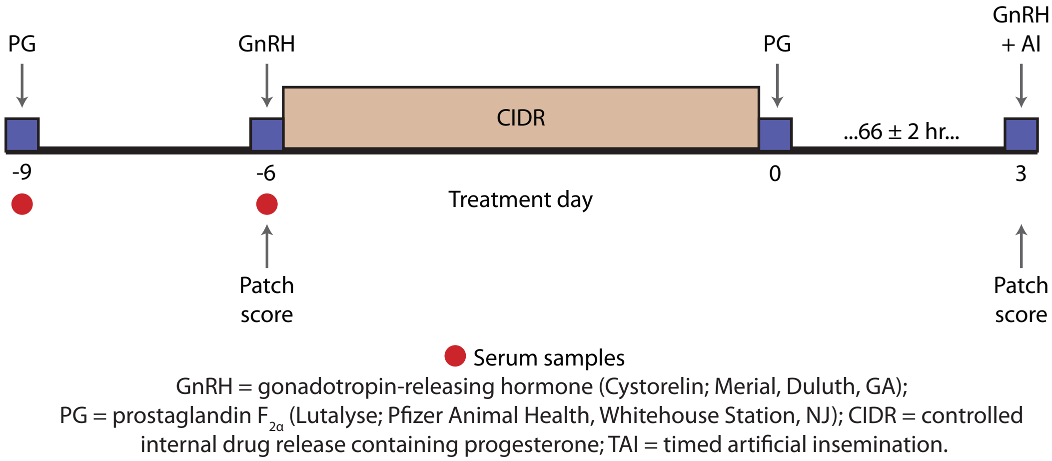


Figure 1. Diagram of treatment protocol.

Figure 2. Representative samples of Estrotect (Western Point, Inc., Apple Valley, MN) heat-detection patches scored as activated, partially activated, or non-activated.

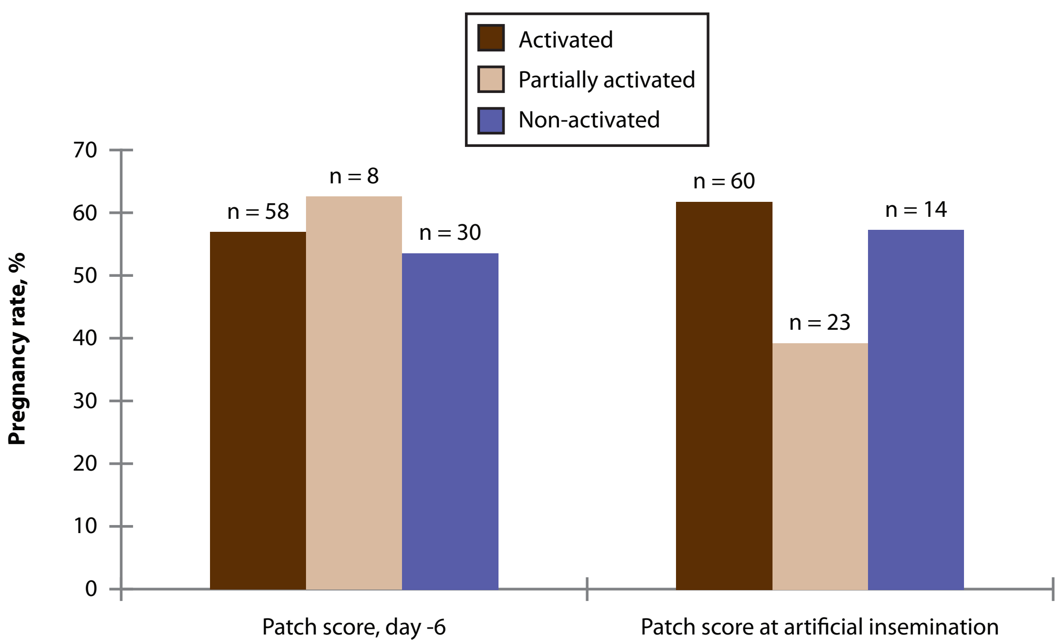


Figure 3. Relationship of patch score to pregnancy rate to fixed-timed artificial insemination.

Presynchronizing $PGF_{2\alpha}$ and GnRH Injections Before Timed Artificial Insemination CO-Synch + CIDR Program

S.L. Hill, S.L. Pulley, KC Olson, J.R. Jaeger, R.A. Breiner, G.C. Lamb[1], and J.S. Stevenson

Introduction

Fixed-time artificial insemination is an effective management tool that reduces the labor associated with more conventional artificial insemination programs requiring detection of estrus. The 7-day CO-Synch + controlled internal drug release (CIDR) insert protocol has been shown to effectively initiate estrus and ovulation in cycling and non-cycling suckled beef cows, producing pregnancy rates at or greater than 50% in beef cows. The gonadotropin-releasing hormone (GnRH) injection that begins the CO-Synch + CIDR program initiates ovulation in a large proportion of cows, particularly anestrous cows. The CIDR, which releases progesterone intravaginally, prevents short estrous cycles that usually follow the first postpartum ovulation in beef cows. Our hypothesis was that inducing estrus with a prostaglandin injection followed 3 days later with a GnRH injection, 7 days before applying the 7-day CO-Synch + CIDR protocol, might increase the percentage of cycling cows that would exhibit synchronous follicular waves after the onset of the CO-Synch + CIDR protocol. We also hypothesized that the additional GnRH injection would increase the percentage of anestrous cows that would ovulate, thereby increasing pregnancy outcomes.

Experimental Procedures

A total of 809 primiparous and multiparous cows in 11 pastures at 4 operations in Florida and Kansas were enrolled in this study. Characteristics of suckled beef cows enrolled by location are summarized in Table 1. Cows were stratified by breed, days postpartum, and parity, and then assigned randomly to 1 of 2 treatments. Control cows received the standard CO-Synch + CIDR program (100 μg GnRH; 2 mL Factrel, Pfizer Animal Health, Whitehouse Station, NJ) 7 days before and 72 hours after receiving 25 mg prostaglandin F_{2a} (PG; 5 mL Lutalyse; Pfizer Animal Health). A new CIDR insert (Pfizer Animal Health) containing 1.38 g progesterone was placed intravaginally at the time of the first GnRH injection (day −10). Treated cows (Figure 1; PG-3-G) received 25 mg PG 10 days before (day −20) followed by 2 mL Factrel 7 days before the CO-Synch + CIDR program began.

Body condition scores (1 = thin; 9 = very fat) were assigned at the time PG was administered to all cows on day −20. Estrus-detection patches (Estrotect, Rockway, Inc., Spring Valley, WI) were affixed to all cows. Estrus-detection patches were removed on day −17 if completely colored; otherwise, they were removed on day −10 and scored (0 = not colored, 1 = partially colored, and 2 = completely colored). On day −3, CIDR inserts were removed, a second estrus-detection patch was applied, and PG was administered to all cows in both treatments.

[1] Deptartment of Animal Science, North Florida Research and Education Center, University of Florida, Marianna.

Blood samples were collected via caudal vessel puncture at days −20, −17, −10, −3, and 0. Samples were assayed for progesterone by using radioimmunoassay. Cows with blood progesterone >0.95 ng/mL on days −20, −17, or −10 or with a completely colored estrus-detection patch by day -10 were assumed to have reestablished estrous cycles and were classified as cycling. The sample collected at day −3 reflected progesterone concentrations resulting from the CIDR insert, a functional corpus luteum, or both.

Artificial insemination was performed 68 to 70 hours after CIDR insert removal on day 0, and estrus-detection patches were removed and scored. Cows were either exposed to cleanup bulls 10 to 12 days later or reinseminated at subsequent estrus. At 35 days after artificial insemination, pregnancy was confirmed by transrectal ultrasonography (Aloka 500V, 5MHz transrectal transducer, Wallingford, CT). A positive pregnancy outcome required the presence of a corpus luteum and uterine fluid or uterine fluid and an embryo with a heartbeat. A final pregnancy diagnosis was determined 35 days after the end of the breeding season via transrectal ultrasonography. Embryonic losses in cows that conceived to the timed artificial insemination were determined at that time.

Results and Discussion

Cyclicity in the cows averaged 49.9% across the 4 locations at the beginning of the protocol (Table 1). The percentage of primiparous cows varied by location (62.8 to 83.4%). Average body condition score ranged from 4.9 to 5.6. Unusually hot and dry conditions affected all locations, and a total of 11 cows either died or were sold before the final pregnancy diagnosis. Considerable variation in pregnancy outcomes was observed among locations; however, pregnancy rates did not differ between treatments (Figure 1). Cyclicity and the cyclicity-treatment combinations also did not affect pregnancy outcomes (Table 2). In contrast, cows that had calved more than 77 days before timed artificial insemination had better ($P = 0.002$) pregnancy outcomes than those that calved less than 77 days before artificial insemination. Cows with greater body condition scores (≥5.5) than thinner cows also had greater pregnancy rates.

Implications

Results indicate that the PG-3-G treatment and control were equally effective fixed-time artificial insemination protocols, even in herds with a large percentage of anestrous cows. Both of these protocols were more effective for cows that were at least 77 days since calving and had a minimum body condition score of 5.5.

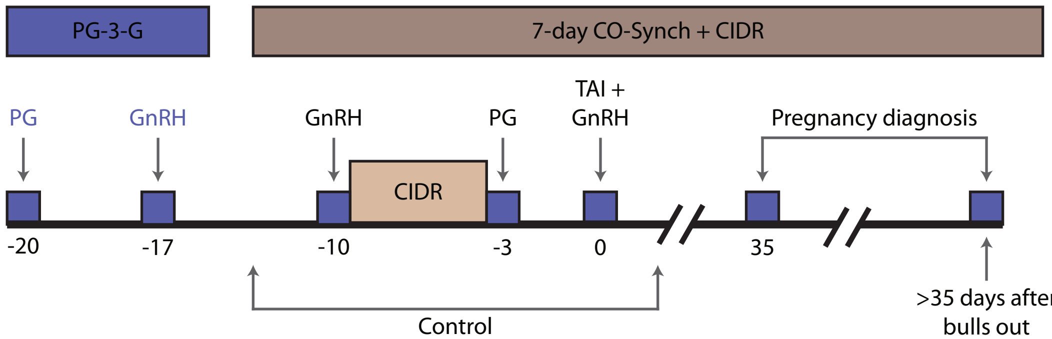
Table 1. Location characteristics of suckled beef cows enrolled in the study

Location	Breed	Number of cows	2-year-olds, %	Days postpartum at artificial insemination[1]	Body condition score[1]	Cyclicity, %[2]
Florida	Angus, Charolais, Brangus	169	16.6	69 ± 0.7	5.6 ± .04	56.2
Kansas						
K-State Agricultural Research Center–Hays	Angus × Hereford	195	37.4	80 ± 1.0	5.5 ± .04	32.3
K-State Commercial Cow-Calf Unit	Angus × Hereford	261	16.9	71 ± 0.7	5.5 ± .04	50.6
K-State Purebred Beef Unit	Angus, Hereford, Simmental	184	24.5	69 ± 1.2	4.9 ± .05	62.0

[1] Mean ± Standard Error.
[2] Percentage cyclicity at the onset of the CO-Synch + CIDR (controlled internal drug release) program.

Table 2. Pregnancy rates in suckled beef cows after presynchronization with PG-3-G before CO-Synch-CIDR (controlled internal drug release)

Item	%	n	*P*-value
Treatment			0.336
PG-3-G	49.0	399	
Control	45.1	399	
Cycling status			0.415
No	45.4	405	
Yes	48.6	393	
Treatment × cycling status			0.721
PG-3-G (not cycling)	48.0	192	
PG-3-G (cycling)	49.9	207	
Control (not cycling)	42.9	213	
Control (cycling)	47.4	186	
Days postpartum at artificial insemination			0.002
<77	39.6	386	
≥77	54.6	412	
Body condition score			0.065
<5.5	43.3	415	
≥5.5	50.9	383	



GnRH = gonadotropin-releasing hormone (Factrel; Pfizer Animal Health, Whitehouse Station, NJ); PG = prostaglandin $F_{2\alpha}$ (Lutalyse; Pfizer Animal Health); CIDR = controlled internal drug release containing progesterone; TAI = timed artificial insemination.

Figure 1. Experimental protocol illustrates the sequence of treatments and measurements. The PG-3-G treatment included the control standard 7-day CO-Synch + CIDR timed artificial insemination program.

