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**Paul Beck, Editor; Jason Apple, Shane Gadberry,
Beth Kegley, and Charles Rosenkrans, Jr., Assistant Editors**

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Cover photo: First calf heifers fed total mixed diets pre-calving at the University of Arkansas System Division of Agriculture's Southwest Research and Extension Center; credit: Shane Gadberry, University of Arkansas System Division of Agriculture, Department of Animal Science, Cooperative Extension Service, Little Rock, Ark.

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**ARKANSAS ANIMAL SCIENCE
DEPARTMENT REPORT 2016**

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INTRODUCTION

Welcome from the Department of Animal Science! This is the 19th edition of the Arkansas Animal Science publication. As always, thanks to the faculty, staff and graduate students in the Department of Animal Science and to Dr. Paul Beck who served as editor along with Drs. Jason Apple, Shane Gadberry, Beth Kegley, and Charles Rosenkrans for serving as assistant editors.

Readers are invited to the departmental website at animalscience.uark.edu; the Livestock and Forestry Branch Station website at Batesvillestation.org; the Southwest Research and Extension Center website at aaes.uark.edu/research-locations/swrec; the Southeast Research and Extension Center website at aaes.uark.edu/research-locations/serec.aspx; and the Cooperative Extension Service, Animals and Forages website at <http://uaex.edu/farm-ranch/animals-forages/> for further information about our research and Extension programs.

I am sure you will agree, research and Extension programs from this department will help in developing best management practices that will increase whole farm/ranch efficiency, and ultimately, increase producer profitability. We appreciate your interest in the work that we do to enhance animal production in this state.

Sincerely,

A handwritten signature in black ink, appearing to read "M. Looper". The signature is fluid and cursive, with the first name "Michael" and last name "Looper" clearly distinguishable.

Michael Looper
Department Head

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Comparison of Draxxin and Zactran on growth performance, morbidity, and economic cost in high-risk, newly received beef calves

Jase Ball¹, Elizabeth Kegley¹, Pete Hornsby¹, Jana Reynolds¹, and Jeremy Powell¹

Research Highlights

- Growth performance did not differ between Draxxin- and Zactran-treated calves.
- Overall cost of antibiotics administered were similar between treatments.
- Percentage morbidity was greater in Zactran-treated calves than in Draxxin-treated calves for first and second antibiotic administration.

Introduction

Metaphylactic treatments are used in cattle enterprises as a means to mitigate bovine respiratory disease (BRD), which is still the largest economic detriment to the United States beef population. The prevalence of BRD in stocker calves increases when cattle are stressed from a variety of sources, including transport, weaning, and commingling. The administration of metaphylactic antimicrobials upon arrival has reduced morbidity and mortality rates while increasing average daily gain (ADG) in newly received beef calves. Other factors that influence BRD, include weather, innate immunity, and management practices that the calf underwent at the farm of origin. Metaphylactic treatments are increasing in importance in their ability to combat BRD due to variations in drug costs. Early administration of an effective antimicrobial has had the greatest effect on mitigating BRD symptoms in previous research. Draxxin (tulathromycin) and Zactran (gamithromycin) are 2 metaphylactic drugs designed to target BRD pathogens by developing high and persistent levels of the drug in lung tissue. The objective of this study was to compare the efficacy of Draxxin and Zactran on growth performance, morbidity, antibiotic usage, and cost in newly received beef bull calves.

Materials and Methods

A total of 207 crossbred bull beef calves [body weight (BW) = 639 ± 12 lb] arrived on 5 different dates and were assigned to 1 of 2 treatments in a completely randomized design. Upon arrival, calves were tagged in the ear, vaccinated for respiratory and clostridial pathogens, dewormed, tested for the prevalence of persistent infection with bovine viral diarrhea virus, and administered either 1.1 mL/100 lb BW of Draxxin with a strict 7-day post-metaphylactic interval (PMI) or 2 mL/110 lb BW of Zactran with a 5-day PMI. Cattle were observed daily for signs of morbidity and a clinical attitude score [0 (normal) to 5 (morbid)] was recorded. Calves that scored a 1, or greater, and were PMI eligible were pulled and rectal temperatures were recorded. If temperature exceeded 104 °F, calves on both treatments were given Baytril with a 2-day post-treatment interval (PTI), whereas if the calf was pulled a second time and met the criteria for another antibiotic, Excede was the final antibiotic administered. All calves were weighed on day 0 and 14 from arrival and again on March 29, 2016 with 180 bulls weighed on April 4, 2016 prior to transport to the feedlot.

Results and Discussion

Growth performance parameters including initial and final body weights and average daily gain did not differ between Draxxin- and Zactran-treated calves over the course of the study (Table 1). Draxxin calves initial weight was 635 ± 12.3 lb compared to 644 ± 12.3 lb for Zactran-treated calves, whereas final weights were 759 ± 6.2 lb for Draxxin calves and 762 ± 6.2 for Zactran calves. Average daily gain was similar for both treatments with calves averaging 1.61 and 1.67 lb/d for calves treated with Draxxin or Zactran, respectively. Percentage BRD morbidity (28% vs. 13%) was greater in the Zactran treatment for calves that were treated once with Baytril after initial metaphylactic administration. Percent BRD morbidity for calves retreated with Excede after previously being treated with Baytril following a 2-day PTI was greater in Zactran calves (16% vs. 4%). There were no differences in percentages of chronic calves, relapses, and mortalities due to treatment. Chronic calves were defined as calves that were treated 2 times for BRD and gained less than 0.5 lb per day. Initial antibiotic costs were greater in cattle administered Draxxin compared to Zactran-treated calves (\$31.54 vs. \$23.85). First and second treatment antibiotic cost for cattle were greater in Zactran-treated calves. However, there were no differences between Draxxin and Zactran in terms of overall medical cost (\$36.07 vs. \$35.97), exclusive of labor or chute charges. Rectal temperature and clinical attitude scores did not differ between Draxxin- and Zactran-treated calves. Cattle arriving at different times in concert with seasonal weather changes may have impacted the prevalence of BRD in the treated cattle. Also, cattle may have possessed BRD without showing outward clinical signs. Although this study did not show a decrease in performance in concert with greater morbidity, typically economic losses are greater in treated calves. Metaphylaxis treatment protocols did not affect BW and ADG, but differences were found in the percentage of calves treated with antibiotics for clinical BRD and in the number of antibiotics used. Additionally, both Draxxin and Zactran are potentially effective strategies for minimizing BRD in high-risk calves. The use of metaphylactic treatment was an effective management tool for reduction of BRD- related sickness in newly weaned beef calves.

Acknowledgements

Support provided by the University of Arkansas System Division of Agriculture.

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Table 1. Cost comparison and percentage morbidity comparing the efficacy of Draxxin and Zactran in high risk feeder cattle.

Item	Treatment		SEM ^a	P- value
	Draxxin	Zactran		
Cost, \$				
Initial treatment	31.54	23.85	0.3	<0.0001
First treatment (Baytril)	3.77	8.79	1.2	0.004
Second treatment (Excede)	0.77	3.33	0.6	0.002
Overall	36.07	35.97	1.6	0.96
Morbidity, %				
Treated once (Baytril)	13	28	-	0.009
Treated twice (Excede)	4	16	-	0.004
Chronic ^b	3	7	-	0.19
Relapse ^c	29	55	-	0.11
Mortality	0	2	-	0.15

^a Standard error of mean only represented for cost analysis, percent morbidity analyzed using Chi-square.

^b Includes cattle treated 2 times for clinical bovine respiratory disease (BRD) that failed to gain 0.5 lb/d for the backgrounding period, plus dead calves.

^c From the cattle treated one time for clinical BRD, the percentage of cattle that were treated with a second antibiotic for clinical BRD.

