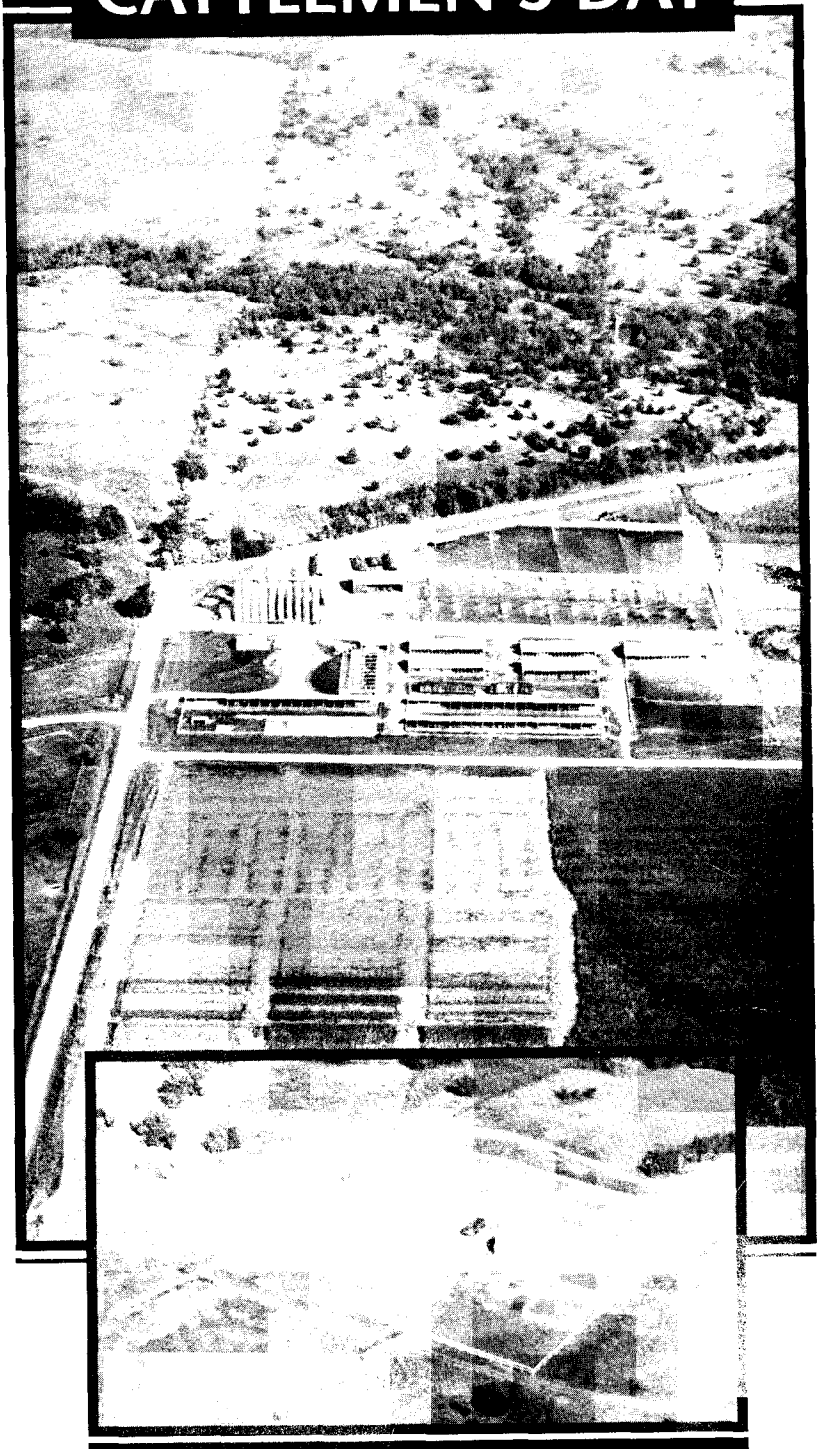
1992 CATTLEMEN'S DAY



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Agricultural Experiment Station
Kansas State University, Manhattan
Walter R. Woods, Director

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Contribution No. 92-407-S from the Kansas Agricultural Experiment Station.