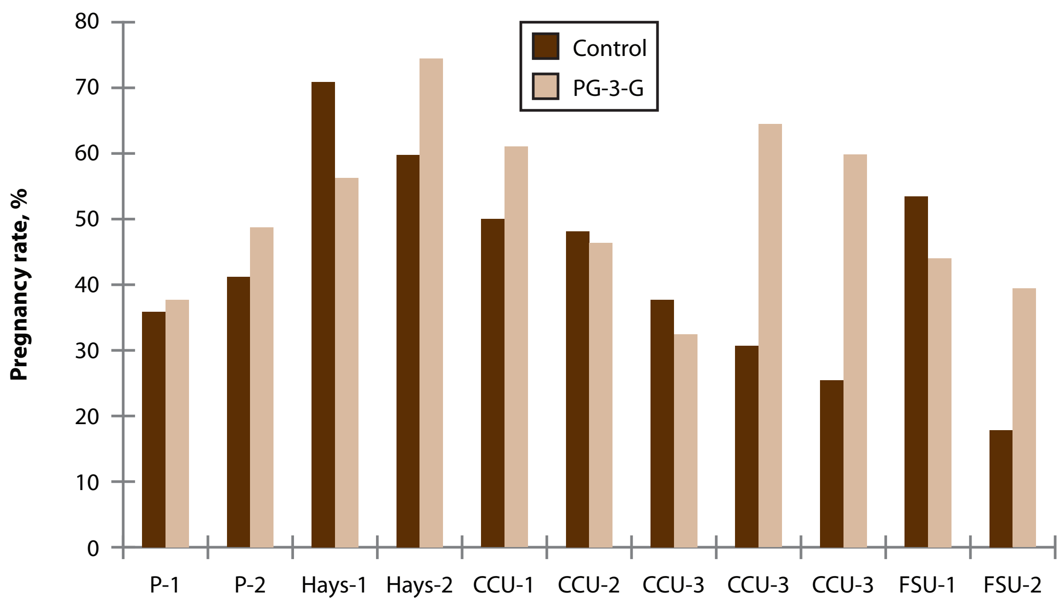


Figure 2. Timed artificial insemination pregnancy rates achieved at each pasture location. There were 2 pastures in Florida (FSU), 2 pastures at the Kansas State University Agricultural Research Center–Hays (Hays), 5 pastures at the K-State Commercial Cow-Calf Unit (CCU), and 2 pastures at the K-State Purebred Beef Unit (P).

Exposure of Prepubertal Beef Bulls to Cycling Females Affects Neither Age at Puberty Nor Ability to Pass an Initial Breeding Soundness Examination

N. Miller, R. Breiner, T. Taul, S. Tucker, and K. Fike

Introduction

Age at puberty is a crucial factor influencing a young bull's ability to pass a breeding soundness examination (BSE) at a year of age, and reducing that age may prove beneficial to beef producers. For beef females, exposure to mature bulls is known to hasten the onset of puberty and also can reduce the duration of postpartum anestrus. Relatively little research has evaluated the effects of female exposure on beef bull sexual development. Bulls are thought to use visualization rather than olfaction as their primary and preferred way to detect estrus in females. The purpose of this study was to determine whether continuous, long-term fence-line exposure of prepubertal beef bulls to estrous-cycling beef females influences a bull's age at puberty and subsequent ability to pass a BSE.

Experimental Procedures

Angus, Hereford, Simmental, and Simmental × Angus bulls (n = 77) developed from the Kansas State University Purebred Beef Unit were used in this study. Bulls were stratified by age and breed, then randomly assigned to receive continuous fence-line and visual contact with: (1) beef females exhibiting estrous cycles (Exposed; n = 41), or (2) no visual or fence-line contact with beef females (Control; n = 36) from an average age of 6.5 to 12 months. Bulls were housed in 4 dirt dry-lot pens with 2 pens per treatment. An 11-ft-high plywood wall served as a visual barrier between the exposed and control bulls, thus preventing the control bulls from observing the cycling beef females, with a minimum of 140 ft from control bulls to penned females. All bulls were fed a grower diet designed for bulls to achieve an approximate average daily gain of 3.5 lb per day.

Cycling beef females (n = 9) were maintained in a pen adjacent to the exposed bulls so the bulls had continuous visual and nose-to-nose contact with the females. Transrectal ultrasound for observing ovarian structures was performed on all females to ensure they were cycling prior to beginning the study. Beef female estrous cycles were synchronized so 4 to 5 females were in estrus each week of the study. Estrotect patches (Rockway, Inc., Spring Valley, WI) were utilized to aid in estrus detection each week to confirm that females were exhibiting estrous behavior.

When a bull averaged 196 ± 21.5 days of age, its initial body weight, scrotal circumference, and blood sample (to assess testosterone) was collected before enrollment in the study. A second body weight, scrotal circumference, and blood sample was collected on day 9 of the study and repeated every 28 days until the study concluded.

Beginning when bulls obtained a scrotal circumference ≥10.2 inches, a semen sample was obtained via electroejaculation using a SireMaster Professional electronic ejaculator (SireMaster, Manhattan, KS) with a 2.5-inch diameter probe (SireMaster, Manhattan, KS). All semen collections and evaluations were conducted at the Kansas Artificial Breeding Service Unit. Semen collection continued every 28 days until the bull achieved puberty. Bulls were considered pubertal if they achieved: (1) ≥10.2 inches scrotal circumference, (2) 5.0×10^6 sperm/mL, and (3) ≥10% progressive motility. A veterinarian conducted bull BSEs after approximately 5.5 months of treatment, when bulls averaged 363 ± 21.5 days of age. Semen samples were obtained from all bulls via electroejaculation, regardless of whether they had previously achieved puberty. Bulls passed the BSE if their semen sample had a minimum 30% progressive motility and 70% normal sperm morphology in addition to meeting all other BSE criteria, including an acceptable scrotal circumference for their age. Bulls that did not meet these minimum criteria at the initial examination were retested 20 days later.

Assessments of bull behavior were conducted twice monthly during the study, both when cycling females were in estrus and when they were not. Each day of assessment consisted of three 1-hour observation periods with a minimum of 1 observer per pen. The number of homosexual mounting attempts and flehmen responses were recorded for all bulls in each pen. In addition, exposed bulls were assessed for the number of times they entered a specified cycling female area (10 ft from each side of the cow pen) per hour of observation.

Results and Discussion

Treatment and day interacted ($P = 0.0003$) to affect bull body weight. Exposed bulls were heavier ($P = 0.02$) at day 149 of the study when bulls averaged 11.5 months of age compared with control bulls (1,122 ± 16 lb and 1,068 ± 16 lb, respectively). Scrotal circumference increased ($P < 0.001$) throughout the study but was unaffected by treatment ($P = 0.7$). Day of the study and treatment interacted ($P = 0.03$) to affect testosterone concentrations. Control bulls had greater ($P = 0.002$) testosterone concentrations than exposed bulls at day 93 of the study when bulls averaged 9.5 months of age (11.87 ± 0.78 ng/mL and 8.20 ± 0.77 ng/mL, respectively).

Bull age, weight, scrotal circumference, and semen characteristics at puberty were similar ($P > 0.10$) among exposed and control bulls (Table 1). The percentage of bulls that passed their first BSE was also similar ($P = 0.54$; Figure 1). A total of 14 bulls failed their BSE because of inadequate normal sperm morphology or percentage motile sperm. Eight bulls were retested 20 days after the first BSE. Of those 8, 4 bulls failed a second time, and the primary reason for failure of 3 bulls was sperm motility and normal morphology below the minimum passing standards. Age affected ($P = 0.03$) whether a bull passed or failed the BSE. Most research indicates that poor semen evaluations are the primary reason for failure of a BSE by yearling beef bulls, particularly inadequate percentage normal sperm morphology. Of the bulls that had achieved puberty during the study (n = 51), 47 passed the BSE (96.1%) and only 2 failed (3.9%). Pubertal exposed bulls had a BSE passing rate of 93.1%, and 100% of the control bulls that achieved puberty during the study passed their first BSE.

Bull sexual behavior assessments were conducted as potential indicators of female influence on developing bulls. A 3-way interaction ($P = 0.05$) between treatment, month of assessment, and stage of the estrous cycle (estrus or not in estrus) when the assessment was conducted was observed for the number of mounting attempts. Exposed bulls exhibited more homosexual mounting activity when females were in estrus than when they were not in estrus during months 1 ($P = 0.02$), 3 ($P < 0.001$), 4 ($P = 0.01$), and 5 ($P = 0.07$) of the study. Exposed bulls entered the designated cow area more often when females were in estrus and during the first month of the study; entrance level generally decreased with each subsequent estrus assessment. The bulls likely found the females a novel stimulus, but their interest generally waned over time. Bull homosexual mounting attempts and flehman responses were similar ($P > 0.10$) between exposed and control bulls when females were in estrus. Collectively, sexual behavior assessment results indicate no clear influence of bulls' exposure to cycling females on their display of sexual behaviors.

Implications

Continuous and long-term exposure of young, developing beef bulls to cycling beef females does not enhance their sexual development, nor does it influence the percentage of bulls passing their initial BSE at a year of age.

Table 1. Number of bulls reaching puberty by day 149 of study (average 11.5 months of age) and mean age, scrotal circumference, body weight, and semen characteristics at puberty for bulls with continuous fence-line exposure to cycling beef females (Exposed) and bulls not exposed to females (Control)

Item	Exposed	Control	*P*-value
Number of bulls pubertal, %	29 (56.9)	22 (43.1)	...
Age, days	320.3 ± 5.3	311.3 ± 5.9	0.28
Scrotal circumference, in.	13.6 ± 0.2	13.7 ± 0.2	0.65
Weight, lb	1026 ± 27	963 ± 30	0.25
Sperm concentration, 10^6/mL	85.53 ± 9.6	106.12 ± 10.8	0.35
Motility, %	45.2 ± 4.3	34.2 ± 4.5	0.23
Normal morphology, %	33.8 ± 4.3	24.8 ± 4.9	0.17

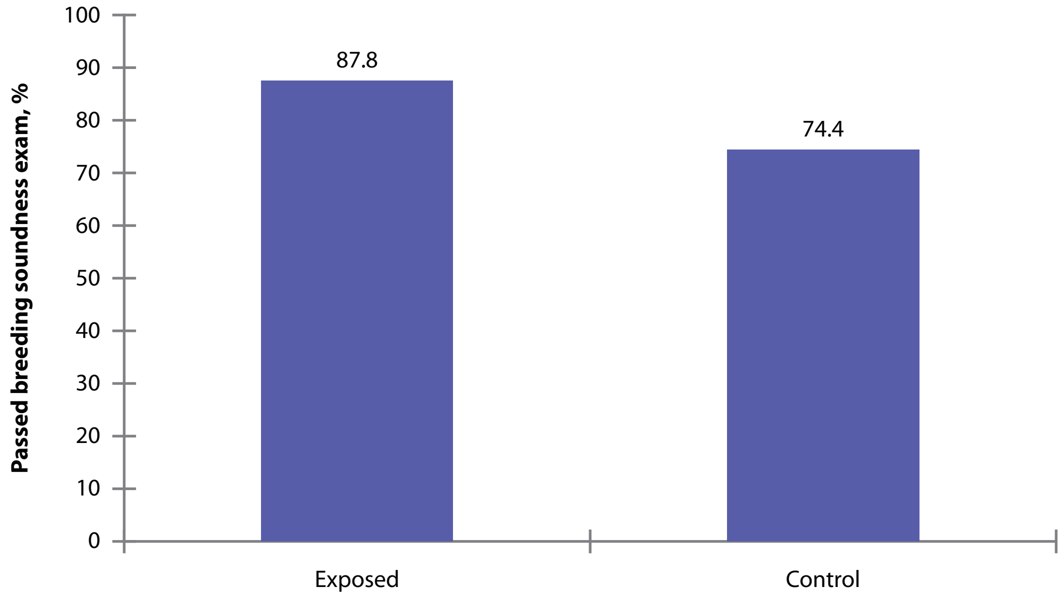


Figure 1. Percentage of developing beef bulls exposed (Exposed) or not exposed (Control) to cycling beef females that passed their initial breeding soundness examination (conducted at an average of 363 days of age).

Effects of Corn Processing and Wet Corn Gluten Feed on Newly Received and Growing Cattle

A.V. Siverson, E.C. Titgemeyer, S.P. Montgomery, D.A. Blasi, and B.E. Oleen

Introduction

Newly arrived feedlot cattle present numerous challenges and are often considered to be the most difficult type of fed cattle to handle. Receiving cattle typically are highly stressed and have had feed withheld for a significant amount of time. Formulating rations that are cost-effective and nutrient-dense is essential to accommodating lowered intake. The objective of this experiment was to evaluate effects of corn processing (whole shelled or dry-rolled), wet corn gluten feed (WCGF) inclusion, and their interaction on cattle performance.

Experimental Procedures

All procedures used in the care, handling, and sampling of animals were approved by the Kansas State University Institutional Animal Care and Use Committee.

Crossbred steers (n = 279; 507 lb initial body weight) were assembled through commercial sale barn market facilities and used in a randomized complete block design with a 2 × 2 factorial arrangement of treatments to evaluate the effects of corn processing (whole shelled versus dry-rolled) and WCGF inclusion (0% or 30%). All calves were blocked by truck (n = 3), stratified by arrival weight, and randomly assigned to pens. Twenty-four pens of equal size were used to allow for 6 pens per treatment. The day after arrival, all calves were dewormed and vaccinated for clostridial and viral diseases. Calves also were given a subcutaneous injection of Excede (Pfizer Animal Health, Whitehouse Station, NJ) at a rate of 7 ml/head.

Calves were fed twice daily for a total of 60 days. The test diets (Table 1) were whole shelled corn (WSC) with no WCGF (WSC/0WCGF), WSC with 30% WCGF (WSC/30WCGF), dry-rolled corn (DRC) with no WCGF (DRC/0WCGF), and DRC with 30% WCGF (DRC/30WCGF). All diets contained the same amount of alfalfa and prairie hay. Diets without WCGF contained 5% molasses to condition the total mixed ration. The amount of feed delivered to each pen was recorded on a daily basis. Total mixed diets were sampled weekly. Cattle were weighed at initial processing (day 0), during revaccination (day 14), and on days 28 and 60. Fecal grab samples were taken from each animal and composited by pen on days 14, 28, and 60 and subsequently analyzed for starch concentration. At the end of the experiment (day 60), all calves were weighed.