Comparison of treatment protocols for bovine respiratory disease in high-risk, newly received beef calves

Jase Ball¹, Elizabeth Kegley¹, Pete Hornsby¹, Jana Reynolds¹, Jeffrey Sarchet², and Jeremy Powell¹

Research Highlights

- Growth performance was similar across both metaphylactic treatment protocols.
- Overall antibiotic treatment costs did not differ.
- Percentage morbidity was greater in Micotil-treated calves compared to Draxxin-treated calves.

Introduction

Bovine respiratory disease (BRD) is a large economic liability to the United States beef population with an estimated cost of \$750 million annually, while negatively affecting the health of many animals. Weaning, transport, and other stressful events create opportunities for the development of BRD with the majority of cases occurring in weaned calves within 3 weeks after arrival to a new facility. One effective strategy in mitigating the effects of BRD in incoming cattle is to administer metaphylaxis (mass treatment) with an antibiotic during initial processing. Metaphylactic antimicrobials lower morbidity and mortality rates while increasing average daily gain (ADG). Therefore, efficacy, cost, and convenience of varying metaphylactic treatments and their subsequent treatment protocol is of interest to both producers and researchers. Successful treatment of BRD-affected animals is maximized by early administration of an effective antimicrobial which decreases overall BRD morbidity in high-risk cattle. Draxxin (tulathromycin) and Micotil (tilmicosin) are members of the macrolide antimicrobial class that develop high and persistent drug concentrations in plasma and tissue. The objective of this study was to evaluate different metaphylaxis protocols for BRD on performance, morbidity, antibiotic usage, and cost in high-risk, newly received beef calves.

Materials and Methods

Crossbred male beef calves [n = 176; body weight (BW) = 510 ± 3.5 lb] were stratified by body weight and assigned randomly to 1 of 2 metaphylactic drug treatments in a randomized complete block design. Upon arrival, calves were tagged in the ear, vaccinated for respiratory and clostridial pathogens, dewormed, castrated (if applicable), tested for the prevalence of persistent infection with bovine viral diarrhea virus, and administered either 1.1 mL/100 lb BW of Draxxin with a strict 7-day post-metaphylactic interval (PMI) or 1.5 mL/100 lb BW of Micotil with no PMI. Cattle were observed daily for signs of morbidity and a Clinical Attitude Score [0 (normal) to 5 (morbid)] was recorded. Calves that scored a 1 or greater and were PMI eligible were pulled and rectal temperatures were recorded; if temperature exceeded 104 °F, calves on the Draxxin treatment were given Excede with a 7-day post-treatment interval (PTI) as the initial treatment antibiotic and calves on the Micotil treatment were given Baytril with a 2-day PTI. If the calf was pulled a second time and met the criteria for another antibiotic, a final treatment was admin-

istered, Draxxin cattle received Advocin and Micotil-treated cattle received Resflor. Calves were weighed on day -1, 0, 15, 41, and 42.

Results and Discussion

Body weights were similar for cattle receiving either Draxxin or Micotil for the duration of the study (initial: 511 vs. 510 lb; final: 598 vs. 589 lb; Table 1). Average daily gain over the entirety of the study was 2.07 lb/d for Draxxin-treated calves compared to 1.85 lb/d in Micotil-treated calves. Percentage BRD morbidity was greater for first treatment, second treatment, and relapse (treated twice) in the calves that received Micotil compared to those that received Draxxin: 53% of Micotil-treated calves were treated at least once for clinical BRD and 28% of the calves treated once were re-treated. This is compared to 28% of Draxxin-treated calves that were treated once and of those calves 5% were re-treated. Cattle that relapsed after being treated once were 53% for Micotil-treated calves and 16% for Draxxin-treated calves. Chronic calves were defined as calves that were treated 2 times for BRD and gained less than 0.5 lb per day with 6% chronics for Micotil-treated calves compared to 1% for Draxxin-treated calves. Initial antibiotic cost were greater (\$24.93 vs. \$12.38/head) in cattle administered Draxxin compared to Micotil-treated cattle. Both first and second treatment antibiotic cost for cattle were greater in Micotil-treated cattle compared to Draxxin-treated cattle. However, there were no differences across treatments in terms of overall medical cost (\$30.60 vs. \$32.99/head), exclusive of labor or chute charges. Rectal temperature and Clinical Attitude Scores did not differ across treatments over the 42-day study. General economic losses associated with BRD are typically related to reduced ADG and increased morbidity which was not congruent with the results of this study. Metaphylaxis treatment protocols did not significantly affect BW and ADG, but differences were found in the percentage of calves treated with antibiotics for clinical BRD and in the number of antibiotics used. The use of metaphylactic treatment potentially can be a management tool for reduction of BRD-related sickness in newly weaned beef calves.

Acknowledgements

The authors would like thank Zoetis for their support and donation of products. Support was also provided by the University of Arkansas System Division of Agriculture.

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² Zoetis Inc., Florham Park, N.J.

Table 1. Cost comparison and percentage morbidity on different treatment protocols of high risk feeder cattle.

Item	Treatment		SEM ^a	P- value
	Draxxin	Micotil		
Cost, \$				
Initial treatment	24.93	12.38	0.12	<0.0001
First treatment	4.78	12.97	1.2	0.0003
Second treatment	0.89	7.64	1.5	0.008
Overall	30.60	32.99	2.5	0.51
Morbidity, %				
Treated at least once for clinical BRD	28	53	12.9	0.0003
Treated at least twice for clinical BRD	5	28	21.7	<0.0001
Chronic ^b	1	6	3.2	0.08
Relapse ^c	16	53	14.7	0.0001
Average daily gain, lb				
Day 1 to 42	2.07	1.85	0.12	0.21

^a Standard error of the mean for morbidity represents Chi-square standard error.

^b Includes cattle treated 2 times for clinical bovine respiratory disease (BRD) that failed to gain 0.5 lb/d for the backgrounding period, plus the 1 dead calf.

^c From the cattle treated 1 time for clinical BRD, the percentage of cattle that were treated with a second antibiotic for clinical BRD.

Effect of injectable castration regimen on beef bull calves

Jase Ball¹, Elizabeth Kegley¹, Jeremy Powell¹, Paul Beck², Jason Apple¹, and Danny Cox³

Research Highlights

- There were no differences in growth performance between calves that remained bulls and calves surgically or chemically castrated.
- There were no differences in scrotal thickness, growth performance or testosterone concentrations regardless of the dosage concentration of zinc.
- The injectable castration method resulted in serum testosterone concentrations similar to calves that had been surgically castrated.

Introduction

Husbandry practices in the beef industry that are associated with pain, discomfort, and distress include castration, dehorning, and branding. It has been estimated there are approximately 15 million castration procedures performed in the United States annually to reduce aggressiveness and sexual activity, prevent unwanted breeding, and improve the meat quality. In Arkansas, only 17% of male calves sold in livestock auctions weighing between 300 and 550 pounds were already castrated; and of the bulls placed on feed in feedlots in 2008, roughly 91% were castrated, predominantly by band castration (64%) or surgical castration (19%). Economically, castration post-weaning affects profitability by decreasing average daily gain and increasing susceptibility to bovine respiratory disease. Currently, no commercially available injection sterilization method exists for beef cattle in the United States, although there has been a zinc solution utilized in other species. An injectable sterilization method could be an alternative castration method which could potentially reduce pain, stress, performance loss, and minimize the prevalence of bovine respiratory disease. Therefore, this research project was designed to evaluate an injectable zinc solution at 3 dosage levels for the efficacy of castration in beef bull calves prior to weaning on weight gain, testosterone production, and testicle atrophy.

Materials and Methods

On May 15, 2014, 31 bull calves and their dams were separated from a larger group of cow-calf pairs. On June 3, 2014, calves were allocated to treatments by bodyweight (average BW = 284 ± 55 lb) and birthdate. Twenty-seven bull calves were allocated to 3 injectable castration treatments reflecting 3 levels of dosage concentration of a zinc-based solution and administered as 1 mL (1 cc equivalent) of zinc solution to each teste. Two bull calves were castrated using a surgical technique while 2 bull calves were left intact until the termination of the study at weaning. Calves were weighed with no further shrink on 28-day intervals and weaned from dams on September 30, 2014. At each subsequent 28-day interim weight collection and at the end of the study on October 3, 2014, calves were bled via jugular venipuncture to determine serum

testosterone. On the same day, the thicknesses of the right testicle and scrotum were measured. Bodyweight and performance were analyzed using the general linear model procedure of SAS. Serum testosterone concentrations and thicknesses of the right testicle and scrotum were analyzed using repeated measures analyses. Orthogonal contrasts were used to compare intact vs. castrated, injection vs. surgical, and linear and quadratic effects for zinc dosage.