EFFECT OF PHYSICAL FORM AND LEVEL OF ALFALFA IN CORN-BASED DIETS FOR FINISHING STEERS'

R. T. Brandt, Jr. and R. V. Pope

Summary

One hundred-eighty British crossbred steers (760 lb) were used in a 3x2 factorially arranged experiment to evaluate the main effects of alfalfa form (chopped hay, dehydrated pellets, or a 50:50 mixture of hay:dehy) and level (5 or 10% of diet DM) on finishing steer performance. Alfalfa (third-cutting, 23.9% CP) was harvested in alternate rows from a common field. No interactions between alfalfa form and level were detected. Steers fed chopped hay or the 50:50 mixture gained faster ($P < .05$), consumed more feed ($P < .05$), and had heavier final and carcass weights ($P < .05$) than steers fed dehy pellets. Steers fed 10% alfalfa gained faster ($P < .05$), consumed more feed ($P < .0003$), and had heavier carcass weights ($P < .02$) vs those fed 5% alfalfa. Feed efficiency was unaffected by alfalfa form or level. Lower feed intakes and numerically higher incidences of liver abscesses indicated less ruminal tactile stimulation and more subacute acidosis for dehy pellets vs hay or the 50:50 mixture and for 5 vs 10% alfalfa, respectively. Positive associative responses of 5.1% ($P = .07$) on daily gain and 2.9% ($P = .11$) on dry matter intake suggested that the 50:50 mixture provided enough long particles for adequate rumen function at the alfalfa levels studied.

Our results suggests more dehy pellets than chopped hay must be fed to provide similar roughage value.

(Key Words: Alfalfa, Hay, Dehydrated Pellets, Finishing Diets.)

Introduction

Chopped alfalfa hay has a relatively long average particle length. This probably aids rumen function in cattle fed high grain diets, which, in turn, maximizes consumption and lessens the incidence of acidosis and related health problems. However, wind losses during processing, storage, and ration mixing and in the feed bunk can be substantial. Other problems include increased ration and processing dust and storage difficulty. Use of dehydrated alfalfa pellets (dehy) instead of chopped hay would minimize wind losses and dust at the feedlot, increase bulk density to lessen shipping costs, and aid in ease of storage. Reduction in leaf loss from harvesting, processing, and feeding might also result in higher nutritional value for dehy. However, because particle size is smaller, dehy may not provide ruminal tactile stimulation and may result in depression in performance relative to chopped hay. Whether combining chopped hay and dehy, enhances the feeding benefits of each is also unknown. Therefore, our objective was to evaluate the main effects and interaction of alfalfa form (chopped hay, dehy, or 50:50 mixture) and level (5 or 10% of diet DM) on finishing steer performance and carcass traits.

[1]The cooperation of Ray Bert, Sedgwick, KS, who supplied alfalfa used in this study, is gratefully acknowledged.

Experimental Procedures

Third-cutting alfalfa from a common field was harvested in July, 1991, in alternate rows as either hay or dehy. Hay was sun-cured, baled, and stored immediately in a barn. It was then chopped through a tub grinder equipped with a 2 x 3 in rectangular screen, shipped to the Beef Research Unit, Manhattan, and stored in a covered hayshed until fed. Dehydrated alfalfa was wilted to 30-40 % moisture, chopped, ground through a 5/32 in. screen, made into 1/4 in. pellets, shipped, and stored at the Beef Research Unit in a grain bin until fed.

One hundred eighty British crossbred steers (760 lb), selected from a larger group of 247 based on uniformity in weight and breed type, were allotted to one of five weight replicates. Within each replicate, steers were allotted to one of six pens for a 3 **X** 2 factorially arranged experiment. Main effect factors were alfalfa form (chopped hay, dehy, or a 50:50 mixture of chopped hay:dehy) and level (5 or 10% of diet DM). Steers had been processed using standard procedures and adapated to full feed before the trial started. Initial and final weights were the average of two consecutive, early morning weights. Steers were slaughtered at a commercial plant, and carcass data obtained following a 24-h chill. Carcass data were collected on four replicates, because the fifth (light) replicate did not have desired weight or finish when the trial was terminated. The trial was conducted from August 1 - December 9, 1991.

Results and Discussion

There was no interaction between alfalfa form and level for any variables in this study. Therefore, data were pooled across main effects. Steers fed alfalfa as chopped hay or the mixture gained faster ($P < .05$) and consumed more feed ($P < .05$) than steers fed dehy (Table l), suggesting that the roughage value (ability to elicit tactile stimulation) was lower for dehy than for chopped hay. The fact that performance between steers fed chopped hay or the mixture did not differ may indicate some minimal requirement for long or coarse particles. Improvement in liveweight gain resulted in heavier ($P < .05$) carcasses for steers fed chopped hay or the mixture vs dehy. No differences were observed in other carcass or slaughter characteristics, although steers fed dehy or the mixture tended to have a higher incidence of liver abscesses, despite the feeding of tylosin for liver abscess control.