Results

No effects of corn processing (Table 2) were observed ($P \geq 0.34$), substantiating earlier research indicating that lightweight cattle are able to masticate corn effectively. Final body weight and average daily gain increased with the inclusion of WCGF in diets ($P = 0.03$ and $P = 0.04$, respectively). There was tendency to increase dry matter intake in the diets with WCGF ($P = 0.13$). An impact was observed for WCGF on efficiency for the receiving period (d 0 to 28; $P = 0.03$), but no improvement in WCGF was observed for the 60-day feeding period. Digestibility (Table 3) of dry matter was improved with the inclusion of WCGF in the diet ($P = 0.006$). An interaction between corn and WCGF was observed ($P = 0.017$). Starch digestibility was improved with WCGF ($P = 0.009$). No corn processing effects were observed for digestibility of dry matter or starch (all $P \geq 0.32$).

Implications

Processing corn for receiving and growing cattle is unnecessary. WCGF inclusion improved gains, tended to increase feed intake, and improved digestibility of dry matter and starch.

Table 1. Composition of diets containing whole shelled corn or dry rolled corn with 0 or 30% wet corn gluten feed (WCGF) expressed on a 100% dry matter basis

	Whole shelled corn		Dry-rolled corn	
Ingredient, %	0WCGF	30WCGF	0WCGF	30WCGF
Whole shelled corn	47.1	28.6	—	—
Dry-rolled corn	—	—	47.1	28.6
Wet corn gluten feed	—	30.0	—	30.0
Alfalfa hay	17.5	17.5	17.5	17.5
Prairie hay	17.5	17.5	17.5	17.5
Molasses	5.0	—	5.0	—
Supplement	12.9	6.4	12.9	6.4
Dry corn gluten feed	5.2	1.8	5.2	1.8
Soybean meal	2.2	—	2.2	—
Dried distillers grains	1.9	—	1.9	—
Urea	0.85	—	0.85	—
Wheat middlings	0.75	3.1	0.75	3.1
Fat	0.26	—	0.26	—
Salt	0.39	0.38	0.39	0.38
Limestone	0.32	0.82	0.32	0.82
Potassium chloride	0.26	0.02	0.26	0.02
Calcium phosphate (21% P)	0.65	—	0.65	—
Magnesium oxide	0.06	0.001	0.06	0.001
Beef vitamin[1]	0.004	0.001	0.004	0.001
Ruminant trace mineral[1]	0.003	0.001	0.003	0.001
Molasses	—	3.0	—	3.0
Rumensin 90[2]	0.014	0.019	0.11	0.019

[1] Cargill Animal Nutrition, Minneapolis, MN.
[2] Elanco Animal Health, Greenfield, IN.

Table 2. Effects of whole shelled corn (WSC) and dry-rolled corn (DRC) with and without wet corn gluten feed (WCGF) on average daily gain, feed intake, and efficiency

	Whole shelled corn		Dry-rolled corn			*P*-values		
Item	0WCGF	30WCGF	0WCGF	30WCGF	SEM	Corn	WCGF	Corn × WCGF
Days on feed	60	60	60	60				
Initial weight, lb	508.0	508.0	508.2	508.0	0.21			
Final weight, lb	703.5	719.2	707.7	715.0	4.77	0.97	0.03	0.42
Dry matter intake, lb/day								
Day 0 to 14	12.4	12.6	12.8	12.6	0.23	0.34	0.80	0.34
Day 0 to 28	14.3	15.1	14.8	14.5	0.23	0.83	0.40	0.03
Day 0 to 60	16.3	17.4	16.6	16.6	0.34	0.45	0.13	0.12
Average daily gain, lb								
Day 0 to 14	3.1	3.6	3.1	3.5	0.25	0.82	0.08	0.67
Day 0 to 28	3.3	3.7	3.3	3.7	0.12	0.69	0.004	0.89
Day 0 to 60	3.3	3.5	3.3	3.5	0.09	0.93	0.04	0.40
Gain:feed								
Day 0 to 14	0.247	0.289	0.244	0.276	0.029	0.67	0.07	079
Day 0 to 28	0.230	0.242	0.224	0.257	0.010	0.66	0.03	0.30
Day 0 to 60	0.20	0.20	0.20	0.21	0.006	0.60	0.47	0.65

Table 3. Effects of whole shelled corn (WSC) and dry-rolled corn (DRC) with 0 or 30% wet corn gluten feed (WCGF) on digestibility of diet dry matter and starch

	Whole shelled corn		Dry-rolled corn			*P*-values		
Digestibility, %	0WCGF	30WCGF	0WCGF	30WCGF	SEM	Corn	WCGF	Corn × WCGF
Dry matter	59.69	60.19	55.73	61.86	1.15	0.32	0.006	0.017
Starch	68.40	73.39	68.83	71.15	1.35	0.50	0.009	0.33

Wet Distillers Grain and Solubles vs. Wet Corn Gluten Feed for Newly Received and Growing Cattle

E.R. Schlegel, S.P. Montgomery[1], C.I. Vahl, B.E. Oleen, W.R. Hollenbeck, and D.A. Blasi

Introduction

In many instances, due in part to price per unit of energy and proximity to production, Kansas beef producers have the opportunity to incorporate grain-processing byproducts such as wet distillers grains with solubles (WDGS) and wet corn gluten feed (WCGF) into diets for newly received and growing cattle. Although a number of previous studies have compared these two byproducts for use in finishing diets, little information is available for receiving and growing cattle diets. Therefore, the objective of this study was to compare the performance outcomes of newly arrived and growing calves fed either WDGS or WCGF relative to a standard corn-based diet.

Experimental Procedures

All procedures were approved by the Kansas State University Institutional Animal Care and Use Committee. Over a 9-day period (May 15 through 23, 2012), 280 steers and bulls (30% bulls; 518 lb initial body weight) were assembled through sale-barn market facilities in Tennessee and transported to the Kansas State University Beef Stocker Unit. Upon arrival, all calves were weighed, ear-tagged, mass medicated with Draxxin (Pfizer Animal Health, Whitehouse Station, NJ) (1.1 mL/100 lb), and palpated for sex (bull or steer). Calves were then given free-choice access to long-stem prairie hay and water overnight. The following day, calves were vaccinated against clostridial and respiratory diseases and dewormed, and bulls were surgically castrated. Cattle within each load (3 total) were then randomly assigned to 1 of 3 treatments for a total of 24 pens. Castrated bulls were distributed equally among the eight pens within each load. Experimental treatments consisted of a feeding a diet that contained no corn byproducts (Control) or diets containing either 30% WCGF or 30% WDGS on a dry matter basis (Table 1). Feed bunks were checked twice daily, and feed was delivered in amounts sufficient to result in clean feed bunks in both morning and afternoon. Calves were fed their respective diets at approximately 7:00 a.m. and 3:00 p.m. daily for 58 days. Calves then were fed a common diet for an additional 14 days to equalize gut fill, after which time cattle were weighed to determine a final body weight. Daily dry matter intake, gains, and feed efficiencies were determined for each pen of calves. Growth performance and feed intake data were analyzed as a randomized complete block design. Health data were analyzed using Pearson's chi-square.

Results and Discussion

Growth performance is shown in Table 2. Feeding WDGS during the receiving period increased dry matter intake but did not improve growth performance compared with cattle fed the Control and WCGF diets. Feeding WDGS during the growing period

[1] Corn Belt Livestock Services, Cedar Rapids, IA.

provided for increased ADG and improved feed efficiency compared with cattle fed the Control or WCGF diets. First-time treatments for bovine respiratory disease decreased in calves fed WDGS.

Implications

Replacing corn, molasses, and a portion of a protein supplement with 30% WCGF or 30% WDGS on a dry matter basis to receiving and growing cattle results in similar or improved growth performance. Because WCGF and WDGS are usually priced lower than corn, diets are less costly, thus decreasing cost of gain.

Table 1. Composition of diets fed to highly stressed crossbred steers during the receiving and growing period

Item	Control	Corn gluten feed	Wet distillers grains
Ingredient, % of diet dry matter			
Cracked corn	47.14	28.57	28.57
Wet corn gluten feed	-	30.00	-
Wet distillers grains + solubles	-	-	30.00
Alfalfa hay	17.50	17.50	17.50
Prairie hay	17.50	17.50	17.50
Supplement	12.86	6.43	6.43
Molasses	5.00	-	6.32
Nutrient concentration			
Dry matter, %	85.90	76.1	60.3
Crude protein, %	14.07	14.96	17.14
Calcium, %	0.62	0.63	0.65
Phosphorous, %	0.43	0.49	0.44
Potassium, %	1.17	1.19	1.09
NEm, Mcal/100 lb	77.19	78.79	81.79
NEg, Mcal/100 lb	48.43	49.93	52.03

Table 2. Growth performance of crossbred steers fed diets containing corn (Control), wet corn gluten feed (WCGF), or wet distillers grains with solubles (WDGS) during the receiving and growing periods

Item	Control	WCGF	WDGS	SEM
Initial weight, lb	516	517	516	4.624
28-day weight, lb	630	637	635	6.892
72-day weight, lb	744[a]	746[a]	771[b]	14.07
Average daily gain, lb				
Day 0–28	4.01	4.25	4.16	0.177
Day 0–72	3.16[a]	3.18[a]	3.53[b]	0.129
Dry matter intake, lb/day				
Day 0–28	12.21[a]	12.58[a]	13.61[b]	0.3361
Day 0–72	16.29	15.67	15.97	0.376
Gain:feed, lb/lb				
Day 0–28	0.330	0.338	0.307	0.013
Day 0–72	0.19[a]	0.20[a]	0.22[b]	0.0070
First-time treatments for bovine respiratory disease, % of calves	12.77	13.33	4.40	—

[a,b] Means within a row without a common superscript are different, $P < 0.05$.

Calf Health and Performance During Receiving Is Not Changed by Fence-Line Preconditioning on Flint Hills Range vs. Drylot Preconditioning

E.A. Bailey, J.R. Jaeger, J.W. Waggoner, G.W. Preedy, L.A. Pacheco, and KC Olson

Introduction

Ranch-of-origin preconditioning can improve the welfare and performance of beef calves by decreasing the stress associated with weaning, transport, diet change, and commingling with other calves. Preconditioning methods that involve pasture weaning coupled with maternal contact (i.e., fence-line weaning) have been promoted as possible best management practices for minimizing stress. Prior studies focused on performance and behavior during preconditioning on the ranch of origin. Little information has been published relating to carryover effects of fence-line preconditioning compared with conventional drylot preconditioning on performance and behavior during feedlot receiving.

Our objectives were to measure growth and health during a 28-day ranch-of-origin preconditioning phase and during a 60-day feedlot receiving phase among beef calves subjected to 1 of 3 ranch-of-origin preconditioning programs: (1) drylot preconditioning + dam separation, (2) pasture preconditioning + fence-line contact with dams, and (3) pasture preconditioning + fence-line contact with dams + supplemental feed delivered in a bunk. In addition, we recorded incidences of behavioral distress among these treatments during first 7 days of feedlot receiving.

Experimental Procedures

Angus × Hereford calves (n = 460; initial body weight = 496 ± 77 lb) originating from the Kansas State University commercial cow-calf herds in Manhattan and Hays, KS, were used in this experiment. Calves were weaned at approximately 180 days of age. All calves were dehorned, and steer calves were castrated before 60 days of age. At weaning, calves were weighed individually and assigned randomly to 1 of 3 ranch-of-origin preconditioning methods: (1) drylot weaning + dam separation (Drylot), (2) pasture weaning + fence-line contact with dams (Pasture), and (3) pasture weaning + fence-line contact with dams + supplemental feed delivered in a bunk (Pasture+Feed).

All calves were vaccinated against respiratory pathogens (Bovi-Shield Gold 5; Pfizer Animal Health, Whitehouse Station, NJ), clostridial pathogens (Ultrabac 7; Pfizer Animal Health), and *H. somnus* (Somubac; Pfizer Animal Health). In addition, calves were treated for parasites (Ivomec; Merial Limited, Atlanta, GA). Booster vaccinations were administered 14 days later.

Within location, calves assigned to each treatment were maintained for 28 days in a single native pasture (minimum area = 118 acres). Calves were allowed fence-line contact with their dams for 7 days (minimum frontage = 656 feet; four-strand, barbed-wire fence with the bottom two wires electrified). Cows were moved out of visual and auditory range after 7 days. Fresh water, salt, and mineral supplements were available continuously. Calves assigned to the Drylot treatment were transported (<30 miles) immediately after separation from dams and confined within location to a single earth-surfaced pen (minimum area = 215 ft^2/calf; bunk space = 18 inches/calf).

Calves assigned to the Drylot treatment were fed a diet formulated to promote 2.2 lb average daily gain (ADG) at a dry matter intake equivalent to 2.5% of body weight during the preconditioning phase of the study (Table 1). Calves assigned to Pasture had access to native forage only (Table 2), whereas calves assigned to Pasture+Feed had access to native forage and received a ration of the diet fed to Drylot calves at a rate of 1% of body weight 3 times each week. Calves assigned to Pasture+Feed were sorted into a single pen located adjacent to the fence line shared with dams at 9:00 a.m. on Mondays, Wednesdays, and Fridays during the preconditioning phase. The ration was offered in portable bunks (bunk space = 18 inches/calf).

All calves were monitored for symptoms of respiratory disease twice daily during the preconditioning phase of our study. Calves with clinical signs of bovine respiratory disease were removed from pens or pastures and evaluated. Calves were assigned a clinical score (scale of 1 to 4; 1 = normal, 4 = moribund) and were weighed and assessed for fever. Calves with a clinical illness score >1 and a rectal temperature >104°F were treated with therapeutic antibiotics according to label directions (first incidence = Baytril, Bayer Animal Health, Shawnee Mission, KS; second incidence = Nuflor, Merck Animal Health, Summit, NJ). Cattle were evaluated 72 hours after the initial treatment and re-treated based on observed clinical signs.