Results and Discussion

There were no effects of castration or castration method on bodyweight or preweaning average daily gain. Over the course of the experiment, mean average daily gain was nearly or slightly above 2 lb/day for the initial two 28 day intervals (1.95 ± 0.15 and 2.01 ± 0.18 lb/day, for periods 1 and 2, respectively), yet declined to 1.63 ± 0.17 lb/day in period 3 and to 0.33 ± 0.15 lb/day in the final period before weaning. The decline in performance during the late summer is due to seasonal deterioration in forage quality and was not related to treatments imposed. Bodyweight at weaning averaged 445 ± 30 lb.

There was a main effect of treatment on serum testosterone concentrations (Table 1). Intact bulls had greater serum testosterone concentrations compared to bulls castrated with any method, and there were no differences due to castration method. There was a treatment × day interaction for serum testosterone as bulls had greater testosterone concentrations on day 122 compared to castrated, regardless of method, while day 0 concentrations were similar for all treatments. There was no main effect of treatment on teste thickness or scrotal circumference. There was a treatment × day interaction, no change in the thicknesses of the scrotum and testes of intact bulls was observed from day 28 to 122; however, the thicknesses of scrotums and testes for calves given all zinc dosages decreased as the study progressed. There were no differences in thicknesses of scrotums and testes due to the dosage amounts of zinc solution.

Acknowledgements

The authors would like thank Cowboy Animal Health for support and donation of the zinc solution (Calviex). Support was also provided by the University of Arkansas System Division of Agriculture.

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² Southwest Research and Extension Center, University of Arkansas System Division of Agriculture, Hope, Ark.

³ Cowboy Animal Health, LLC, Plano, Texas.

Table 1. Effect of castration, castration method, and injectable castration Calviex dose on serum testosterone concentrations and testis and scrotum thickness (least squares means).

Item	Castration method [†]					SE	
	Inj1	Inj2	Inj3	Surg.	Intact	Injection treatments (n = 9/trt.)	Intact and Surg. (n = 2/trt.)
Serum testosterone[‡], ng/mL						0.056	0.118
June 3, day 0	0.05 ^{a¶}	0.11 ^{a§}	0.14 ^{a§}	0.05 ^a	0.16 ^{a§}		
July 1, day 28	0 ^a	0.07 ^{a§}	0.01 ^a	0 ^a	0.13 ^{a§}		
July 28, day 56	0.01 ^a	0.11 ^{a§}	0.01 ^a	0 ^a	0.32 [§]		
August 25, day 83	0.01 ^a	0 ^a	0.04 ^a	0 ^a	0.02 ^a		
October 3, day122	0.01 ^a	0.04 ^a	0 ^a	0 ^a	0.99 [‡]		
Testis and scrotum thickness[§], mm						1.73	3.64
July 1, day 28	36.2 ^{‡§}	36.7 [‡]	33.8 ^{‡§}	-	24.1 ^{ab}		
July 28, day 56	25.3 ^a	27.3 ^a	26.8 ^a	-	29.5 ^{a‡§}		
August 25, day 83	15.1 ^{cd}	17.8 ^{bc}	19.5 ^{bc}	-	27.2 ^a		
October 3, day 122	10.2 ^e	13.0 ^{de}	11.7 ^{de}	-	28.5 ^{a§}		

[†] Inj1 = least Zn concentration, Inj2 = intermediate Zn concentration, Inj3 = greatest Zn concentration, Surg. = surgically castrated, Intact = non-castrates.

[‡] Treatment, $P = 0.005$; Day, $P = 0.002$; Treatment \times day interaction, $P = 0.0002$.

[§] Treatment, $P = 0.29$; Day, $P < 0.0001$; Treatment \times day interaction, $P < 0.0001$.

[¶] Means without a common letter differ $P < 0.05$.

Efficacy of a novel intranasal zinc solution on health and growth performance of high risk, newly received stocker cattle

Makenzie Foster¹, Beth Kegley¹, Jeremy Powell¹, Paul Beck², Jana Reynolds¹, Pete Hornsby¹,
Doug Galloway¹, Jase Ball¹, and Jiangchao Zhao¹

Research Highlights

- Intranasal zinc did not appear to have a positive effect on average daily gain and did not decrease morbidity and mortality in calves susceptible to bovine respiratory disease.
- Treating all calves appears to have a negative effect on performance; however selectively treating calves with bovine respiratory disease could be more efficacious.
- Anosmia derived from the treatment of zinc may have had an effect on feed intake.

Introduction

Bovine respiratory disease (BRD) is a major problem in every facet of the cattle industry due to decreasing economic output, production and increases in medical costs, labor and death loss. Newly received calves are at a high risk for contracting BRD due to increased levels of stress which can negatively affect the calves' immune system rendering them susceptible to bacterial and viral pathogens. In its upper respiratory form, BRD is similar to the common cold in humans displaying similar symptoms. Zinc, an essential dietary mineral, has been shown to act as a competitive inhibitor and can disrupt replication of the virus. Pharmaceutical companies have used an intranasal zinc spray in humans to help decrease the severity and duration of the common cold. Applying Zn solutions via mucosal application, in addition to antibiotic treatment for BRD, could have a positive effect on the calf's immune response and growth performance; therefore the objective of this study was to evaluate whether a mucosal application of Zn would impact health and growth performance in high-risk, newly received stocker calves.

Material and Methods

A total of 239 male beef calves were stratified by arrival gender and body weight (608 ± 5.3 lb) and assigned randomly into either treatment with 3 mL of a Zn solution containing 36.24 mg of Zn administered intranasally, or untreated (no intranasal treatment). Upon arrival, cattle were identified with individual ear tags, weighed, arrival sex recorded, rectal temperature taken, ear notched for detection of persistent infection with BVD, and vaccinated with a clostridial and a pentavalent modified-live virus respiratory vaccine. Calves were observed daily for signs of morbidity and a clinical illness score [1 (normal) to 5 (morbid)] was recorded. Cattle that scored >1 and had a rectal temperature 104°F were treated with an antibiotic. If rectal temperature $\geq 104^\circ\text{F}$ persisted past the first antibiotic post-treatment interval, cattle were re-treated according

to a pre-planned protocol. Growth performance, costs, and rectal temperatures were analyzed using the mixed procedure of SAS. Percentage morbidity was analyzed using the GENMOD and FREQ procedures. The experimental unit utilized was pen while individual calf served as the observational unit.

Results and Discussion

Body weights were similar between treatments throughout the duration of the study (Table 1). Calves treated with Zn had a lower average daily gain from day 7 to 28 and day 14 to 28 compared to control calves. Control calves tended to be treated with 3 antibiotics more often than Zn-treated calves, but overall antibiotic costs did not differ between treatments. There were no differences for rectal temperatures of calves due to treatment. The nasal atomizer used to deliver the spray to the calves was a little uncomfortable for the calves as well as awkward for the handler; thus, calves may not have received Zn at the desired level. Zinc-treated calves were restrained longer in the chute than the control calves for the administration of the intranasal solution, which could have increased their stress level, thereby negatively impacting their immune system. Due to the possibility of anosmia (loss of smell), the calves administered Zn may have gained less than the control calves. From the results of this study, calves treated intranasally upon arrival with a Zn solution had no differences in overall growth performance and minimal differences in morbidity compared to control calves.

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Table 1. Effect of intranasal zinc on performance of high risk cattle.