Pooled across alfalfa level, steers fed 10% alfalfa gained 4.8% faster ($P < .05$) and consumed 7% more dry matter ($P < .0003$) than those fed 5% alfalfa. Feed efficiency did not differ, which may indicate that the lower energy content of the 10% alfalfa diet was offset by its higher consumption. Feeding 10% alfalfa resulted in heavier ($P < .02$) carcasses at slaughter. Although not statistically significant, there was a numerical reduction in the incidence of liver abscesses for 10 vs 5% alfalfa.

Associative effects of chopped hay and dehy were evaluated using orthogonal contrasts. An associative effect is one where the observed response for a mixture of components differs from that predicted from the response of the individual components fed separately. Daily gain, feed consumption, and feed efficiency were 5.1, 2.9, and 2.7% higher, respectively, for the 50:50 alfalfa mixture than was predicted from chopped hay and dehy fed separately. The most practical explanation for this result seems to be that the 50:50 mixture provided enough longer particles for rumen function at the alfalfa levels we evaluated. The quality of alfalfa used in this study was extremely high (third cutting; 23.9% crude protein). It is possible that pelleting the lower quality alfalfa typically used in feedlots and(or) increasing pellet size would alter animals' response to pelleted alfalfa in finishing diets.

Table 1. Effect of Alfalfa Physical Form on Performance and Carcass Traits of Steers

Item	Alfalfa form		
	Chopped hay	Dehy	Mixture'
No. pens	10	10	10
No. steers	60	60	60
Initial wt, lb	761	759	761
Final wt, lb[b]	1137	1107	1141
Daily gain, lb	3.07[d]	2.85[e]	3.11[d]
Daily feed, lb DM	21.1[d]	19.9[e]	21.1[d]
Feed/gain"	6.90	6.99	6.76
Carcass traits			
Hot weight, lb	732[d]	720[e]	73a[d]
Dressing pct.	64.0	63.8	64.3
Backfat, in	.52	.51	.53
Marbling	Sm56[de]	Sm32[d]	Sm61[e]
Pct. choice	80	77	79
Liver abscesses, %	14	20	25

[a]50:50 mixture of chopped hay and dehydrated pellets.
[b]Pencil shrunk 4%.
[c]Calculated and analyzed statistically as gain/feed.
[de]Means in a row with different superscripts differ (P < .05).

Table 2. Effect of Alfalfa Level on Performance and Carcass Traits of Steers

Item	Alfalfa level, % of DM		SE	P value*
	5	10		
No. pens	15	15		
No. steers	90	90		
Initial wt, lb	760	760	.5	
Final wt, lb[b]	1119	1137	6	
Daily gain, lb	2.94	3.08	.05	.05
Daily feed, lb DM	20.0	21.4	.23	.0003
Feed/gain'	6.80	6.94	.09	.29
Carcass traits				
Hot weight, lb	723	737	4	.02
Dressing pct.	64.1	64.0	.2	.81
Backfat, in	.50	.54	.02	.29
Marbling	Sm49	Sm50	08	.87
Pct. choice	76	82		.72
Liver abscesses, %	22	16		44

[a]Probability of a treatment difference. Probability values for pct. choice and liver abscesses were generated from Chi-square analyses.
[b]Pencil shrunk 4%.
[c]Calculated and analyzed statistically as gain/feed.

INFLUENCE OF FAT AND MONENSIN LEVELS ON PERFORMANCE OF FINISHING STEERS

R. T. Brandt, Jr. and R. V. Pope

Summary

To evaluate effects and potential interaction of supplemental fat (0 to 4% tallow) and monensin (0, 20, 40 g/ton) in a corn-based finishing diet, 96 Continental crossbred steers (860 lb) were used in a 2 × 3 factorially arranged randomized complete block design. Consumption by steers fed the 0% fat diet decreased linearly ($P < .0001$) with increased monensin level, whereas consumption by steers fed 4% fat diets decreased curvilinearly ($P < .08$), indicating that monensin depressed intake much less when the diet contained fat. Daily gain decreased linearly ($P < .02$) with increased monensin level for steers fed no supplemental fat, but remained constant in steers fed 4% fat. Feed efficiency was improved ($P < .025$) by 4% fat across levels of monensin. This study provides further evidence of interactions between monensin and supplemental fat in effects on animal performance.

(Key Words: Fat, Monensin, Feedlot, Performance.)

Introduction

The potential exists for interactions between ionophores and supplemental fat in affecting ruminal fermentation and performance of finishing cattle. Because both fat and ionophores possess antimicrobial activities, the net effect of including both in finishing diets could be unpredictable. Because ionophores are fat-soluble, they may associate with lipids in ruminal contents and not be evenly dispersed throughout the rumen. Previous research at Kansas State on interactions between supplemental fat and ionophores has led to the hypothesis that supplemental fat might raise the threshold level for ionophore response in finishing diets. Our objective was to measure the effect of increasing ionophore levels in diets with or without supplemental fat.