After the 28-day preconditioning period, all calves were transported 4 hours from the ranch of origin to the Western Kansas Agricultural Research Center in Hays, KS, and weighed individually upon arrival. At that time, calves were stratified by gender and assigned to 1 of 18 pens by treatment (6 pens/treatment). Animals were fed their receiving diet (Table 3) once daily. If all feed from the previous day was consumed, total feed delivered was increased by approximately 2% of the previous day's feed delivery. Bunks were managed using a slick-bunk management method to minimize feed refusals. Dry matter intake was estimated based on feed delivered to the pen. Calf health was monitored as during the preconditioning phase of the study.

Beginning on the morning after feedlot arrival, animal behavior was assessed 3 times daily for 7 days by two trained observers. The numbers of calves performing specific behaviors (eating, pacing, vocalizing, drinking, resting, and ruminating) were recorded for each pen. Observations were taken 1 hour before feeding, at the time of feeding, and 6 hours post-feeding. In addition, calves were weighed individually on days 30 and 60 of the receiving phase of the experiment.

Results and Discussion

Preconditioning period

Calf ADG during the 28-day preconditioning period tended ($P = 0.08$) to be greater for drylot-weaned calves than for pasture-weaned calves receiving no supplement (Table 4). Based on the chemical analyses of our pasture forage, these results were expected. Another study found that fence-line weaned calves gained more weight than abruptly weaned calves during the first 2 weeks of preconditioning and maintained that difference for 10 weeks postweaning, but calves in that study were fed a single diet across treatments.

Our treatments were designed such that calves assigned to Drylot were on a greater plane of nutrition than calves assigned to the Pasture and Pasture+Feed treatments. This condition is typical of drylot- vs. pasture-preconditioning programs in Kansas. Supplement provided to Pasture+Feed in our study was designed to train pasture-weaned calves how to eat from a feed bunk rather than to promote body weight gains that were competitive with Drylot calves. One causative feature of poor initial feedlot performance is stress associated with learning to eat from a bunk. In our study, incidence of undifferentiated fever was not different ($P = 0.22$) among treatments during the preconditioning phase.

Receiving period

We observed calves at the time of feeding as an indicator of their desire to eat from a bunk during the first 7 days of receiving. A greater (Treatment × day; $P < 0.05$) proportion of Drylot calves compared with Pasture calves came to the bunk at time of feeding during the first 5 days of receiving (Figure 1). Similarly, a greater proportion (Treatment × day; $P < 0.05$) of Drylot calves came to the bunk at time of feeding during the first 4 days of receiving compared with Pasture+Feed calves.

During the receiving period, Drylot calves had greater ($P < 0.01$) ADG from arrival to day 60 and greater body weight ($P < 0.01$) on day 60 than either pasture-weaned treatment (Table 5). This increase in performance was driven by greater ($P < 0.01$) feed intake of Drylot calves compared with the pasture groups. In addition, feed efficiency was greater ($P = 0.01$) for Drylot calves than for Pasture calves, whereas Pasture+Feed calves were intermediate and not statistically different from the other groups. Providing calves with supplement in a bunk on pasture did not improve receiving ADG ($P > 0.05$) or dry matter intake ($P > 0.05$) compared with pasture-weaned calves that received no supplemental feed.

Pasture-weaned calves in our study were supplemented infrequently (3 times weekly for 4 weeks) and ate less feed during receiving that drylot-weaned calves. It may be possible to achieve greater performance and feed intake with pasture-weaned calves during receiving when supplementation is provided more frequently than in our study.

Incidence of undifferentiated fever during the receiving period was small (0.9%); therefore, we did not report summary statistics on these data. Previous work reported greater incidence of disease during receiving in drylot-weaned calves compared with pasture-weaned calves. In our study, the health of drylot-weaned calves was equivalent to that of pasture-weaned calves. Overall, our cattle were healthier than in the aforementioned research, so we were unable to detect health differences among treatments.

Implications

We interpreted these data to suggest that animal performance and welfare during the receiving period were not improved by pasture preconditioning compared with drylot preconditioning. Based on our behavior and performance data, it appeared that previous experience consuming a concentrate-based diet from a bunk paid greater dividends during receiving than reducing stress associated with maternal separation through fence-line contact with dams. Best-management practices for animal welfare may involve initiating diet transitions from forage to grain at the ranch of origin. Pasture-preconditioning systems may be a lower-cost alternative to conventional drylot-preconditioning systems, but may not produce equivalent growth performance during pre-shipment preconditioning and receiving.

Table 1. Composition of the preconditioning diet[1]

Ingredient composition	DM, %
Alfalfa extender pellets	33.0
Corn gluten feed	18.2
Wheat middlings	14.6
Cracked corn	11.5
Cottonseed hulls	10.9
Dried distillers grain	7.8
Supplement	4.0
Nutrient composition	
Crude protein, %	14.28
Net energy for maintenance, Mcal/kg	1.50
Net energy for gain, Mcal/kg	0.93

[1] Diet also contained salt, Zn sulfate, and Rumensin 80 (Elanco Animal Health, Greenfield, IN).

Table 2. Nutrient composition of native pasture forage available to pasture-weaned beef calves (dry matter basis)

Nutrient, %	Manhattan	Hays
Dry matter	89.5	91.3
Crude protein	3.2	4.1
Neutral detergent fiber	74.4	74.8
Acid detergent fiber	51.8	48.6

Table 3. Composition of the receiving diet

Ingredient composition	DM, %
Ground sorghum grain	47.8
Wet distillers grains	11.0
Ground sorghum hay	33.9
Supplement[1]	7.3
Nutrient composition	
Crude protein, %	16.82
Net energy for maintenance, Mcal/kg	1.50
Net energy for gain, Mcal/kg	0.93

[1] Supplement contained Rumensin 80 and Tylan 40 (Elanco Animal Health, Greenfield, IN), limestone, salt, and trace minerals.

Table 4. Performance of beef calves while subjected to 1 of 3 28-day ranch-of-origin preconditioning regimens

	Drylot	Pasture + Supplement	Pasture	SEM
Start weight, lb	498	503	503	31.8
End weight[1], lb	518	485	481	23.4
Average daily gain, lb	0.68[a]	-0.62[ab]	-0.75[b]	0.405
Incidence of fever, %	5.01	0.63	1.91	1.825

[1] Body weight measured immediately upon feedlot arrival.
[a, b] Means within rows without common superscripts tend to differ ($P = 0.08$).

Table 5. Performance of beef calves subjected to 1 of 3 ranch-of-origin preconditioning regimens during a 60-day feedlot receiving period

	Drylot	Pasture + Supplement	Pasture	SEM
Arrival body weight, lb	518	485	481	23.4
Body weight day 30, lb	584[a]	549[b]	534[b]	8.6
Body weight day 60, lb	697[a]	655[b]	644[b]	9.5
Average daily gain (ADG), day 0–30, lb	2.47[a]	2.40[a]	1.96[b]	0.088
ADG, day 0–60, lb	3.13[a]	2.93[b]	2.82[b]	0.130
Dry matter intake, lb/day	17.20[a]	17.02[b]	16.98[b]	0.015
Feed/gain, lb/lb	5.49[a]	5.80[ab]	6.04[b]	0.004

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

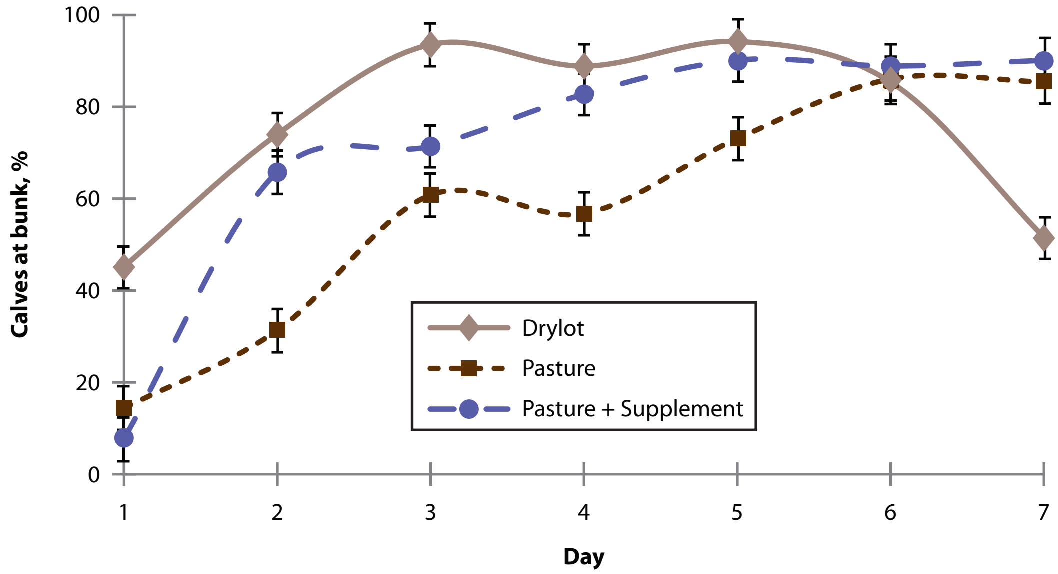


Figure 1. Proportion of calves observed at feed bunks immediately after feed delivery (Treatment × time, $P < 0.05$; maximum SEM = 4.71).

Efficiency of Early Weaned Beef Calves Is Not Improved by Restricting Feed Intake During 84-Day Growing Phase

E.A. Bailey, J.R. Jaeger, J.W. Waggoner, G.W. Preedy, L.A. Pacheco, and KC Olson

Introduction

Early weaning can be used by cow-calf producers to reduce stocking rates by 20% to 30% during drought. Ranchers may be reluctant to wean early because of reduced calf weights and reduced revenue compared with weaning calves at conventional ages. To avoid revenue shortfalls, calves can be retained and grown before selling; however, grain prices are currently at unprecedented levels. Feeding grain-based diets to calves less than 125 days of age has been associated with excessive fat accumulation early in the feeding period and decreased carcass weights. Conversely, several researchers have noted marked improvements in feed efficiency when grain-based finishing diets were limit-fed. High feed costs and early fat deposition may be attenuated by limit-feeding a grain-based diet to early weaned calves. Our goal was to measure performance and efficiency of lightweight, early weaned beef calves during an 84-day postweaning growing phase when feed intakes were varied to achieve targeted gains of 1, 2, or 3 lb/day.

Experimental Procedures

Angus × Hereford calves (n = 243; initial body weight = 343 ± 68 lb) originating from the Kansas State University commercial cow-calf herd in Hays, KS, were used in this experiment. All calves were dehorned and steer calves were castrated before 60 days of age. Calves were weaned at approximately 100 days of age. At weaning, calves were weighed individually and assigned randomly to 1 of 3 rates of gain: 1 lb/day (Logain), 2 lb/day (Midgain), and 3 lb/day (Higain). Calves were fed a common diet (Table 1); growth and health performance were evaluated during an 84-day backgrounding period.

At weaning, calves were blocked by gender and assigned to 1 of 18 pens (6 pens/treatment). Animals were fed once daily. One common diet was formulated using formulation software that predicted calves to gain ~3 lb/day at maximal intake. We fed this diet to all treatments but restricted the intake of the Logain and Midgain calves to a level that decreased their predicted gain to 1 and 2 lb/day, respectively.

Calf body weights were measured at weaning and every 28 days thereafter until the end of the study. Initial feed allowances were determined based on initial body weight and targeted rates of gain. Feed deliveries were adjusted every 28 days to match observed rates of gain. Treatment diets were individually fed once daily at 6:00 a.m. throughout the study.

All calves were vaccinated against respiratory pathogens (Bovi-Shield Gold 5; Pfizer Animal Health, Whitehouse Station, NJ), clostridial pathogens (Ultrabac 7; Pfizer Animal Health), and *H. somnus* (Somnubac; Pfizer Animal Health) on the day of weaning. In addition, calves were treated for internal and external parasites (Ivomec; Merial Limited, Atlanta, GA) at weaning. Booster vaccinations were administered 14 days later.

All calves were monitored for symptoms of respiratory disease twice daily during our study. Calves with clinical signs of respiratory disease were removed from pens and evaluated. Calves were assigned a clinical morbidity score (scale of 1 to 4; 1 = normal, 4 = moribund), weighed, and assessed for fever. Calves with a clinical illness score >1 and a rectal temperature >104°F were treated with therapeutic antibiotics according to label directions (first incidence = Baytril, Bayer Animal Health, Shawnee Mission, KS; second incidence = Nuflor, Merck Animal Health, Summit, NJ). Cattle were evaluated 72 hours after treatment and re-treated based on observed clinical signs.

Results and Discussion

Daily gain increased ($P < 0.01$) as feed allowance increased (Table 2). At the end of the 84-day experiment, Higain calves weighed more ($P > 0.01$) than either Midgain or Logain calves. We were unsuccessful in reaching our targeted average daily gain for the Midgain and Higain treatments, likely due to limitations of the prediction equations used by our formulation software.

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). Unexpectedly, feed efficiency did not differ ($P = 0.77$) among treatments. Previous research noted that feed efficiency of older cattle increased dramatically when feed intake was restricted; we expected comparable increases in efficiency in our lightweight, early weaned calves. Incidence of undifferentiated fever was not different among treatments ($P = 0.95$) and was relatively mild (6% or less) overall.