Item	Treatment		SEM ^a	P - value
	Control	Zinc		
Body weight, lb				
Initial	608.0	610.2	1.3	0.60
Day 7	613.5	614.6	1.5	0.83
Day 14	625.2	628.5	1.7	0.55
Final	694.7	688.7	2.1	0.38
Average daily gain, lb				
Day 0 to 7	3.1	3.3	0.19	0.65
Day 0 to 14	2.2	2.6	0.11	0.34
Day 0 to 28	1.9	1.7	0.05	0.67
Day 7 to 14	1.7	1.9	0.09	0.23
Day 7 to 28	1.9	1.5	0.06	0.04
Day 14 to 28	2.2	1.5	0.08	0.01
Day 28 to 45	2.2	2.6	0.08	0.21
Overall	2.2	2.2	0.05	0.98
Rectal temperature, °F	102.83	102.95	0.03	0.10
Morbidity, % ^b				
Treated once	71.7	67.2		0.40
Treated twice	36.7	29.4		0.22
Treated thrice	17.5	9.2		0.06
Chronic	4.2	3.4		0.72
Dead	0.83	0.84		0.98
Relapse	51.2	43.8		0.40
Antibiotic cost, \$/calf	24.75	22.66		0.64

^a SEM for morbidity was analyzed utilizing Chi Square.

^b Chronic was declared if calf was treated 3 times and gained <0.5 lb/day; Relapse denotes animals treated with a second antibiotic.

Using 300 days of grazing principles to reduce hay requirements in southwest Arkansas

Paul Beck¹, Brandon Stewart¹, Michael Sims¹, Shane Gadberry², and John Jennings²

Research Highlights

- Increasing management intensity of cow-calf production in intensive management at moderate stocking rate (MR) decreased stored forage requirements and increased forage availability during the summer compared with low intensity management with continuous grazing at a moderate stocking rate (CG).
- Even with the added costs of stockpiling bermudagrass and interseeding complementary cool-season annual grasses, net returns of MR were comparable to CG.
- Finally, increased management intensity allowed stocking rates to double in intensive management with high stocking rates (HR), decreasing costs per cow and increasing net return per acre, while reducing needs for stored forages compared with CG.

Introduction

From 1976 to 2014, hay production per cow in Arkansas and the southeastern United States has increased by 136%. Producers have faced increasing costs of production with increases in costs of diesel, fertilizer, and equipment leading to large increases in the cost of hay production. Yet it has been estimated that hay is commonly fed for over 130 days/year in the southeastern United States. Stockpiling bermudagrass provides a means to carry forage over from a period of excess forage production in the late summer to a time of forage deficit in the late fall. Complementary forage systems based on warm-season perennial grasses and cool-season annual grasses have been shown to reduce hay and feed requirements. Rotational grazing has benefits to production including: increased harvest efficiency by grazing livestock, improved persistence of desirable forage plants, and ease of application of additional management practices. The objective of this research was to determine the effect of application of multiple grazing management practices at two stocking rates on the productivity and economics of the cow-calf enterprise in the southeastern United States.

Materials and Methods

Pasture management systems included: CG—low intensity management with continuous grazing at a moderate stocking rate (SR = 2 acres/cow); MR—intensive management at moderate stocking rate (2 acres/cow); HR—intensive management with high stocking rates (1 acre/cow). This research was conducted over 4 years, on 12-acre warm-season grass-based pastures. There were three pasture replications for each grazing system and cows remained on pastures year-long. Cows in CG grazed three pastures using continuous stocking grazing management at 2 acres/cow stocking rate without the benefits of other forage management options (complementary forages or stockpiling). The remaining pastures were divided into six paddocks (2 acres/paddock) for rotational stocking grazing management with a stocking rate of either 6 or 12 cows per pasture. The MR and HR pastures were also managed such that bermudagrass was stockpiled for utilization

later in the fall and complementary cool-season annual grasses were interseeded into pastures for use during the late winter and early spring. During the summer, cows assigned to each pasture grazed each paddock for 7 days before rotating to the next paddock in the sequence, allowing for 35 days of rest for each paddock before the next grazing event. Residence time in paddocks was adjusted for removal of excess forage for stockpiling bermudagrass in July or interseeding of cool-season annuals in October.

Results and Discussion

Hay Production and Feeding. The MR pastures produced 3.5 round bales/acre from 4 acres in each pasture and the HR pastures averaged 2.5 round bales/acre from 1 acre in each pasture. The annual total excess forage harvested from MR averaged 12,100 pounds/pasture and the total excess forage harvested from HR averaged 2200 pounds/pasture. Cows in CG (107 days) system were fed hay for 70 days longer during the winter than HR (37 days) which were fed hay 22 days longer than MR (15 days). Furthermore, CG (3388 pounds of hay/cow) cows were fed over 3-times more hay per cow than HR (979 pounds of hay/cow) and over 5-times more hay per cow than MR (640 pounds of hay/cow). A considerable amount of the hay feeding in the HR system occurred during the autumn (late September to early October) while bermudagrass stockpile was accumulating growth and cool-season annuals were being interseeded. The feeding of hay during this timeframe has advantages due to the reduced rainfall at this time compared with feeding hay during the late winter and early spring. Feeding hay in the dryer time of year to accumulate forage to utilize later in the year resulted in less rutting of pastures by hay feeding equipment. The cost of hay fed to cows in CG (\$125.09/cow) was greater than MR (23.66/cow) or HR (\$36.13/cow), which were similar.

Cow and Calf Performance. The effects of grazing management on cow and calf performance are presented in Table 1. Cow body weight at the start of each annual production cycle in November and again in January was lighter in HR than CG and MR. In May, body weight of cows in MR tended to be 50 pounds greater than CG, while HR did not differ from either CG or MR. Cow body

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weight and body condition score (BCS) in July did not differ due to pasture management; but at weaning in October, body weight of HR was 5% less than CG and MR which were similar. Cow body condition score did not differ among pasture management systems in November, but tended to be 0.3 units greater in CG and MR than HR during January. Cow BCS at calving or in May, July, October did not differ among pasture management systems. Pregnancy rate determined at weaning did not differ by pasture management system. Calf body weight at birth, or in May and July did not differ among management systems. At weaning in October, calves in HR were 40 pounds lighter than CG and were 18 pounds lighter

than MR. Calves in MR tended to have 22 pounds lower weight at weaning than CG. Even though calf weaning weights were the least for HR, body weight weaned per acre was 89% greater for HR compared with CG and MR, which were similar.

Acknowledgements

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Table 1. Effect of grazing management practices on hay requirements and performance of cow-calf pairs.

Item	Treatment ^a		
	CG	MR	HR
Cow BW, pounds			
November	1192	1217	1142
January	1201	1201	1104
May	1122	1175	1153
July	1195	1217	1210
October	1201	1223	1148
Cow BCS			
November	6.1	6.1	5.9
January	6.1	6.1	5.8
May	5.9	6.0	5.9
July	6.0	6.1	6.1
October	6.0	6.0	5.9
BCS at calving	5.9	6.0	5.9
Pregnancy rate, %	78	80	89
Calf body weight, pounds			
Birth	92	90	88
May	244	233	235
July	383	372	367
Weaning	521	499	482
BW weaned per acre, lbs	226	217	420

^a Treatments were: CG—low intensity management with continuous grazing at a moderate stocking rate (SR = 2 acres/cow); MR—intensive management at moderate stocking rate (2 acres/cow); HR—intensive management with high stocking rates (1 acre/cow).
BW—body weight; BCS—body condition score.

Enhanced management sustains growth performance in steers grazing pastures with varying levels of fescue toxicity (ergovaline)

Shane Gadberry¹, Jose Diaz², John Tucker³, Kristie Loeschner³, Tom Hess³, Don Hubbell, III³, Paul Beck⁴, Doug Hufstедler⁵, and John Richeson⁶

Research Highlights

- This study demonstrates the effectiveness of cumulative management strategies to increase weight gain of steers grazing toxic fescue pastures.
- The economic return above specified costs for adopting enhanced management when growing steers on toxic fescue pasture is estimated at \$18 to \$63 per steer calf during a 90-day growing period.