Experimental Procedures

Ninety-six Continental crossbred steers (860 lb) that had previously been adapted to a high grain diet were selected from a larger group of 125 steers, based on uniformity of weight and breed type. Steers had previously received monensin (20 g/ton), although it was withheld for 7 days before this study was initiated. The steers were allotted to one of four weight replicates and then to one of six pens within each replicate in a 2 × 3 factorial experiment. Main effect factors were supplemental fat level (0 or 4% of diet DM) and level of monensin (0, 180, 360 mg/hd/d). Monensin was incorporated into complete supplements based on projected feed intake reduction with monensin. The final concentrations of monensin in the complete diet (90% DM basis) were 0, 20 and 40 g/ton for the 0, 180 and 360 mg/hd/d treatments, respectively.

Initial and final weights were the average of early morning, full weights on 2 consecutive days. All steers were fed an equal amount (20 lb/hd daily) of the control diet for 5 days before final weights were taken to minimize end point weighing errors resulting from differences in gut fill. The trial was conducted from September 10 to November 25, 1991 (77 days).

Results and Discussion

Results are shown in Table 1. Linear fat × ionophore interactions were observed for DM intake ($P < .02$) and average daily gain ($P = .10$). The nature of the interaction effect on DM intake is shown in Figure 1. In the 0% fat diet, DM intake decreased linearly ($P < .0001$) with increased monensin level. DM consumption by steers fed diets with 4% tallow decreased curvilinearly (linear, $P < .05$; quadratic, $P < .08$) with monensin level. Monensin caused less intake reduction in diets with 4% fat. Because of the interaction on DM intake, daily gain of steers fed no supplemental fat decreased linearly ($P < .02$) with monensin level, whereas monensin level had no effect ($P > .65$) on gains of steers fed diets with 4% supplemental fat (Figure 2). There was a main effect of fat ($P < .025$) on feed efficiency (Figure 3). Inclusion of 20 g/ton monensin in the 0% fat diet resulted in a numerical increase of 2.0% in feed efficiency compared to the control without monensin. The nature of the interaction effect on DM intake was similar to that observed in previous studies, suggesting that monensin may associate with the fat phase of gastrointestinal contents, thereby minimizing the expression of its activity on intake reduction. This effect might be ruminal, metabolic, or both and warrants further investigation. Higher levels (40 g/ton) of monensin decreased DM intake and cattle performance to an economically unjustifiable level in the 0% fat diet. This trial was relatively short (77 days); a longer feeding period might yield different results.

Table 1. Effect of Fat and Monensin Levels on Finishing Steer Performance

	Added fat, % of DM					
Item	----------0----------			----------4----------		
Monensin						
mg/hd/d[a]	0	180	360	0	180	360
g/ton	0	20	40	0	20	40
No. pens	4	4	4	4	4	4
No. steers	16	16	16	16	16	16
Initial wt, lb	862	857	857	861	861	861
Final wt, lb	1137	1113	1077	1122	1139	1117
Daily gain, lb[b]	3.58	3.33	2.85	3.39	3.62	3.33
Daily DM, lb[c]	23.8	21.6	19.7	21.3	21.7	19.8
Feed/gain[d]	6.62	6.49	6.90	6.29	6.06	5.99

[a]Intended level.
[b]Fat × ionophore level interaction. For 0% fat diet, linear effect ($P < .02$) of inophore level.
[c]Fat × ionophore interaction ($P < .02$). For 0 and 4% fat diets, linear ($P < .001$) and curvilinear ($P < .08$) effects of ionophore level, respectively.
[d]Fat effect ($P < .025$).

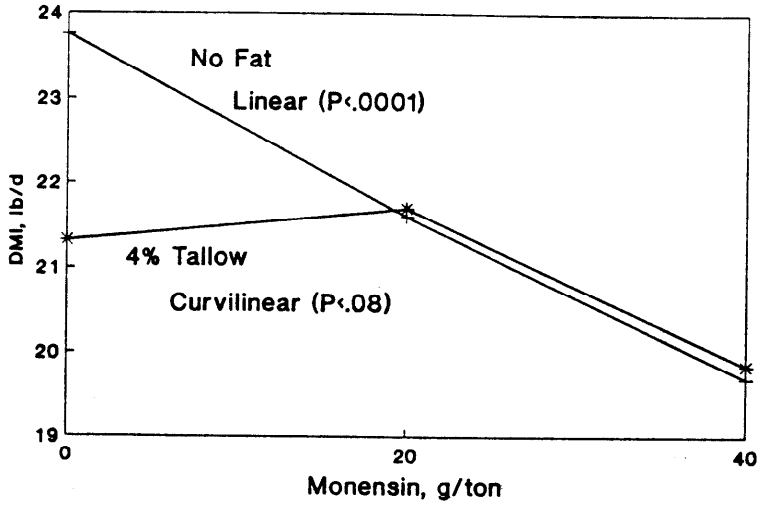

Figure 1. Interaction Effect of Monensin and Fat Levels on Dry Matter Intake.