Implications

Lightweight, early weaned calves that were fed a grain-based diet at restricted rates did not exhibit improved feed efficiency relative to their full-fed counterparts. In addition, there appeared to be limitations associated with predicting feed intake and performance of lightweight, early weaned calves fed a grain-based diet.

Table 1. Composition of backgrounding diet on a 100% dry matter basis

Ingredient, %	Concentration
Dry-rolled sorghum grain	39.3
Dried distillers grains	17.5
Sorghum silage	40.1
Supplement[1]	3.1
Nutrient	
Crude protein, %	14.09
Net energy for maintenance, Mcal/lb	0.77
Net energy for gain, Mcal/lb	0.50

[1] Supplement contained Rumensin 80 and Tylan 40 (Elanco Animal Health, Greenfield, IN), limestone, salt, and trace minerals.

Table 2. Performance of beef calves fed a common diet to achieve targeted gains of 1, 2, or 3 lb/day

	Targeted average daily gain			
	1 lb/day	2 lb/day	3 lb/day	SEM
Weaning weight, lb	341	341	347	11.5
Final weight, lb	444[a]	468[a]	510[b]	9.0
Average daily gain, lb				
Arrival to day 28	1.07[a]	1.51[b]	1.87[c]	0.102
Day 28 to 56	1.54[a]	1.62[a]	2.00[b]	0.099
Day 56 to 84	1.02[a]	1.46[b]	1.96[c]	0.107
Overall	1.21[a]	1.53[b]	1.94[c]	0.064
Feed intake, lb/day	4.57[a]	6.03[b]	7.58[c]	0.002
Feed:gain	3.77	4.00	3.87	0.333
Incidence of fever, %	4.89	6.05	5.85	3.046

[a,b,c] Values with different superscript letters are different, $P < 0.05$.

Effects of Infrequent Dried Distillers Grain Supplementation on Spring-Calving Cow Performance

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Introduction

Feed and supplement costs and the expenses associated with delivery of winter supplements account for a large proportion of the total operating expenditures for cow-calf producers. Cattle grazing low-quality dormant native range (<6% crude protein) typically are unable to consume sufficient protein from the forage base, which limits microbial activity and forage digestion. Supplemental protein often is required to maintain cow body weight and body condition score during the last trimester of pregnancy. Low cow body condition scores at calving are common and may negatively affect lactation, rebreeding rates, and calf weaning weight. Failure to maintain proper nutritional status during this period severely affects short-term cow performance, reduces overall herd productivity, and limits profit potential.

The most effective means of supplying supplemental protein to cows consuming dormant native range is to provide a small amount of high-protein feedstuff (>30% crude protein). Dried distillers grains with solubles (DDGS) are a by-product of the ethanol refining process. Distillers grains supply the recommended 30% crude protein level, are readily available, and often are favorably priced compared with more traditional feedstuffs.

With the rising costs of inputs in today's cow-calf sector, reducing cost is necessary to maintain viability of the national cowherd. Reducing the frequency of supplementation results in less labor and fuel use, effectively reducing input costs; however, this is viable only as long as cow performance is maintained at acceptable levels. Therefore, the objective of this study was to examine the effects of infrequent supplementation of dried distillers grains with solubles on cow body weight and body condition score.

Experimental Procedures

Pregnant Angus-cross cows (n = 120; initial body weight = 1,239 lb ± 170 lb; initial body condition score [scale of 1 to 9; 1 = extremely emaciated, 9 = extremely obese] = 5.0 ± 0.5) were maintained on common native range pastures (7.5% crude protein, Table 1) for 84 days. The range site mainly comprised the following species: sideoats grama (*Bouteloua curtipendula*), western wheatgrass (*Agropyron smithii*), blue grama (*Bouteloua gracilis*), Japanese brome (*Bromus japonicus*), and buffalo grass (*Bouteloua dactyloides*). Range samples for nutritional analysis were obtained prior to starting the trial. Sorghum hay (6.9% crude protein, Table 1) was processed daily and provided at 50% of the expected maximum forage intake each day to ensure adequate forage availability. Free choice mineral (Suther's Prairie Cow 4P; Suther's Feeds, Frankfort, KS) and salt were available throughout the study. Dried distillers grains with solubles

(29.5% crude protein, Table 1) originated from a single location and were stored in bulk for use throughout the treatment period.

Cows were stratified by age, body condition score, and weight and assigned randomly to one of three supplement treatments. Treatments consisted of (1) DDGS daily supplemented (Daily), (2) DDGS supplemented every 3 days (3Day), and (3) DDGS supplemented every 6 days (6Day). Cows were sorted daily into treatment groups, and supplements were delivered at approximately 8:30 a.m. Due to facility limitations, only one set of bunks was available, so on days when multiple supplement treatments were fed, each group was given ample time to finish the supplement before being moved out of the feeding area. Cows were allotted 28 linear inches of bunk space/cow. Dried distillers grains with solubles was offered to supply 0.5 lb/cow daily of crude protein (1.8 lb DDGS/cow daily); for example, cattle receiving supplement once every 6 days received 3 lb of crude protein (10.8 lb DDGS/cow) on the day of supplementation.

Treatments were administered from December 27, 2011, until March 20, 2012, approximately 1 week prior to the expected onset of calving. On day 84, treatments were terminated and cows were moved to a different native range pasture, offered free-choice sorghum hay, and supplemented with DDGS daily at the same rate for the duration of the calving season. Cows were weighed and body condition was scored every 28 days throughout the duration of the study, immediately following calving (within 12 hours), and on day 132 (prior to turnout). Body condition scores were assigned by two independent, qualified observers.

Performance data were analyzed using the GLM procedure of SAS (SAS Institute, Cary, NC). Initial body weight and body weight at calving, body weight change, initial and calving body condition score, body condition score change, calf birth weight, and average calving date were used as the dependent variables. Values were determined to be statistically different when $P \leq 0.05$.

Results and Discussion

Initial body weight and body condition score were not different among treatments ($P > 0.05$, Table 2). Body weight and body condition score at calving also did not differ among treatments. As a result, changes in body weight and body condition score throughout the experiment were not significant ($P = 0.82$ and $P = 0.74$, respectively). Supplementation frequency did not affect calf birth weight or average calving date, and cow body weights at turnout were similar ($P > 0.05$) among treatment groups.

Implications

Dried distillers grains with solubles may be supplemented as infrequently as once every 6 days without adversely affecting performance of spring-calving cows. The labor and fuel savings associated with reducing supplementation frequency will result in lower overall supplementation costs.

Table 1. Nutrient composition (dry matter basis) of native range, dried distillers grains with solubles (DDGS), and sorghum hay

Item	Native range	DDGS	Sorghum hay
Dry matter, %	74.43	89.24	86.61
Crude protein, %	7.49	29.53	6.93
Net energy for maintenance, Mcal/lb	0.32	0.88	0.48
Net energy for gain, Mcal/lb	0.08	0.55	0.23
Neutral detergent fiber, %	59.18	30.39	59.30
Acid detergent fiber, %	44.43	17.08	36.89
Total digestible nutrients, %	42.57	76.59	52.75
Calcium, %	0.58	0.08	0.49
Phosphorus, %	0.11	0.80	0.15
Sulfur, %	0.09	0.43	0.10

Table 2. Performance of cows receiving dried distillers grains with solubles daily (Daily), at 3-day intervals (3Day), or at 6-day intervals (6Day)

	Supplementation interval				
Item	Daily	3Day	6Day	SEM	*P*-value[1]
Number of cows	38	31	37		
Initial weight, lb	1241.7	1256.4	1239.6	16.3	0.91
Calving weight, lb	1243.3	1256.5	1247.0	16.7	0.95
Weight change, lb	1.5	0.3	7.4	4.9	0.82
Turnout weight, lb[2]	1312.8	1329.2	1301.2	16.5	0.80
Body condition score[3]					
Initial	5.07	5.18	4.97	0.05	0.23
Calving	5.28	5.31	5.16	0.04	0.37
Change	0.21	0.13	0.19	0.04	0.74
Calf weight, lb	84.6	86.9	83.4	0.97	0.33
Average calving date	03/24/2012	03/22/2012	03/22/2012	0.44	0.20

[1] No statistically significant differences among the means of each treatment ($P \geq 0.05$).
[2] Weight at turnout onto summer native range pasture (May 7, 2012).
[3] Scale of 1 to 9; 1 = extremely emaciated, 9 = extremely obese.

Hydrated Lime Matrix Decreases Ruminal Biohydrogenation of Flaxseed Fatty Acids

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Introduction

Omega-3 fatty acids are essential nutrients for humans, but dietary intake of these nutrients by many Americans is inadequate due to low consumption of omega-3-rich foods such as fish, walnuts, and flaxseed. In contrast, per capita consumption of red meat is relatively high, but these products normally contain only small amounts of omega-3 fatty acids. Feeding cattle diets that contain omega-3 fatty acids has consistently increased the proportion of the desirable fats that accumulate in beef. Unfortunately, the proportion of dietary omega-3 fats that are deposited into beef tissues is relatively low, because microorganisms within the rumen biohydrogenate the unsaturated omega-3 fatty acids extensively to produce the saturated fats that are characteristic of beef fat. Encapsulation of fats has been proposed as a method for improving efficiency of transfer of omega-3 fats into beef. Encapsulation processes apply a protective barrier on the surface of fats or fat-containing feeds, which theoretically decreases fats' susceptibility to microbial biohydrogenation. Protective coatings must remain intact to retain their functionality, and physical damage to the coatings that occurs with normal handling can result in poor efficacy because the core material is exposed to microorganisms in the rumen. Embedding feed particles within a homogeneous protective matrix constitutes a potentially useful alternative to protective surface barriers. The matrix is created by mixing feed particles that are to be protected with a suitable matrix material that is resistant to microbial digestion and subsequently forming the mixture into pills. In cases where physical damage occurs, exposure of the core material is confined to the broken surface, and the remainder of the matrix retains its ruminal stability.

The objective of this study was to determine if embedding flaxseed within a matrix of hydrated dolomitic lime could be used as a method to decrease biohydrogenation of polyunsaturated omega-3 fatty acids, thus improving efficiency of omega-3 fatty acids absorption into the bloodstream.

Experimental Procedures

Forty-five steers (556.6 ± 40.2 lb) were blocked by weight and randomly assigned to individual pens, then pens were assigned to dietary treatments (15 replicates). Steers were fed for 14 days with a basal diet consisting of 50% forage and 50% concentrate (Control). In treatments 2 and 3, a portion of flaked corn was replaced with ground flaxseed (Flax) or ground flaxseed that had been embedded within a matrix of hydrated dolomitic lime (L-Flax) as shown in Table 1. Cattle were fed once daily, and weights of unconsumed feed were determined daily.

[1] Lhoist North America, Fort Worth, TX.

Animals were weighed and blood samples were taken from the jugular vein for analysis of long-chain fatty acid (LCFA) concentrations on day 0, 7, and 14 of the study. Heparinized vacuum tubes were used to collect whole blood. Blood samples were immediately placed on ice, then centrifuged at 1,200 x g for 20 minutes to recover blood plasma. Concentrations of major fatty acids in the blood plasma were determined by gas chromatography.

Data were analyzed using the MIXED model procedure of SAS (Version 9.0) with diet, sampling day, and the diet × sampling day interaction as fixed effects and with feeding location as a random effect. Animal was the experimental unit.

Results and Discussion

Table 2 summarizes the concentrations of major long-chain fatty acids in blood plasma on days 0, 7, and 14 after feeding the experimental diets. Day 0 values represent the baseline, and thus are similar for all treatment groups. We were unable to detect alpha-linolenic acid (C18:3n3), a key omega-3 fatty acid, in blood plasma on day 0. This result was expected, because the diet fed during the pre-trial period consisted of ingredients that normally contain relatively small amounts of omega-3 fatty acids. After 7 days of feeding the experimental diets, concentrations of alpha-linolenic acid remained relatively low in the Control group but increased markedly in blood plasma of cattle fed flaxseed. The increase in plasma concentrations of alpha-linolenic acid was even more dramatic in cattle fed the dolomitic hydrate-flaxseed mixture. Plasma concentrations of omega-3 fatty acids in cattle fed the embedded flaxseed were more than 4 times the level observed in cattle fed flaxseed, suggesting the dolomitic lime hydrate was effective as a protective matrix. The differences among treatments remained after 14 days, demonstrating that it is feasible to increase tissue concentrations of omega-3 fatty acids by incorporating omega-3-rich ingredients into the diet. Furthermore, embedding ground flaxseed into a matrix consisting of dolomitic lime hydrate constitutes an effective method for increasing the proportion of polyunsaturated omega-3 fatty acids absorbed from the gastrointestinal tract for deposition into tissues.

Implications

Embedding ground flaxseed within a protective matrix consisting of dolomitic lime hydrate is an effective method for delivery of omega-3 fatty acids to improve the efficiency of transfer from the diet into tissues of cattle.

Acknowledgements

The hydrated lime embedding process is the subject of a U.S. patent application jointly submitted by Kansas State University and Lhoist North America (Fort Worth, TX).