Introduction

Research has shown that calves given a steroidal implant, fed an antibiotic, or supplemented with a highly digestible fiber-based feed supplement, gain on average, 0.22, 0.13, and 0.84 lb/day more than calves not receiving these respective management strategies. The objective of this study was to evaluate the growth response of steers to a cumulative management strategy including a steroidal implant, an ionophore (a feed supplement that does not require a veterinary feed directive), and supplementation at 1% body weight. Our hypothesis was cumulative management would result in at least a 1 lb/day improvement in growth due to the additive benefit of the combination strategy.

Materials and Methods

In autumn 2015 and again in the spring 2016, 84 weaned steer calves were assigned to 1 of 16 pastures. The autumn and spring stocking rates were 1 and 1.67 calves per acre. Calves grazed for 91 and 84 days autumn and spring. Eight of the 16 pastures were assumed non-toxic due to establishment of Estancia (a non-toxic, endophyte-infected fescue) autumn 2013. The remaining 8 pastures were old stand fescue assumed to be endophyte infected. Within each pasture type, 4 pastures were assigned to enhanced management including: a Component TE-G (containing 40 mg trenbolone acetate, 8 mg estradiol, and 29 mg tylosin tartrate) implant on day 0, supplementing with a 50:50 corn gluten feed: soybean hull pellet blend, and topdressing the daily supplement with Vigortone 3V6 mineral with Rumensin (150 mg/calf, daily equivalent). Supplement was fed at 1% body weight (as-fed basis) using the most recent shrunk weight. Both the supplement and mineral topdress were fed Monday thru Friday, and the feed amount was adjusted for feed that would be fed Saturday and Sunday. Calves were weighed on a 28-day interval to adjust supplemental feed. At each seasonal mid-point, pasture samples were analyzed

for ergovaline, a toxin believed to be the main culprit for fescue toxicosis. Average daily gain response was analyzed with a mixed model including ergovaline level as a continuous fixed covariate, enhanced management as a fixed categorical covariate, their interaction, and a random covariate to account for both pasture-by-pasture and seasonal variation in available forage.

Results and Discussion

Interim pasture ergovaline ranged from 90 ppb to 3060 ppb with an average of 1324 ppb. Some Estancia pastures had ergovaline results comparable to the known toxic pastures. The fitted model response is illustrated in Fig. 1 and the prediction equation for the average daily gain response was $\text{daily gain (lb/day)} = 1.3210676 - 0.0003422 \times \text{ergovaline} + 0.7991320$ (when enhanced management is used) $+ 0.0002995 \times \text{ergovaline}$ (when enhanced management is used). Enhanced management improved overall weight gain by 0.8 lb/day and reduced the fescue toxicity impact on weight gain by 0.04 lb/day for every 1000 ppb increase in ergovaline level. At low toxicity (500 ppb), the predicted increase in weight gain from enhanced management was 0.95 lb/day; whereas, at high toxicity (2000 ppb), the predicted increase was 1.4 lb/day. Using a 500 lb steer calf value of \$1.57/lb, a price slide of \$0.12/cwt, and cumulative input costs of \$2 for the implant, \$2 for the ionophore, and \$43 for supplement over a 90-day period, the added return to enhanced management was estimated at \$18/steer at low toxicity and \$63/steer at high toxicity.

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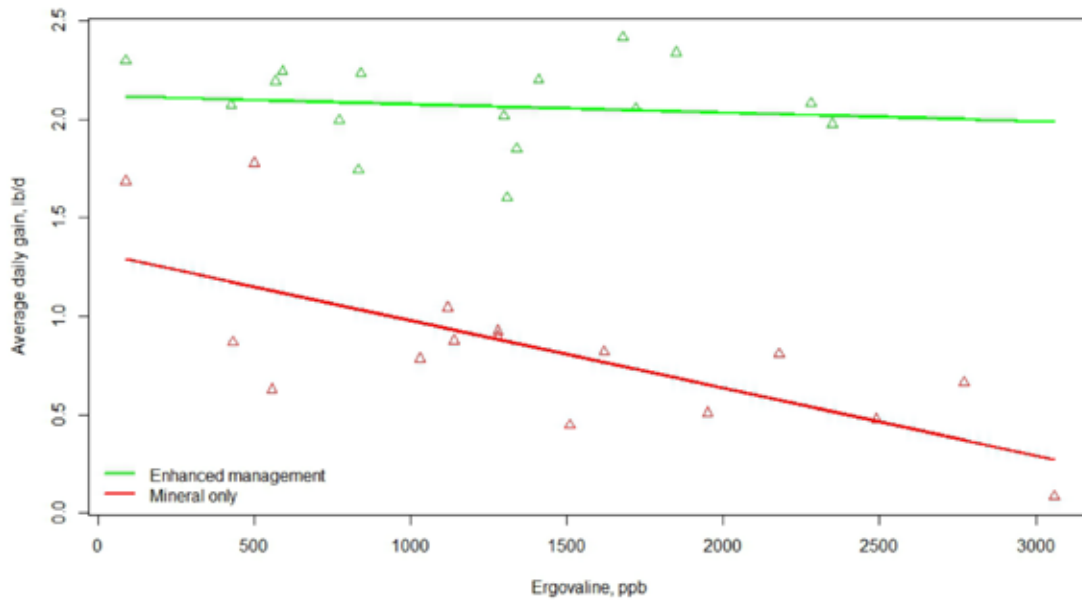


Fig. 1. Average daily gain response of steers to enhanced management (Component TE-G implant, 150 mg/day Rumensin, and 1% body weight supplementation 50:50 corn gluten feed:soybean hull pellets) grazing pastures of varying levels of toxicity potential.

Effects of pre- and postpartum mineral supplementation on primiparous beef heifer reproductive performance

Jamie Hawley¹, Beth Kegley¹, and Jeremy Powell¹

Research Highlights

- Results suggest pre- and postpartum mineral supplementation may influence primiparous beef heifer reproductive performance.
- Reproductive tract scores and synchronized conception rate tended to be greater for heifers supplemented copper.

Introduction

Co-products from ethanol production have become a prevalent cost-effective alternative for coping with high prices for feedstuffs such as corn. As a result, these co-products have become more widespread in cow-calf operations as a feed source. Sulfuric acid used during ethanol production to optimize fermentation and distillation conditions has had the unintended consequence of contributing to elevated sulfur (S) concentrations in co-products. Copper (Cu) status in cattle is susceptible to a number of antagonists, including S, to potentially result in poor reproduction. Accordingly, the effects of excess dietary S on pre- and postpartum nutritional management and subsequent reproduction have gained interest because dietary S concentrations have increased as the consumption of co-products has increased. The influence of pre- and postpartum S supplementation on subsequent reproductive performance has not been widely investigated, and it is plausible that greater dietary S would decrease beef heifer reproductive performance due to a reduction in Cu absorption and utilization. Therefore, the objective of this study was to evaluate the influence of pre- and postpartum dietary Cu and S supplementation on beef heifer reproductive performance.

Materials and Methods

Thirty-six primiparous beef heifers (20 ± 0.5 months of age) of predominantly Angus breeding were stratified by body weight (876 ± 54.8 lb), body condition score, and anticipated calving date and assigned to 12 pens for a 260-day study. Pens were assigned randomly to 1 of 4 treatments: 1) 0.15% S and 3 mg Cu/lb; 2) 0.15% S and 5 to 6 mg Cu/lb (3 to 4 mg from tribasic Cu chloride); 3) 0.55% S (from sodium sulfate) and 3 mg Cu/lb; or 4) 0.55% S (from sodium sulfate) and 5 to 6 mg Cu/lb (3 to 4 mg from tribasic Cu chloride). A cracked corn and soybean meal-based supplement delivered each treatment starting at 170 ± 16 days of gestation through 150 ± 16 days in lactation. Heifers grazed mixed-grass pasture and were provided access to predominantly fescue hay in quantities to ensure ad libitum intake. A 7-day controlled internal drug release-prostaglandin F₂ alpha protocol synchronized estrus beginning 75 ± 17 days postpartum. Estrus was detected using behavioral observations and heat detection patches, and heifers were inseminated 3 to 12 hours after the first observation of standing heat. Reproductive-tract scores and pregnancy were determined using transrectal ultrasonography.