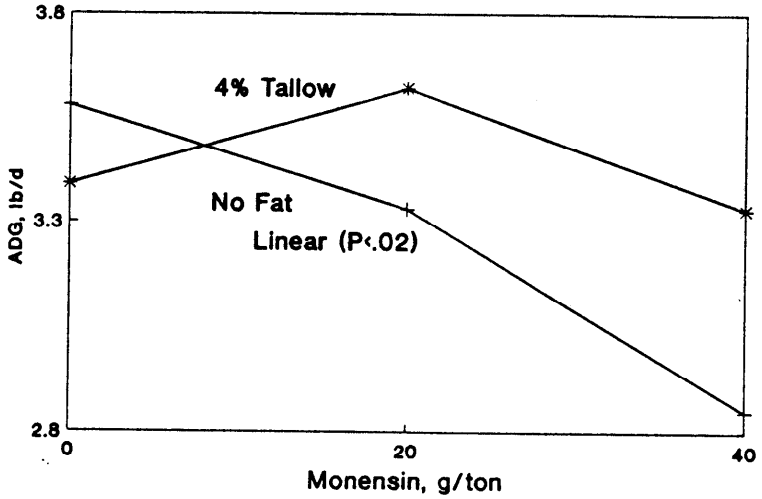

Figure 2. Interaction Effect of Monensin and Fat Levels on Average Daily Gain.

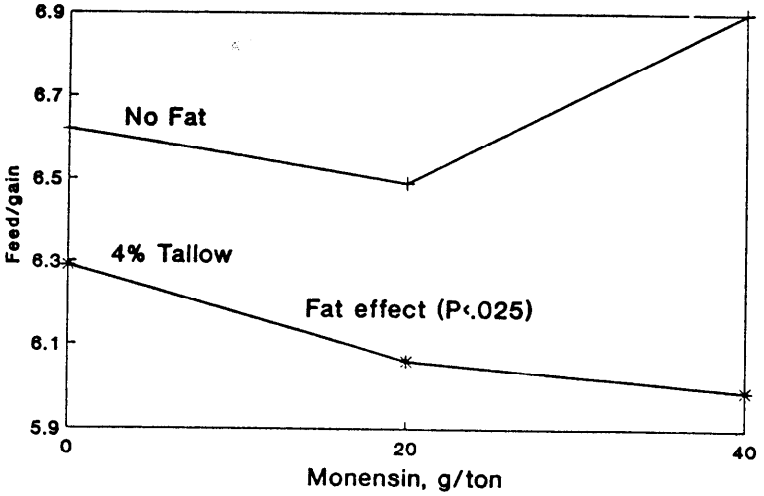

Figure 3. Effect of Monensin and Fat Levels on Feed Efficiency (feed/gain).

EFFECTS OF INTERACTIONS BETWEEN *ASPERGILLUS ORYZAE* EXTRACT (AMAFERM[1]) AND ANTIMICROBIAL COMPOUNDS ON THE GROWTH OF RUMINAL BACTERIA

A. A. Beharka and T. G. Nagaraja

Summary

The effect of Amaferm, with or without antimicrobial compounds, was determined on the growth rate of pure cultures of predominant ruminal bacteria. Adding Amaferm to media containing chlortetracyline or neomycin tended to diminish the negative effects of those compounds on the growth rate of some ruminal bacteria, even when they had shown no positive response to Amaferm alone. However, adding Amaferm to media containing tylosin decreased the growth rate of *Selenomonas ruminantium* D. These results indicate that Amaferm interacts both positively and negatively with certain antimicrobial compounds.

(Key Words: *Aspergillus oryzae* Extract, Rumen Bacteria, Antimicrobial Compounds.)

Introduction

The use of fungal supplements in ruminant diets date back to 1924. However, results of those early studies were inconclusive. Partly because of concerns about antibiotics, interest has been renewed in using microbial products as feed additives in ruminant diets. Microbial feed additives contain either microorganisms (yeasts, molds, or bacteria); their dry products; the medium in which they grew; and/or the residues of their metabolism.