Table 1. Composition of diets fed during the pre-trial adaptation period and for experimental diets without flaxseed (Control), with ground flaxseed (Flax), or with ground flaxseed embedded within a protective matrix of dolomitic lime hydrate (L-Flax)

Ingredients, %	Pre-trial	Control	Flax	L-Flax
Wet corn gluten feed	30.00	30.00	30.00	30.00
Wheat straw	25.00	25.00	25.00	25.00
Prairie hay	25.00	25.00	25.00	25.00
Steam-flaked corn	10.36	12.78	12.86	8.50
Linseed meal	--	3.01	1.22	1.50
Corn oil	--	1.19	0.10	--
Ground flaxseed	--	--	2.79	--
Hydrate-encapsulated flaxseed	--	--	--	8.13
Glycerin	5.00	--	--	--
Supplement[1]	4.64	3.02	3.03	1.87

[1] Formulated to provide 300 mg/day Rumensin (Elanco Animal Health, Greenfield, IN), 1,000 IU/lb vitamin A, 0.3% salt, 0.7% calcium, 0.7% potassium, 0.1 ppm cobalt, 10 ppm copper, 0.6 ppm iodine, 60 ppm manganese, 0.25 ppm selenium, and 60 ppm zinc in the total diet on a 100% dry matter basis.

Table 2. Concentrations (μg/mL) of major long-chain fatty acids in blood plasma of cattle fed diets without flaxseed (Control), with ground flaxseed (Flax), or with ground flaxseed embedded within a protective matrix of dolomitic lime hydrate (L-Flax)

	Day 0			Day 7			Day 14				*P*-value		
Item[a]	Control	Flax	L-Flax	Control	Flax	L-Flax	Control	Flax	L-Flax	SEM	Day	Diet	Day × Diet
C16:0	73	77	75	79	79	84	77	75	89	3.2	0.02	0.01	0.08
C18:0	123	126	125	149	149	151	130	126	147	6.2	<0.01	0.16	0.32
C18:1	77	81	80	92	87	79	83	86	86	4.8	0.10	0.72	0.35
C18:2	300	277	293	288	266	303	311	261	337	13.2	0.18	<0.01	0.14
C18:3n3	0	0	0	0	19	78	0	30	87	2.7	<0.01	<0.01	<0.01

[a] Long-chain fatty acids are identified as follows: C16:0 is palmitic acid (saturated), C18:0 is stearic acid (saturated), C18:1 is oleic acid (monounsaturated), C18:2 is linolenic acid (a polyunsaturated omega-6 fatty acid), and C18:3n3 is alpha-linolenic acid (a polyunsaturated omega-3 fatty acid).

Orally Dosing Steers with Lactipro (*Megasphaera elsdenii*) Decreases the Quantity of Roughages Fed During Finishing

K.A. Miller, C.L. Van Bibber-Krueger, and J.S. Drouillard

Introduction

The cost of roughages is relatively high in comparison to their contribution of nutrients to feedlot diets. Widespread drought has affected roughage supplies in the cattle-feeding regions of the United States, further increasing the cost of roughages for feedlots. Despite their relatively high cost, roughages are incorporated into finishing diets to maintain rumen function and to manage ruminal acidosis. The greatest proportion of roughage is utilized early in the feeding period when cattle are being transitioned from forage-based diets to concentrate-based diets, allowing ruminal microbes to adapt gradually to higher levels of starch and sugars. If cattle are not properly adapted to concentrate-based diets, undesirable lactic acid-producing microorganisms, such as *Streptococcus bovis*, can rapidly proliferate and produce large excesses of lactic acid in the rumen. This condition can precipitate feedlot acidosis, which can have serious consequences for health and performance of cattle.

Lactipro (MS Biotec, Wamego, KS) is a probiotic drench containing *Megasphaera elsdenii,* which is a lactate-utilizing bacterium that prevents lactic acid accumulations in the rumen of grain-fed cattle. Lactipro has been used successfully to accelerate the adaptation of cattle from roughage-based diets to concentrate-based diets. The objective of this study was to determine if Lactipro could be utilized to eliminate the step-up period for feedlot cattle, and in so doing decrease the amount of roughage required during the finishing period.

Experimental Procedures

Four hundred and forty-three crossbred steers were utilized in a randomized complete block design to determine if steers given Lactipro at initial processing could be placed directly onto finishing diets to reduce the quantity of roughage fed during finishing. Steers were fed brome hay prior to arrival at the feedlot and were processed approximately 24 hours later. At processing, steers were weighed, given uniquely numbered ear tags, vaccinated against common viral and clostridia diseases, treated for internal and external parasites, and implanted with Revalor XS (Intervet Inc., Millsboro, DE). Steers were assigned to a traditional step-up program (Control) consisting of 3 step-up diets fed for 6 days each followed by the finishing diet for the remainder of the study, or were dosed with 100 mL of Lactipro at processing and placed directly onto the finishing diet (Lactipro). Steers were assigned to treatment based on alternating order through the chute, resulting in 24 pens with 14 or 15 steers per pen and another 12 pens containing 7 to 8 steers each, thus providing 18 replicates per treatment. Diets were based on steam-flaked corn, wet corn gluten feed, and corn silage (Table 1). Steers were fed once daily and had free-choice access to their respective diets for 115 days before being weighed and shipped to a commercial abattoir. At the time of slaughter, hot carcass weight and liver score data were collected. USDA yield and quality grades; 12th-rib fat thickness; percentage kidney, pelvic, and heart fat; ribeye area; and marbling score were recorded after chilling carcasses for 24 hours.

Results and Discussion

A steer in the Lactipro group died on day 19, and gross necropsy revealed a preexisting bacterial infection as the cause of death. Another steer in the Lactipro group was euthanized on day 49 due to infectious lameness originating with a hoof abrasion. Digestive disorders and respiratory disease were not observed among animals in either treatment during the study.

Steer performance is summarized in Table 2. Steers placed on the traditional step-up program consumed 17% more roughage ($P < 0.01$) and tended ($P = 0.07$) to have greater dry matter intake compared with steers dosed with Lactipro and placed directly onto the finishing diet. Average daily gain and gain efficiency were similar for steers in the two treatments.

In previous research with Lactipro, we have observed similar feed intakes, gains, and efficiencies for cattle stepped-up traditionally compared with cattle dosed with Lactipro and placed directly onto feed. In the present study, no clinical symptoms of acidosis or behavioral abnormalities were evident in either treatment, but feed intake declined sharply for the first several days for the cattle that were dosed with Lactipro and placed directly onto the high-grain diet. The tendency for lower feed intake by Lactipro steers in the current study did not affect their growth performance compared with the control group, and the differences in feed intake were generally limited to the first 18 days on feed (Figure 1). The lingering differences in feed deliveries for the two treatments during the early part of the feeding period can be attributed to our bunk management protocol, which limited the daily increases in feed delivery to no more than 1 lb of dry matter per head daily. Essentially, cattle in the Lactipro treatment were not allowed to make up for this early deficit until feed intake plateaued two or more weeks later. This protocol has been implemented to prevent overconsumption when traditional step-up programs are utilized; however, we do not know if these same protocols are necessary when the cattle have been dosed with Lactipro.

Carcass characteristics are summarized in Table 3. Treatment did not affect carcass weight; dressed yield; ribeye area; percentage of kidney, pelvic, and heart fat; 12th-rib fat thickness; or the incidence of liver abscesses ($P \geq 0.23$). There were no differences in USDA yield grade, marbling score, or carcasses classified as USDA Prime and Certified Angus ($P \geq 0.31$). The percentage of carcasses grading Choice tended ($P = 0.07$) to be greater for the Lactipro group, and the percentage grading Select tended ($P = 0.06$) to be greater for cattle in the Control group.

Formation of liver abscesses is facilitated by acidosis, which damages the ruminal wall. As a result of this physical damage, bacteria can pass from the rumen into the bloodstream and subsequently are transported to the liver, where they colonize and form abscesses. The lack of difference in incidence or severity of liver abscesses suggests that Lactipro was effective in preventing ruminal acidosis in steers placed directly onto the finishing diet. We did observed a trend for improved carcass quality when steers were placed directly onto finishing diets, which may be the result of additional days on a high-concentrate diet. This result is consistent with our observations in previous studies with heifers, where marbling score increased when heifers were given Lactipro and placed onto accelerated step-up regimens.

Implications

Roughage required during the finishing period can be decreased by dosing cattle with Lactipro and placing them directly onto high-concentrate finishing diets.

Table 1. Composition of experimental diets on a 100% dry matter basis

	Step-up diets			
Ingredient, % of dry matter	Step 1	Step 2	Step 3	Finisher
Steam-flaked corn	30.2	40.2	50.2	60.2
Wet corn gluten feed	25.0	25.0	25.0	25.0
Corn silage	40.0	30.0	20.0	10.0
Supplement[1]	2.64	2.64	2.64	2.64
Feed additive premix[2]	2.16	2.16	2.16	2.16
Nutrient analyses, %				
Dry matter	53.9	58.0	62.7	68.3
Crude protein	13.5	13.7	13.8	14.0
Neutral detergent fiber	25.0	22.4	19.9	17.4
Calcium	0.77	0.75	0.72	0.70
Phosphorus	0.44	0.45	0.45	0.45
Potassium	0.92	0.85	0.77	0.70

[1] Formulated to provide 0.3% salt, 0.1 ppm Co, 10 ppm copper, 0.6 ppm iodine, 60 ppm manganese, 0.25 ppm selenium, 60 ppm zinc, 1,000 IU/lb vitamin A, and 10 IU/lb vitamin E in the total diet on a 100% dry matter basis.
[2] Formulated to provide 300 mg Rumensin and 90 mg Tylan (Elanco Animal Health, Indianapolis, IN) per steer daily.

Table 2. Performance of steers orally dosed with Lactipro[1] at initial processing and placed onto a finishing diet

	Treatment			
Item	Control	Lactipro	SEM	*P*-value
Initial weight, lb	887	879	5.4	0.12
Final weight, lb[2]	1461	1449	11.7	0.21
Dry matter intake, lb/day	28.3	27.8	0.26	0.07
Dry matter silage intake, lb/steer	388.7	322.3	2.95	<0.01
Average daily gain, lb	4.99	4.96	0.076	0.65
Feed:gain, lb/lb	5.68	5.60	0.051	0.14

[1] MS Biotec, Wamego, KS.
[2] Gross live weight pencil shrunk by 4%.

Table 3. Carcass traits and liver abscess scores of steers orally dosed with Lactipro[1] at initial processing and placed onto a finishing diet

	Treatment			
Item	Control	Lactipro	SEM	*P*-value
Carcass weight, lb	887	881	7.1	0.23
Ribeye area, sq. in.	14.0	14.0	0.10	0.59
Kidney, pelvic, and heart fat, %	2.29	2.29	0.050	0.92
12th-rib fat thickness, in.	0.54	0.52	0.009	0.28
Marbling score[2]	457	461	4.51	0.55
USDA Prime, %	1.4	0.5	0.64	0.31
USDA Choice, %	80.1	86.5	2.50	0.07
Certified Angus Beef, %	24.4	28.4	2.97	0.35
USDA Select, %	18.6	12.2	2.42	0.06
Liver abscess, %	11.8	10.8	2.14	0.75

[1] MS Biotec, Wamego, KS.
[2] Marbling score values ranging from 400 to 499 represent a small degree of marbling.

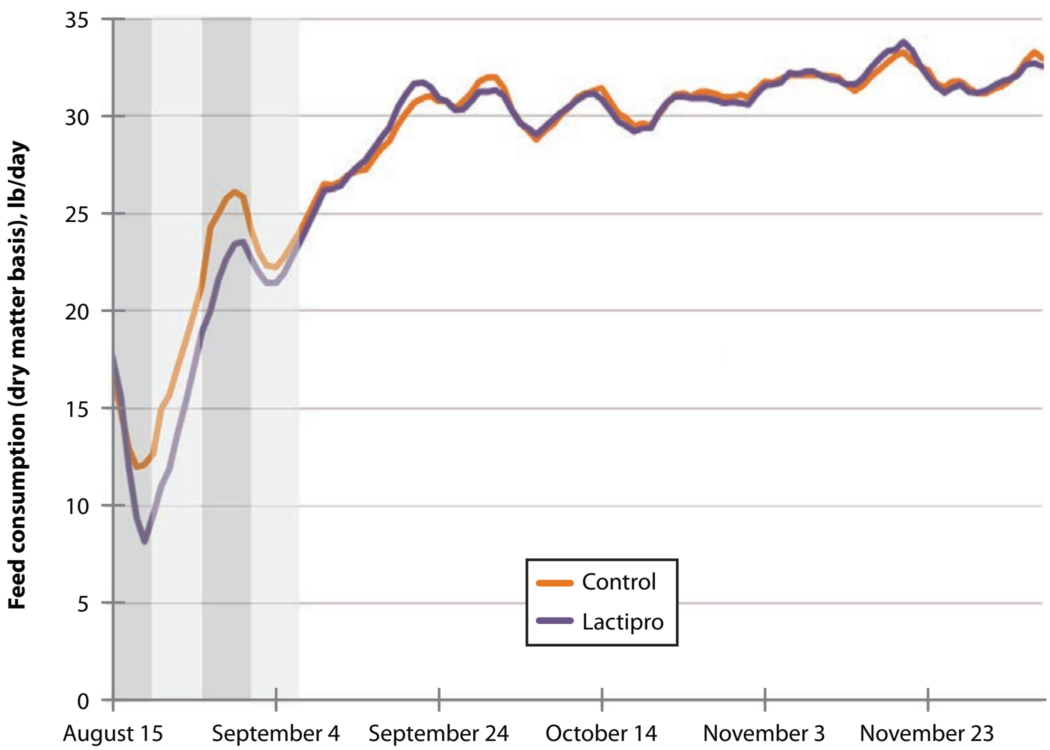

Figure 1. Daily dry matter feed deliveries of steers orally dosed with Lactipro (*Megasphaera elsdenii*; MS Biotec, Wamego, KS) at initial processing and placed directly onto a finishing a finishing diet. Shaded areas represent each of the step-up diets fed to Control steers.