Results and Discussion

Synchronized estrus response was not influenced by mineral supplementation. However, reproductive tract scores and synchronized conception rates tended to be greater for heifers supplemented with Cu, whereas reproductive tract scores and synchronized conception rates tended to be lower for heifers supplemented with S (see Table 1). Trace minerals most likely to influence ruminant reproduction include Cu, cobalt, iodine, selenium, zinc, and manganese. Responses in reproduction to Cu, zinc, and manganese supplementation in ruminants have been variable, and the simultaneous supplementation of several trace minerals has made interpretation of the results difficult. Yet, the beneficial reproductive performance observed in the current study, when Cu supplementation was provided, suggests trace minerals positively impact reproductive performance.

The negative reproductive performance observed in the current study when S was supplemented suggests S decreased reproductive performance due to a reduction in Cu absorption and utilization. Sulfur, in the form of sulfide, is believed to reduce Cu absorption and utilization through the formation of insoluble, unabsorbed Cu sulfide in the rumen. Delayed onset of puberty, repeat breeding, decreased conception rate, anestrus, pregnancy loss, and increased chances of retained placenta are reported to be some of the important clinical signs exhibited by animals experiencing Cu deficiency. The effect of Cu deficiency can range from a very limited effect to a very noticeable decrease in first-service conception and overall pregnancy rates. The role of Cu deficiency in reproduction has not been identified; however, Cu is essential for many enzymes and it has been suggested that reproduction is hampered due to delayed or depressed estrus associated with Cu deficiency-induced anemia.

Acknowledgements

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Table 1. Effect of pre- and postpartum mineral supplementation on primiparous beef heifer reproductive performance.

Item	Treatment ^a			
	LoSLoCu	LoSHiCu	HiSLoCu	HiSHiCu
Reproductive tract score, ^b No. (%)				
2	0 (0.0)	0 (0.0)	1 (14.3)	0 (0.0)
3	3 (50.0)	0 (0.0)	2 (28.6)	1 (11.1)
4	0 (0.0)	2 (25.0)	0 (0.0)	1 (11.1)
5	3 (50.0)	6 (75.0)	4 (57.1)	7 (77.8)
Corpus luteum development, proportion (%)	3/6 (50.0)	6/8 (75.0)	4/7 (57.1)	7/9 (77.8)
Synchronized estrus response, ^c proportion (%)				
First synchronized period	3/6 (50.0)	5/8 (62.5)	2/7 (28.6)	5/9 (55.6)
Second synchronized period ^d	0/3 (0.0)	4/5 (80.0)	2/5 (40.0)	3/6 (50.0)
Third synchronized period ^e	1/3 (33.3)	0/1 (0.0)	1/3 (33.3)	1/4 (25.0)
Synchronized conception rate, ^f proportion (%)	0/6 (0.0)	4/8 (50.0)	2/7 (28.6)	3/9 (33.3)

^a S = sulfur; Cu = copper. LoSLoCu = 0.15% S and 3 mg Cu/lb; LoSHiCu = 0.15% S and 5 to 6 mg Cu/lb; HiSLoCu = 0.55% S and 3 mg Cu/lb; HiSHiCu = 0.55% S and 5 to 6 mg Cu/lb.

^b 1 = no palpable follicles, no tone; 5 ≥ 0.39 inch follicles, good tone, erect corpus luteum present. Reproductive-tract scores assigned 7 days before estrus synchronization.

^c Controlled internal drug release (CIDR)-prostaglandin F_{2α} (PGF_{2α}) 7 day synchronization.

^d Those failing to respond to first CIDR-PGF_{2α} protocol synchronized 10 to 13 days later.

^e Those failing to respond to second CIDR-PGF_{2α} protocol synchronized 10 to 13 days later.

^f Those that became pregnant of those exhibiting estrus and inseminated during synchronization.

Effects of dam age on growth performance and carcass measurements of crossbred steers

Famous Yang¹, Fred Pohlman¹, Jeremy Powell¹, Karen Anschutz¹, Elizabeth Backes¹, John Richeson², James Hornsby¹, Jana Reynolds¹, and Bill Lindsey¹

Research Highlights

- Dam age affected preweaning performance of crossbred male calves.
- Carcass traits and measurements were not affected by dam age.

Introduction

Past research has reported that the most productive cows in a cow herd are approximately 6 years old or older. A recent study reported that dam age affected pre-weaning performance of crossbred male calves, but had minimal effect on carcass traits when steers were finished to a common compositional endpoint over three years. The purpose of this study was to evaluate the effect of dam age on Angus crossbred steer performance and carcass quality measurements over a four-year period.

Materials and Methods

A total of 248 fall-calving, mixed-aged Angus and Angus-crossbred cows bred to Angus or Hereford sires were utilized to determine the effects of dam age on offspring performance and carcass traits. Dams were allocated into 1 of 4 age groups based on age at the time of calving: 1) ≤ 3 years old (Age 3), 2) 4 to 6 years old (Age 4-6), 3) 7 to 10 years old (Age 7-10), and 4) > 11 years (Age 11+). Cattle were housed at the University of Arkansas System Division of Agriculture's beef research unit in Fayetteville with access to pastures. Calves were processed at birth and weaned in May. Dam age was not included in adjusted weaning weight because the effect of dam age was tested. Heifers were retained and for two months after weaning, steers grazed at the farm then transported to the West Texas A&M

research feedlot, located in Canyon, Texas and remained there until harvest. Finished steers were transported to a meat processing plant in Friona, Texas when they reached a minimum 1/2 inch backfat thickness, harvested, and carcass data collected.

Results and Discussion

Table 1 shows the effects of dam age on male calf performance and carcass measurements. Calves born to cows in group Age 11+ had greater birth weight compared with the rest of the groups and Age 3 and Age 4-7 calves had the lowest birth weight. Calves from Age 7-10 had greater adjusted weaning weight than Age 4-6.

Steer carcass measurements (hot carcass weight, ribeye area, yield grade, backfat thickness, percent kidney, pelvic and heart fat, and marbling) were not different regardless of cow age group. The percentage of steers grading choice, select, or prime did not differ between age groups. As previous research suggested, a possible reason for these measurements being similar between treatments is because steers were fed to a common endpoint degree of finish (1/2 inch backfat).

Acknowledgements

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Table 1. Performance and carcass measurements in crossbred steers whose dams differed in age.

Item	Dam age (years) [†]				SEM [‡]	P-value
	Age 3	Age 4-6	Age 7-10	Age 11+		
n	23	92	97	36		
Birth weight, lb	71 ^{c§}	73 ^c	78 ^b	82 ^a	2.81	<0.01
Adjusted weaning wt, lb	423 ^{ab}	421 ^b	453 ^a	432 ^{ab}	10.6	<0.01
HCW, lb [¶]	819	817	822	818	16.8	0.96
REA, in ^{2#}	13.9	13.3	13.3	13.0	0.28	0.17
Yield grade	3.4	3.4	3.4	3.4	0.25	0.98
Backfat thickness, in	0.73	0.70	0.68	0.68	0.05	0.63
KPH, (%) ⁺⁺	3.4	3.0	3.0	3.1	0.70	0.67
Marbling	466	469	456	453	24.6	0.67
Select, n, (%) ^{4**}	4 (18%)	20 (22%)	25 (26%)	9 (25%)	-	-
Choice, n, (%) ^{**}	18 (82%)	68 (75%)	70 (72%)	27 (75%)	-	-
Prime, n, (%) ^{**}	0 (0%)	3 (3%)	2 (2%)	0 (0%)	-	-

[†] Age 3 = dam age ≤ 3 years old; Age 4-6 = dam age between 4 to 6 years old; Age 7-10 = dam age between 7 to 10 years old; Age 11+ = dam age > 11 years old.