One commercially available product is Amaferm, a fermentation extract of the mold *Aspergillus oryzae*. Amaferm supplementation was shown to increase ruminal microbial activity *in vitro* and *in vivo* as evidenced by increased VFA concentration and bacterial numbers, particularly those of fiber-digesting bacteria. Initial experiments with pure cultures of several predominant rumen bacteria indicated that Amaferm can effect the growth and metabolic activity of some (fiber digesters and lactate-utilizers), but not all, ruminal bacteria. Increased microbial activity may partially explain the reports of increased digestion of dry matter, fiber, and crude protein *in vivo* and *in vitro* with Amaferm supplementation.

Antimicrobial feed additives, such as monensin and tylosin, are widely used to increase cattle performance and reduce disease incidence. Microbial products currently do not fall under the FDA feed additive regulations and therefore, can be fed in combination with any other approved compound. However, data on the combined use of microbial feed additives and antimicrobial compounds are limited. Therefore, our objective was to determine the effect of Amaferm in combination with antimicrobial feed additives on the growth rate of selected pure cultures of ruminal bacteria.

Experimental Procedures

Pure cultures of *Selenomonas ruminantium* D (lactate utilizer), *Megasphaera elsdenii*, (lactate utilizer), and *Ruminococcus albus* (fiber-digester), which had previously demonstrated increased growth rate with the addition of Amaferm, and *Prevotella* (*Bacteroides*) *ruminicola* (fiber-digester), *Bacteroides amylophilus* (starch digester), and *Selenomonas ruminantium* HD4 (lactate utilizer), which had previously not been affected by Amaferm,

[1]Biozyme Enterprises, Inc., St. Joseph, MO 64504

were grown in anaerobic, complete carbohydrate, rumen fluid medium to determine the effect of Amaferm with or without selected antimicrobial compounds. The compounds included monensin, tylosin, monensin + tylosin, bacitricin, neomycin, chlortetracycline, and oxytetracycline. Amaferm was filter-sterilized and included at 5%. The medium was inoculated with late-log-phase cultures, and growth was monitored by measuring absorbance.

Results and Discussion

Adding Amaferm to the medium increased ($P < .1$) the growth of *Selenomonas ruminantium* D (growth rate .71 vs .43/h) (Figure 1), *Megasphaera elsdenii* (growth rate .32 vs .43/h), and *Ruminococcus albus* (growth rate .35 vs .26/h) but had no effect on the other bacteria tested.

Selenomonas ruminantium HD4 and *Megasphaera elsdenii* grew slower ($P < .1$) when neomycin and chlortetracycline were added to the media. Adding of Amaferm to the growth media containing neomycin and chlortetracycline increased ($P < .1$) the growth rate of both strains (Figure 1). However, growth rate never reached that of the control. Surprisingly, although Amaferm addition alone had no effect on the growth rate of *Selenomonas ruminantium* HD4 and *Bacteroides amylophilus*, these bacteria grew faster in the presence of Amaferm and neomycin than with neomycin alone ($P < .1$).

In contrast, when *Selenomonas ruminantium* D was grown in combination with tylosin and Amaferm (Figure 2), the growth rate was slower than when it was grown in tylosin alone (growth rate .69 vs .57/h), indicating a possible negative interaction between the two compounds. The combination of tylosin and Amaferm had no effect on the growth rate of *Selenomonas ruminantium* HD4.

Amaferm diminished the negative effect on bacterial growth associated with some antimicrobial compounds, but appeared to have a negative interaction with tylosin.