Crude Glycerin Improves Feed Efficiency in Finishing Heifers

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Introduction

Crude glycerin is the principal byproduct of biodiesel production. The raw feedstocks, animal fats and vegetable oils, yield approximately 90 lb of biodiesel and 10 lb of crude glycerin for each 100 lb of input. When ingested by cattle, glycerin has two major fates: (1) direct absorption by the rumen epithelium, and (2) fermentation by microorganisms within the rumen to generate volatile fatty acid, mainly propionate. Using glycerin in feedlot cattle diets has become common, particularly as a component of liquid feed supplements.

We have evaluated the use of crude glycerin in cattle diets in previous studies and generally have observed positive effects on dry matter intake and feed efficiency when fed up to 8% of the diet on a dry matter basis. Crude glycerin can be highly variable in its composition, however, containing varying proportions of residual alcohol, soaps, and salts. Our focus in the present experiment was on the sodium content of crude glycerin. We hypothesized that the high concentration of sodium in glycerin, when combined with salt that normally is incorporated into feedlot diets, would result in abnormally high levels of sodium that could have deleterious consequences for feed consumption.

The objective of this study was to evaluate feedlot performance and carcass characteristics of finishing heifers fed diets containing high levels of crude glycerin in the presence and absence of added salt.

Experimental Procedures

Three hundred seventy-five crossbred heifers (initial body weight 736 ± 38 lb) were assigned to a randomized complete block experiment to evaluate the effects of adding crude glycerin to finishing cattle diets, both in the presence and absence of supplemental salt. The experiment was carried out at Kansas State University Beef Cattle Research Center in Manhattan, KS. The adjustment period consisted of four step-up diets fed for 5 days each. Animals were fed diets containing (dry matter basis) 50%, 40%, 30%, and 20% corn silage for step-up diets 1, 2, 3, and 4, respectively. Finishing diets (100% dry matter basis; Table 1) consisted of the following 5 treatments: (1) Control with no glycerin and 0.3% salt, (2) 7.5% glycerin with 0.3% salt, (3) 7.5% glycerin with no added salt, (4) 15% glycerin with 0.3% salt, and (5) 15% glycerin with no added salt. Animals were fed their respective diets once daily for 125 days. Starting 23 days prior to harvest, Zilmax (Merck Animal Health, Summit, NJ) was included in the diet for 20 days, followed by a 3-day withdrawal period before harvest. At the end of the experimental period, heifers were weighed then transported to a commercial abattoir. Hot carcass weight and liver abscess scores were obtained on the day of harvest, and after 24 hours we measured 12th-rib fat thickness; ribeye area; percentage of kidney, pelvic and heart fat; marbling score; USDA quality grade, and USDA yield grade. Statistical analyses were performed using the MIXED procedure of SAS (SAS Institute; Cary, NC). Treatment was included in the model as the fixed effect, block was the random effect, and the experimental unit was pen. Contrasts were performed to test the linear and quadratic effects of crude glycerin and the effect of addition of salt to the glycerin-containing diets.

Results and Discussion

Incorporating glycerin into finishing diets had no effect on average daily gain of heifers (Table 2; $P \geq 0.29$), but feed intake decreased in proportion to the amount of glycerin added (linear effect; $P \leq 0.01$); consequently, we observed an improvement ($P \leq 0.01$) in feed efficiency in heifers fed glycerin.

Dressing percentage, ribeye area, and percentage of kidney, pelvic and heart fat were unaffected by our diets ($P \geq 0.10$; Table 3). Feeding glycerin tended to decrease carcass weight ($P = 0.11$), and generally speaking, cattle fed glycerin deposited less fat in the carcass compared with cattle fed the control treatment, as evidenced by decreased12th-rib fat thickness (linear effect of glycerin, $P \leq 0.01$). USDA yield grades followed a similar trend (linear effect of glycerin, $P < 0.01$) and decreased with increasing levels of glycerin in the diet. Marbling also decreased when glycerin was incorporated into the diet, but the magnitude of this change was similar for heifers fed 7.5 and 15% glycerin (linear and quadratic effects of glycerin, $P \leq 0.05$). Similarly, feeding glycerin had a negative impact on quality grade, decreasing the percentage of carcasses classified as Premium Choice ($P < 0.03$).

Removing salt from glycerin-based diets had no impact on gain, feed intake, or feed efficiency. Likewise, carcass characteristics were largely unaffected by the presence or absence of salt ($P \geq 0.10$).

Implications

Including up to 15% crude glycerin in byproduct-based diets improved feed efficiency of finishing heifers by decreasing feed intake but also depressed marbling score and yield and quality grades. Removing supplemental salt from diets containing crude glycerin had no impact on performance or carcass characteristics.

Table 1. Composition of experimental diets (dry matter basis)

		7.5% glycerin		15% glycerin	
Ingredient, % of dry matter	Control	Salt	No salt	Salt	No salt
Corn silage	10.00	10.00	10.00	10.00	10.00
Dry-rolled corn	31.00	21.94	22.30	12.90	13.26
Corn gluten feed	35.00	35.00	35.00	35.00	35.00
Soybean hulls	20.00	20.00	20.00	20.00	20.00
Supplement[1,2,3]	3.70	5.26	5.20	6.80	6.74
Crude glycerin	0.00	7.50	7.50	15.00	15.00
Salt (NaCl)	0.30	0.30	0.00	0.30	0.00
Nutrient analyses, %					
Dry matter	65.7	65.7	65.7	65.7	65.7
Crude protein	14.5	14.5	14.5	14.5	14.5
Neutral detergent fiber	37.2	36.5	36.6	35.9	35.9
Ether extract	3.03	2.66	2.67	2.28	2.30
Calcium	0.70	0.70	0.70	0.70	0.70
Phosphorus	0.53	0.52	0.52	0.50	0.50
Potassium	0.70	0.70	0.70	0.70	0.70

[1] Formulated to provide 0.1 ppm cobalt, 1.0 ppm copper, 0.6 ppm iodine, 60 ppm manganese, 0.25 ppm selenium, 60 ppm zinc, 1,000 IU/lb vitamin A, and 10 IU/lb vitamin E in the total diet on a 100% dry matter basis.

[2] Formulated to provide 300 mg Rumensin, 90 mg Tylan, and 0.5 mg Heifermaxx (Elanco Animal Health; Greenfild, IN) per heifer daily.

[3] Zilmax (Merck Animal Health, Millsboro, DE) was fed for 20 days followed by a 3-day withdrawal before harvest.

Table 2. Feedlot performance of heifers fed crude glycerin with or without added salt

		Treatments							
		7.5% glycerin		15% glycerin				*P*-value[1]	
Item	Control	Salt	No salt	Salt	No salt	SEM	Linear	Quadratic	Salt
No. of cattle	73	73	75	71	73	-	-	-	-
Initial weight, lb	734	736	737	735	735	37.9	0.74	0.50	0.66
Final weight, lb	1333	1307	1336	1323	1308	44.1	0.35	0.15	0.90
Average daily gain, lb	4.03	3.80	4.06	3.98	3.86	0.09	0.29	0.53	0.42
Dry matter intake, lb/day	27.3	26.1	26.0	25.2	24.8	0.75	<0.01	0.83	0.70
Feed:gain, lb/lb	6.76	6.86	6.39	6.29	6.41	0.168	0.03	0.62	0.25

[1] Linear and quadratic refer to linear and quadratic effects of glycerin; salt = contrast between 0 and 0.3% salt in diets that contain crude glycerin.

Table 3. Carcass characteristics of heifers fed crude glycerin with or without added salt

		Treatments							
		7.5% glycerin		15% glycerin				*P*-value[1]	
Item	Control	Salt	No salt	Salt	No salt	SEM	Linear	Quadratic	Salt
Hot carcass weight, lb	814	803	816	803	798	27.7	0.11	0.76	0.57
Dressed yield, %	61.07	61.44	61.06	60.72	61.06	2.10	0.76	0.58	0.48
Ribeye area, sq. in.	14.5	14.5	14.5	14.5	14.8	0.29	0.46	0.76	0.44
Kidney, pelvic and heart fat,%	3.23	3.24	3.19	3.26	3.11	0.05	0.46	0.87	0.07
12th-rib fat thickness, in.	0.86	0.82	0.84	0.81	0.71	0.03	<0.01	0.48	0.25
Liver abscesses, %	10.7	17.3	13.2	16.0	17.6	4.10	0.23	0.69	0.75
USDA yield grade	2.63	2.49	2.56	2.36	2.35	0.11	0.01	0.64	0.73
Marbling[2]	512	485	458	476	474	13	<0.01	0.02	0.16
USDA quality grades									
Prime, %	2.7	4.0	0	0	0	1.32	0.09	0.59	0.13
Premium Choice, %	34.7	20.0	21.1	28.0	25.7	5.07	0.21	0.03	0.89
Choice, %	82.7	82.7	78.9	88.0	87.8	4.26	0.31	0.26	0.65
Select, %	14.7	13.3	19.7	12.0	10.8	4.03	0.51	0.35	0.52

[1] Linear and quadratic refer to linear and quadratic effects of glycerin; salt = contrast between 0 and 0.3% salt in diets that contain crude glycerin.
[2] Marbling scores determined by USDA graders; slight = 300–399, small = 400–499, and modest = 500–599.

Prior Adaptation Improves Crude Glycerin Utilization by Cattle

E.H.C.B. van Cleef, S. Uwituze, C.L. Van Bibber-Krueger, K.A. Miller, and J.S. Drouillard

Introduction

Crude glycerin has increased in availability as a feedstock for cattle as a result of expansion of the biodiesel industry in the United States. This byproduct, when ingested by cattle, is fermented by ruminal bacteria to yield volatile fatty acids that are used as sources of energy by cattle. The primary component of crude glycerin is glycerol, and the fermentation of glycerol is carried out by specific populations of microorganisms. Anecdotal observations from our previous research with crude glycerin in feedlot cattle have suggested that a period of adaptation may be necessary to achieve optimal utilization of the byproduct. Our objective in this study was to evaluate this adaptive response by measuring *in vitro* digestion by ruminal microbes that were obtained from cattle fed diets with or without added glycerin.

Experimental Procedures

Four ruminally cannulated Holstein steers were placed into individual pens in an indoor barn at the Kansas State University Beef Cattle Research Center. Animals were assigned to two finishing diets, which contained either 0 or 15% crude glycerin (100% dry matter basis). Diets were composed of 10% corn silage, corn gluten feed, soybean hulls, dry-rolled corn, and a vitamin mineral supplement (Table 1). After 14 days of adaptation, ruminal contents were collected from each animal, strained through 8 layers of cheese cloth, placed into a preheated thermos, and transported to the Pre-harvest Food Safety Laboratory. The strained ruminal fluid was placed into a large separatory funnel, sparged with carbon dioxide gas, and placed into a 98°F room for 40 minutes and allowed to stratify into layers. The clarified liquid layer was mixed 1:2 with McDougall's buffer and used as the initial microbial inoculums for *in vitro* cultures.

To measure total fermentative activity and composition of fermentative gasses, total mixed rations and buffered ruminal fluid were placed into fermentation flasks equipped with pressure sensitive membranes and radio frequency transmitters that recorded volume of fermentative gasses at 5-minute intervals. Two flasks containing the buffered microbial inoculum without substrate were included as negative controls. The energy substrates used in the remaining flasks consisted of the total mixed rations shown in Table 1, which contained 0 or 15% crude glycerin. The different diet substrates were added to flasks containing buffered inoculums from adapted steers, as well as from steers that had not been previously adapted to glycerin. Samples of fermentative gasses were removed from the head space of each sealed flask after 0 and 24 hours of incubation to determine concentrations of carbon dioxide and methane using a gas chromatograph. At the end of the 24-hour fermentation, contents of the flasks were chilled in an ice bath to terminate microbial activity. The contents were centrifuged, and a 4-mL sample of supernatant was combined with 1 mL of metaphosphoric acid and used to characterize concentrations of major volatile fatty acids.

To measure *in vitro* dry matter disappearance, 30 mL of buffered ruminal contents from cattle fed diets without added glycerin were added to fermentation tubes. An aliquot of the control diet (no glycerin) was added to a portion of the tubes, and the diet containing 15% glycerin was added to others. The process was repeated using ruminal contents from animals previously adapted to diets containing glycerin. Tubes were gassed with carbon dioxide and placed into a 98°F incubator. The tubes were gently swirled every 3 hours during the 24-hour incubation period. At the end of the incubation period, the tubes were chilled and then centrifuged at 30,000 × g for 20 minutes. The clear fluid supernatant was discarded from each tube, and the remaining pellet was dried overnight 221°F. Weight of the resulting residue was measured and subsequently used to determine *in vitro* dry matter disappearance.

The study was arranged as a 2 × 2 factorial, with factor 1 as the diet to which steers were adapted, and factor 2 as type of substrate added to cultures. Data were analyzed using the MIXED procedure of SAS (SAS Institute, Cary, NC).