[‡] SEM = pooled standard error of the mean.

[§] Means within a row without a common letter differ.

[¶] HCW = hot carcass weight.

[#] REA = ribeye area.

⁺⁺ KPH = kidney, pelvic, heart fat %.

^{**} Percentage of Select, Choice, and Prime did not differ between age groups.

Pathogen Transmission by Food Workers

Rebekah Cathey¹, Fred Pohlman², Steve C. Seideman³, and Casey Owens Hanning⁴

Research Highlights

- As the number of meals consumed from a restaurant increase, so does the importance of food safety.
- Not one technique eliminates pathogen transmission completely. However, the use of multiple techniques has proven effective in preventing pathogen transmission to food.

Introduction

As the number of meals consumed from a restaurant increase, so does the importance of food safety. Each year in the United States nearly 14 people die per day from foodborne disease. For well over a century, a proper handwash has been attributed to be the most essential aspect of pathogen prevention.

Continually restaurants fail at preventing bare hand contact with ready-to-eat foods. Even more concerning, during observations, food handlers are also not practicing a proper handwash or a proper handwash is not occurring often enough. There is need for a better understanding of the transmission of pathogens and transmission without proper barriers within the retail food establishments.

The ultimate goal of food safety research is to develop a formalized system to prevent and eliminate pathogen transmission in retail establishments. Therefore, the objective of the study was to determine the most adequate and beneficial method for preventing transmission of pathogens by food workers in retail food establishments. Equally as important, food workers need to understand the importance of their role and the risk they pose when not properly following retail establishment protocols.

Materials and Methods

Noroviruses continue to be the most prevalent foodborne illness throughout the United States. *Norovirus* can be transmitted by hands, food, objects or equipment, aerosols, and water. *Norovirus* shedding can exist for weeks after onset of symptoms. Noroviruses can be shed for up to three weeks. Often individuals shedding *norovirus* do not have any symptoms. Typically, a symptomatic employee is excluded from food handling for 48 hours whereas asymptomatic employees are excluded for 24 hours. These would be employees that were ill but have not shown symptoms of illness for 24 hours.

Many other pathogens are commonly transmitted by food service workers including, *hepatitis A virus*, *Salmonella*, *Shigella* and *Staphylococcus aureus*. Other pathogens can still be implicated in food handler associated outbreaks. Although food handlers know they are required to be excluded many times, they still choose to report to work. Reasons for reporting sick commonly include fear of losing one's job, lack of sick leave, or being short staffed. It needs to be a priority in the food industry to remove the motivation of ill

food handlers from reporting to work. Many times the foodborne outbreaks are due to infection of the food handler followed closely by bare hand contact with ready-to-eat food by the ill food worker.

Results and Discussion

This study sought to gain insights into glove usage in comparison to bare hand contact with ready-to-eat food within retail food establishments. Comparisons were made throughout the United States. In an effort to improve safety within retail food establishments, federal and state data were evaluated to determine incidence of foodborne illness. Further, federal and state food handling regulations were evaluated and compared with incidence reporting.

Centers for Disease Control and Prevention (CDC) define a foodborne disease outbreak, "as the occurrence of two or more similar illnesses resulting from ingestion of a common food." A total of 1527 foodborne outbreaks were reported during 2009-2010 in the United States, including 29,444 cases, 1184 hospitalizations, and 23 deaths. Noroviruses continue to be the most prevalent foodborne illness throughout the United States. *Norovirus* was reported for 42% of the outbreaks with *Salmonella* closely following with 30% of the outbreaks in the 2009-2010.

As the number of meals consumed from a restaurant increase, so does the importance of food safety. Each year in the United States nearly 14 people die per day from foodborne disease. A proper hand wash has been identified as the most essential aspect in prevention of microbial infections for well over a century.

Data indicate that 2.3%, 5.8%, 17.1% and 37.5% of food workers with repeated episodes of vomiting, repeated episodes of diarrhea, sore throat and fever, and frequent coughs, respectively were very likely to report to work. Due to the transmissible nature of illnesses, this can have potential to transmit illnesses from workers, through food, to those consuming the food.

In an effort to prevent pathogen transmission, the food industry has taken a multifaceted approach. Food service workers are excluded from the food establishment if experiencing certain symptoms and/or if certain illnesses have been diagnosed in one's household.

Bare hand contact with ready-to-eat food has been prohibited unless the establishment applies for a variance. Institutionalized establishments are not eligible to apply for a variance due to the highly susceptible population served. Barrier devices are required

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to be utilized. Barrier devices include gloves, tongs, deli tissue and utensils.

Food safety training and education is not replaceable in food establishments. Once employees are hired, appear healthy for work and are given equipment, they must receive training on rules for reporting to work and how to use the equipment they are expected to utilize. Not one technique eliminates pathogen transmission

completely. However, the use of multiple techniques has proven effective in preventing pathogen transmission to food.

Acknowledgements

Support provided by the University of Arkansas System Division of Agriculture.

Detection of ergot alkaloids in cattle serum via P450-Glo assay

Xiaolong Ma¹, Palika Dias-Morse¹, and Charles Rosenkrans, Jr.¹

Research Highlights

- Use of alkaloid detection methods in routine livestock management practices may provide a tool for early diagnosis of ergot alkaloid poisoning and avoid economically significant problems.
- P450 Glo™ assay with cytochrome (CYP) substrate isopropyl acetyl (IPA) is more sensitive substrate than pro-luciferin (PPXE) in assessing the inhibitory effects of ergotamine in cattle serum on CYP activity.
- Pro Glo™ assay with IPA substrate detected CYP inhibition in an ergotamine (ET) concentration dependent manner.

Introduction

Consumption of tall fescue grass, contaminated with ergot alkaloid toxins, can cause significant problems with well-being and performance of livestock. Those health and productivity issues result in a one billion dollar annual loss in livestock production. Development of analytical methods for the detection of alkaloids in bodily fluids may provide tools for producers. Such tools can be used for early diagnosis of ergot alkaloid poisoning, as a marker for selecting replacement animals, or as an indicator of the effectiveness of nutraceuticals and pharmaceuticals. Cytochrome (CYP) enzymes are highly linked to alkaloid metabolism, and cytochrome P450 enzyme activity is inhibited by alkaloids. The P450-Glo™ assay provides a luminescent method to measure cytochrome activity and the effect of chemicals on CYP activity. Previously, we demonstrated that the P450-Glo™ assay was capable of detecting alkaloids in steer urine. Our objective for this project was to determine if the P450-Glo™ assay could detect ergotamine (ET) in cattle serum, and to compare sensitivity of P450 substrates to different ET concentrations in cattle serum.

Material and Methods

Frozen cattle serum was thawed and mixed with commercially available ET (Sigma Chemical Co. St. Louis, Mo.). Stock solution of ET (1 mg ET/1 mL 100% methanol) was serially diluted with serum to assay concentrations of 10, 1, 0.1, 0.01, and 0 mg ET/mL. Serum (12.5 µl) were analyzed in triplicate wells of a 96-well plate. Following the manufacturer's instructions, assays (Promega™, Madison, Wis.) with either pro-luciferin (PPXE) or isopropyl acetyl (IPA) substrates were run separately. The luminescence produced by the activity of cytochrome P450 3A4 was recorded using a luminometer (Perkin

Elmer 1420 Victor 3 V). The CYP450 inhibition for each ergotamine concentration was calculated as a percent activity of the control

$$\frac{\text{net luminescence at 0 alkaloid concentration} - \text{luminescence at given concentration}}{\text{net luminescence at 0 alkaloid concentration}}$$

Data were analyzed using the GLM procedure of SAS (SAS Institute, Inc., Cary, N.C.) with a 2 × 5 factorial treatment structure (two CYP substrates and five ET concentrations).