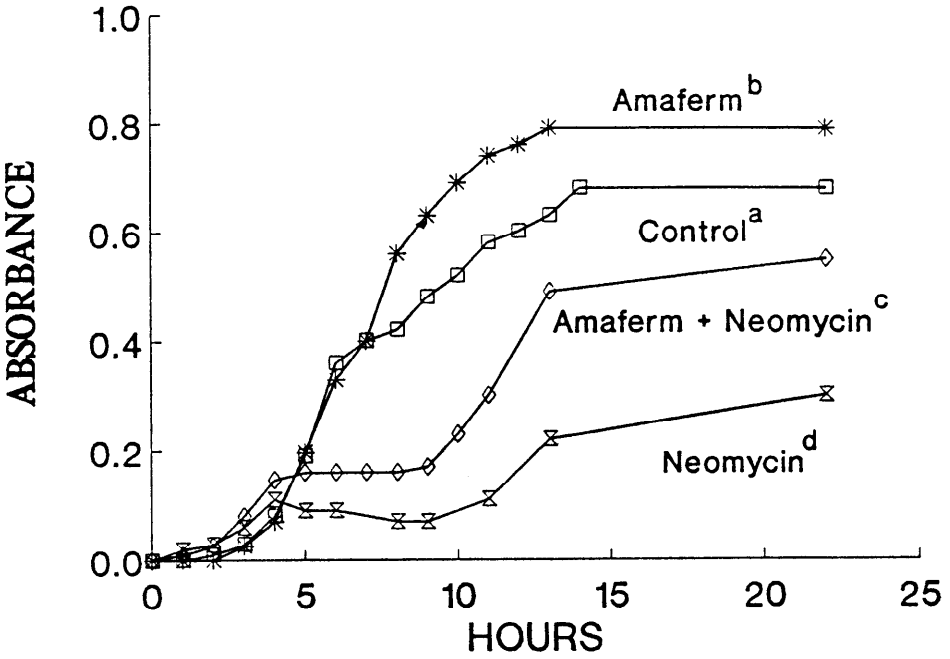

Figure 1. Effect of Amaferm and Neomycin on the Specific Growth Rate of *Selenomonas ruminantium.* Lines with Different Superscripts Differ (P < 1).

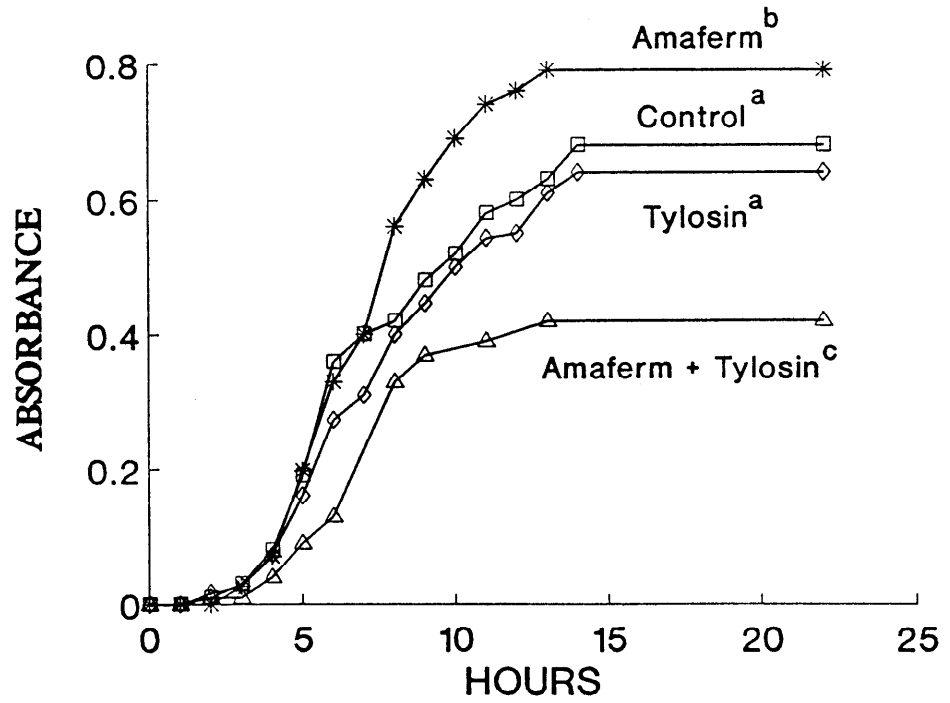

Figure 2. Effect of Amaferm and Tylosin on the Specific Growth Rate of *Selenomonas ruminantium.* Lines with Different Superscripts Differ (P < .1).

EFFECTS OF ESTRADIOL OR AN ESTRADIOL-TRENBOLONE ACETATE REIMPLANT SCHEME AND TIME ON FEED ON PERFORMANCE AND CARCASS TRAITS OF FINISHING STEERS[1]