Results and Discussion

Figure 1 illustrates the effects of donor animal diet and *in vitro* substrate on the disappearance of dry matter (an estimate of digestion) from our cultures. There was a tendency for an interaction ($P = 0.06$) between diet of the donor animals and substrate used during the fermentation. When glycerin was added to *in vitro* cultures containing ruminal inoculum from unadapted animals, digestion was mildly depressed, but digestibility increased slightly when glycerin was added to cultures containing ruminal inoculum from adapted animals. This result supports our hypothesis that prior adaptation is needed to optimize glycerin utilization and is consistent with anecdotal observations of the same from previous feedlot cattle experiments. Total production of volatile fatty acids (Table 2) was not influenced by diets of the donor animals or by substrate utilized in the *in vitro* fermentations. Substrate utilized in the *in vitro* fermentations, but not diet of donor animals, increased production of both propionate and butyrate ($P < 0.01$). Increases in propionate production with glycerol supplementation are consistent with observations from previous experiments, and generally are viewed as energetically favorable. Increases in butyrate also may be viewed as beneficial, because butyrate is the principal energy substrate used by epithelial cells lining the rumen. Production of fermentative gasses (Table 3), including methane and CO_2, was largely unaffected by diets of donor animals or substrate used in the *in vitro* fermentations ($P > 0.10$).

Implications

This study suggests that prior adaptation may result in modest improvements in digestion of diets containing glycerin.

Table 1. Composition of experimental diets (100% dry matter basis)

	Treatments	
Ingredient, % of dry matter	Control	15% glycerin
Corn silage	10	10
Dry-rolled corn	31.0	13.3
Corn gluten feed	35	35
Soybean hulls	20	20
Supplement[1]	4.0	6.7
Crude glycerin	0	15
Nutrient analyses, %		
Dry matter	65.7	65.7
Crude protein	14.5	14.5
Neutral detergent fiber	37.2	35.9
Ether extract	3.03	2.30
Calcium	0.70	0.70
Phosphorus	0.53	0.50
Potassium	0.70	0.70

[1]Formulated to provide 0.3% salt, 0.1 ppm Co, 10 ppm copper, 0.6 ppm iodine, 60 ppm manganese, 0.25 ppm selenium, 60 ppm zinc, 1,000 IU/lb vitamin A, and 10 IU/lb vitamin E in the total diet on a 100% dry matter basis.

Table 2. Production of volatile fatty acids by *in vitro* cultures containing ruminal contents from adapted and unadapted steers when cultures were fed substrates consisting of diets containing 0 or 15% crude glycerin

	Unadapted donor		Adapted donor		*P*-value[a]		
Item, mM	Control	Glycerin	Control	Glycerin	Diet	Substrate	D × S
Total volatile fatty acids	24.2	25.2	12.4	27.9	0.47	0.20	0.26
Acetate	18.3	12.4	6.9	13.3	0.29	0.95	0.22
Propionate	4.2	7.7	3.5	9.8	0.54	<0.01	0.23
Butyrate	1.6	4.1	1.8	3.7	0.91	<0.01	0.70

[a] Diet refers to the finishing diet fed to donor animals; substrate refers to the diet that was included in the *in vitro* fermentations; D × S refers to the interaction between diet of the donor animal and substrate fed to the *in vitro* culture.

Table 3. Composition of fermentative gasses produced by *in vitro* cultures containing ruminal contents from adapted and unadapted steers when cultures were fed substrates consisting of diets with 0 or 15% crude glycerin

	Unadapted donor		Adapted donor		*P*-value[a]		
Item, mL	Control	Glycerin	Control	Glycerin	Diet	Substrate	D × S
Total gas	107.7	108.3	83.4	88.9	0.16	0.84	0.87
Methane	5.0	4.7	5.9	7.3	0.11	0.61	0.45
Carbon dioxide	29.3	25.7	18.0	21.2	0.24	0.98	0.61

[a] Diet refers to the finishing diet fed to donor animals; substrate refers to the diet that was included in the *in vitro* fermentations; D × S refers to the interaction between diet of the donor animal and substrate fed to the *in vitro* culture.

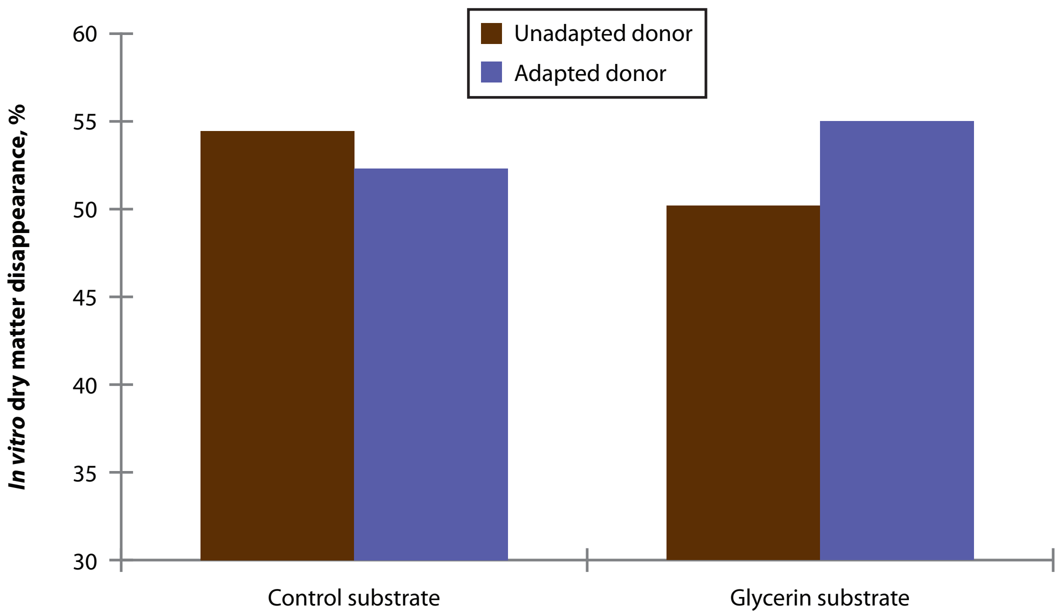

Figure 1. Percentage *in vitro* dry matter disappearance (24-hour incubation) from cultures containing ruminal microorganisms extracted from donor steers fed diets with or without added glycerin. Substrates fed to the *in vitro* cultures consisted of finishing diets containing 0 or 15% crude glycerin. SEM = 2.5. Interaction between donor diet and *in vitro* substrate, *P* = 0.06; effect of donor diet, *P* = 0.48; effect of *in vitro* substrate, *P* = 0.86.

Altering Dietary Calcium Does Not Influence Tenderness in Cattle Fed Zilmax

C.L. Van Bibber-Krueger, K.A. Miller, J.S. Drouillard

Introduction

Tenderness is a key contributor to the sensory attributes of beef, and production practices that decrease tenderness are generally viewed as unfavorable. Zilmax (Merck Animal Health, Summit, NJ) is a potent beta-adrenergic agonist that results in dramatic improvements in carcass weight when fed to cattle, normally for a period of 20 days prior to harvest. Zilmax increases muscle mass at the expense of body fat, and these changes can have favorable effects on retail yield and overall value of beef carcasses. One of the unfavorable side effects of Zilmax is a decrease in meat tenderness. Aging of beef is one means of improving tenderness. During the aging process, proteolytic enzymes degrade the myofibrillar proteins that contribute to the perceptions of tough meat. Activity of these enzymes is stimulated by the presence of calcium ions, and various strategies aimed at increasing intracellular concentrations of calcium have been investigated as a means of improving beef tenderness.

The purpose of this experiment was to determine if dietary calcium could be manipulated during the period of Zilmax supplementation as a means of improving meat tenderness. To do this, we eliminated supplemental calcium from the diet in hopes of inducing the secretion of parathyroid hormone. Parathyroid hormone stimulates the mobilization of calcium deposited in skeletal tissue, and we hypothesized that by decreasing dietary calcium we could potentially increase bone mobilization, and in so doing increase the supply of calcium available to proteolytic enzymes within skeletal muscle to enhance activity of these enzymes post-mortem.

Experimental Procedures

Heifers (n = 96) were stratified by initial body weight and randomly sorted into two treatment groups. Cattle were allotted to feeding pens equipped with concrete floors, fence-line feed bunks, and automatic water fountains with 8 animals per pen (6 pens per treatment). A common finishing diet was fed to all cattle until the final 24 days before harvest. Treatments consisted of: (1) a diet containing supplemental calcium (Calcium) in the form of limestone, and (2) a diet in which the limestone had been removed (No Calcium). Prior to Zilmax supplementation, all cattle were fed the control diet (Table 1). The experimental diets were fed for a period of 21 days in conjunction Zilmax. After 21 days, Zilmax was removed, and cattle were placed back onto a common diet containing limestone for 3 days before harvest.

On the day of harvest, cattle were weighed, loaded onto trucks, and transported 280 miles to a commercial abattoir, where incidence of liver abscesses and hot carcass weight were recorded. Forty-eight hours later, carcass data were collected, including marbling score; 12th-rib fat thickness; ribeye area; percentage kidney, pelvic, and heart fat; USDA yield grade, and USDA quality grade. A 2-inch section was removed from the loin of each carcass, weighed, placed into a plastic bag, vacuum-sealed, and allowed to age under refrigeration for 10 days. After aging, loin sections were removed from the bags, patted dry with absorbent towels, and weighed to determine purge loss during wet aging. A single 1-inch steak was removed from the 12th-rib face, weighed, cooked to an internal temperature, and re-weighed to determine drip loss during cooking. Tenderness of steaks was evaluated by Warner-Bratzler shear force.

Results and Discussion

We speculated that the elimination of supplemental calcium from the diets of feedlot cattle during the period of Zilmax supplementation would stimulate mobilization of calcium from bone. By abruptly switching back to calcium-enriched diets during the post-Zilmax withdrawal period, we believed it might be feasible to achieve a temporary increase in skeletal muscle intracellular calcium concentrations. If calcium concentrations were to increase, it might be possible to stimulate post-mortem activity of calcium-dependant proteases to improve muscle tenderness. Removing calcium from the diet of feedlot heifers during the 21-day period of Zilmax supplementation had no effects on final body weight, average daily gain, or efficiency of feed utilization (Table 2; $P > 0.20$). Similarly, carcass yield and quality attributes (Table 3) did not change in response to altering calcium content of the diet ($P > 0.20$). Shear force values averaged just over 10 lb of force for both treatments, and thus fell within the "acceptable" range of tenderness (Table 4). Altering calcium content had no discernible impact on measures of tenderness in loin steaks.

Implications

Removal of calcium from the diet during the period of Zilmax supplementation had no effect on feedlot performance, carcass characteristics, or beef tenderness.

Table 1. Composition of diets on a 100% dry matter basis

Ingredients	Calcium	No Calcium
Dry-rolled corn	30.97	32.40
Wet corn gluten feed	35.00	35.00
Corn silage	10.00	10.00
Soybean hull pellets	20.00	20.00
Supplement[1,2,3]	4.03	2.6[a]
Analyzed composition, %		
Crude protein	14.8	14.9
Calcium	0.74	0.19
Phosphorus	0.51	0.51
Potassium	0.88	0.89
Neutral detergent fiber	30.4	30.5

[1] Formulated to provide 300 mg Rumensin and 90 mg Tylan (Elanco Animal Health; Greenfield, IN) and 0.4 mg melengestrol acetate (Pfizer Animal Health; Whitehouse Station, NJ) per animal daily, as well as 1,000 IU/lb vitamin A, 10 IU/lb vitamin E, 0.15 ppm cobalt, 10 ppm copper, 0.5 ppm iodine, 60 ppm manganese, 0.25 ppm selenium, and 60 ppm zinc in the total diet on a 100% dry matter basis.

[2] Zilmax (Merck Animal Health, Millsboro, DE) was included in experimental diets for 21 days prior to harvest to provide 8.33 ppm zilpaterol hydrochloride in the total diet dry matter.

[3] Limestone was removed from the supplement fed to the No Calcium treatment throughout the time Zilmax was added to the diet.

Table 2. Feedlot performance of heifers fed diets with or without added calcium during the 21-day period of Zilmax[1] supplementation

Item	Calcium	No Calcium	SEM	*P*-value
Initial body weight, lb	859	868	6.96	0.24
Final body weight, lb	1330	1340	9.69	0.35
Average daily gain, lb	4.06	4.07	0.08	0.91
Dry matter intake, lb	29.57	29.74	0.77	0.84
Gain:feed, lb/lb	0.138	0.137	0.003	0.87

[1] Merck Animal Health, Summit, NJ.

Table 3. Carcass characteristics of heifers fed diets with or without added calcium during the 21-day period of Zilmax[1] supplementation

Item	Calcium	No Calcium	SEM	*P*-value
Hot carcass weight, lb	820	825	8.30	0.57
Dressed yield, %	64.17	64.10	0.36	0.85
Liver abscesses, %	2.1	8.3	4.27	0.20
Ribeye area, sq. in.	14.6	14.9	0.25	0.27
12th-rib fat thickness, in.	0.55	0.59	0.06	0.55
Kidney, pelvic, and heart fat, %	3.14	3.13	0.10	0.89
Yield grade	2.57	2.42	0.12	0.23
Marbling score[2]	496	501	14.6	0.73
Prime, %	2.4	2.1	3.16	0.93
Choice, %	82.7	87.5	6.37	0.49
Select, %	10.7	6.3	5.77	0.47

[1] Merck Animal Health, Summit, NJ.

[2] Marbling scores were determined by a USDA grader: Slight = 300 to 399; Small = 400 to 499; Modest = 500 to 599.

Table 4. Purge loss, drip loss, and tenderness of steaks from heifers fed diets with or without added calcium during the 21-day period of Zilmax supplementation

Item	Calcium	No Calcium	SEM	*P*-value
Purge loss during wet aging, %	1.6	2.0	0.002	0.18
Drip loss during oven cooking, %	19.5	19.3	0.01	0.83
Warner-Bratzler shear force, lb	10.2	10.1	0.26	0.64

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