Results and Discussion

In this assay, CYP enzymes catalyze oxidation of proluciferin to produce luciferin that generates light with the luciferin detection reagent. Therefore, luminance produced in P450-Glo assay directly represents the CYP activity. Our results indicated that activity of CYP enzyme was affected by an interaction between pro-luciferins and ergotamine concentration levels (Fig. 1). Assay containing luciferin IPA substrate showed a clear concentration-dependent CYP inhibition compared to luciferin PPXE substrate at different ergotamine concentrations in serum. This difference can be attributed to the electric characteristics of substrate molecules which play an important role in the site of oxidation in P450 catalyzed reactions. Our findings are in agreement with our previous work with steer urine and suggest that with little modification, the P450-Glo assay has potential as a tool for screening alkaloids in cattle serum.

Acknowledgements

This experiment was conducted with support from the University of Arkansas System Division of Agriculture.

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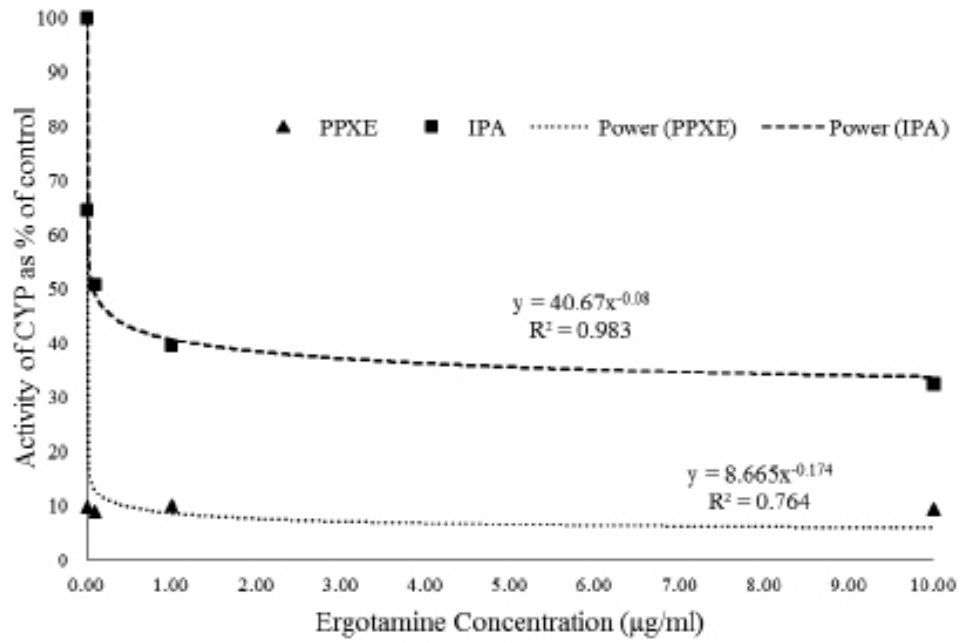


Fig. 1. Inhibition of CYP3A4 reaction in P450-Glo™ luminescent assay with substrates proluciferin PPXE and isopropyl acetyl (IPA) at different ergotamine concentrations.

Teff, pearl millet, and sorghum-sudangrass yields in Northwest Arkansas

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Research Highlights

- Teff yields are relatively small compared with pearl millet and sorghum-sudangrass.
- Pearl millet and sorghum-sudangrasses are still very good choices for summer annual forages.

Introduction

Summer annual forages are popular in Arkansas as they provide a crop for grazing or haying during the hot months of the year when cool season forages only grow in a very limited fashion or lay dormant.

Teff has been on the market for some time but has never been grown extensively in Arkansas. This warm-season grass originated from northern Africa where it is grown as a grain crop, but varieties available in the U.S. are all forage types. Labeled as suitable primarily as hay, we intended to compare yields of this grass with pearl millet and sorghum-sudangrass—two longstanding popular choices of Arkansas producers.

Materials and Methods

'Moxie' Teff, 'Tifleaf 3' pearl millet, and 'Green Graze Supreme' sorghum-sudangrass were planted in an experimental setup in the summer of 2013 at the University of Arkansas System Division of Agriculture's Watershed Research and Education Center in Fayetteville. Seeding rates for these grasses were 10 lb/acre for teff, 20 lb/acre for pearl millet, and 30 lb/acre for sorghum-sudangrass. All three forages were planted on June 14, 2013 into a prepared seedbed with a no-till drill and a planting depth of approximately one-quarter inch into plots of 20 × 40 feet in size. Nitrogen was applied at 60 lb/acre according to soil-test recommendations.

We obtained two whole-plot cuttings, one on July 31 and the second on September 5, 2013, with a commercial plot harvester that allowed for accurate yield measurements for each experimental unit. A forage subsample from each plot was taken at each harvest to determine the dry matter concentration. Data were analyzed using a standard statistical program for mean comparisons.

Results and Discussion

Dry matter yields (lb/acre) are presented in Fig. 1. Sorghum-sudangrass yielded about 50% more than pearl millet and more than twice as much as teff, which yielded about half as much dry matter as pearl millet. Teff and pearl millet did regrow relatively quickly in comparison with sorghum-sudangrass as visible in Fig. 1.

Sorghum-sudangrass showed higher yields than the other two forages selected for this trial. Although teff yields were substantially lower than either pearl millet or sorghum-sudangrass, it may have its place in forage systems in Arkansas. We noted that weed encroachment was virtually non-existent after the first cut in teff because the canopy quickly closed again after the first harvest. Weed growth was minor in the other two grasses because the canopies shaded the soil enough so that only little overall weed growth occurred during the time of the experiment.

Teff is very popular among horse owners due to its quality hay, retention of green color in the bale, and no reports so far of high nitrate or prussic acid concentrations. It is difficult to graze teff, however. Up to 25% of the plants may be pulled from the soil during a single grazing cycle (data not shown). Teff is relatively drought tolerant and will start regrowing quickly under sufficiently high rain events, so it may serve as a summer cover crop on marginal sites. Teff is very popular among horse owners due to its good-quality hay, but grazing of teff is not recommended as plants can get dislodged easily. Teff dry matter yields were relatively small compared to pearl millet and sorghum-sudangrass. Therefore, we recommend using either pearl millet or sorghum-sudangrass as all benefit equally from a prepared seedbed. Teff hay is very much appreciated by horse owners, but achieving high-quality teff hay requires the same principles and diligence in hay-making as with other forages.

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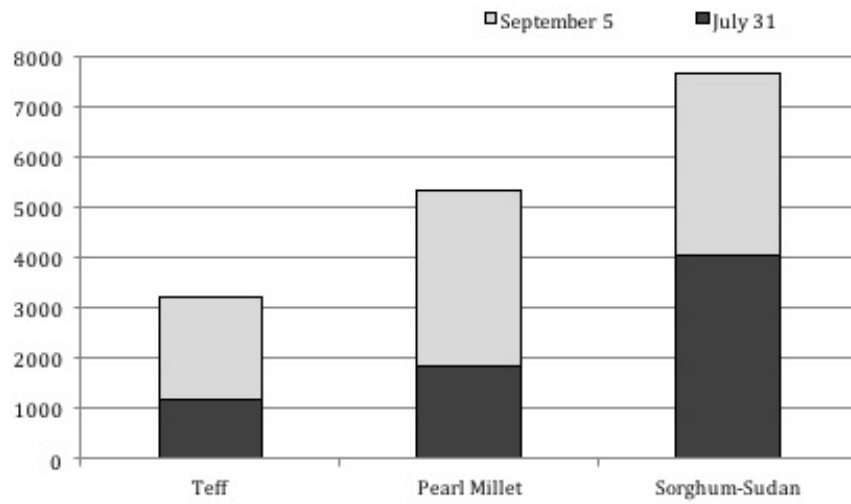


Fig. 1. Combined dry matter yield (lb/acre) of teff, pearl millet, and sorghum sudan from harvests on July 31 and Sep 5, 2013.

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