R. T. Brandt, Jr., M. E. Dikeman, and S. Stroda

Summary

Two hundred eighty-eight predominantly British and British crossbred steers (702 lb) were used in a 2 × 3 factorially arranged experiment. Main effect factors were reimplant scheme [estradiol (E_2) vs estradiol plus trenbolone acetate (E_2 + TBA)] and time on feed (111, 125 or 139 days). The initial slaughter occurred when 65 to 70% of all steers were estimated to grade low Choice. No interactions occurred for any variable measured. Reimplanting 57 days after the initial implant with E_2 + TBA increased overall daily gain 6.9% ($P < .003$) and feed efficiency 4.9% ($P < .005$). Feeding steers for an additional 14 or 28 days resulted in linear decreases in overall daily gain ($P < .005$) and feed efficiency ($P < .0004$). Reimplanting with E_2 + TBA increased ($P < .001$) carcass weight but did not reduce marbling score or percent Choice carcasses. Feeding steers for an additional 14 or 28 days resulted in linear increases ($P < .0001$) in hot carcass weight, ribeye area, adjusted backfat ($P < .004$), and skeletal maturity ($P < .0005$). Additional days on feed increased dressing percentage ($P < .002$) and marbling score ($P < .05$) curvilinearly and tended ($P = .25$) to increase the percentage of carcasses grading Choice and Prime. Incidence of dark cutters was higher ($P < .05$) for E_2 + TBA carcasses, and was very high at the first slaughter date (54 days after reimplantation). Although feeding for an additional 14 or 28 days can result in heavier live and carcass weights, higher dressing percentage, and increased marbling, poor efficiency of gain may create negative feeding margins.

(Key Words: Estradiol, Trenbolone Acetate, Reimplantation, Time on Feed.)

Introduction

The improvement in rate and efficiency of gain in feedlot steers from combined use of estradiol (E_2) and trenbolone acetate (TBA) implants is well documented. It appears that 1) implanting more than once with TBA is not effective and 2) the response to TBA is greater when it's used at reimplant time rather than at the beginning of the feeding period. However, research has shown this may result in an average of 8 to 10% fewer Choice carcasses, particularly if reimplanting with TBA in the form of Finaplix® occurs less than 60 to 70 days before slaughter. The effective payout period of TBA from Finaplix implants is considered to be 60 to 65 days. Because most implant studies have utilized a time-constant slaughter endpoint, whether an additional 14 to 28 days on feed would overcome TBA's observed quality grade reduction, yet maintain a feedlot performance advantage, is largely unknown. Therefore, we evaluated the main effects and potential interaction of reimplant scheme (E_2 vs E_2 + TBA) and additional days on feed (0, 14, or 28) on performance and carcass traits of finishing steers.

[1]The cooperation of Bill Haw, Kansas City, MO, who supplied cattle used in this study, is gratefully acknowledged.

Experimental Procedures

Three hundred eighty-eight predominantly British and British crossbred steers that had been pastured together in an early-intensive stocking program on Flint Hills range were delivered to the KSU Beef Research Unit on July 17, 1991. Steers were individually weighed; ear-tagged; dewormed (Ivomec®); and vaccinated against IBR, PI_3, BVD (modified live vaccine), and seven clostridial organisms. Steers were adapted to a high grain finishing diet over 14 days by stepwise increases in concentrate and reductions in roughage. The final diet, based on rolled corn and sorghum silage (10% of DM), was formulated to contain (DM basis) 12% CP, .70% Ca, .35% P, .36% salt, .70% K, 75 ppm Zn, 1,800 IU Vitamin A/lb, and 27.7 plus 11 g/ton of Rumensin® plus Tylan®, respectively.

Following the step-up period, individual, early morning weights were obtained on 2 consecutive days. Steers were selected on weight and breed type uniformity, implanted with E_2 (Synovex-S®; 20 mg estradiol benzoate plus 200 mg progesterone), and allotted to one of four weight replicates. Within each replicate, steers were randomly allotted to one of six pens, with the exception that Angus and Angus-crossed cattle were stratified equally across pens. Each pen was randomly assigned to one of six treatments in a 2×3 factorially arranged experiment. Main effect factors were reimplant type (E_2 or E_2 + TBA) and additional time on feed (0, 14, or 28 days). Trenbolone acetate was supplied in the form of Finaplix-S (140 mg TBA). The initial slaughter was when 65 to 70% of all steers in the study were estimated to grade Choice, based on projected performance and visual appraisal. Thus, slaughter dates were 54, 68, and 82 days following reimplantation. Final weights were the average of early morning weights on 2 consecutive days. Weighing, shipping, and slaughter procedures were identical for each slaughter group. Carcass measurements were made following a 24-hour chill.

Results and Discussion

There was no effect of interaction between reimplant scheme and time on feed on any performance or carcass variables. Therefore, results are presented for main effects of reimplant scheme and additional days on feed. There was no difference in steers' performance during the initial implant period (Table 1), indicating that all groups responded similarly to the initial E_2 implant. However, use of E_2 + TBA vs E_2 alone increased ($P < .0001$) daily gain 13.9% and feed efficiency 10.8% during the reimplant period, which resulted in an additional 28 lb ($P < .003$) of final live weight for the E_2 + TBA steers. The large differences observed in the reimplant period resulted in improvements of 6.9% ($P < .003$) in daily gain and 4.9% ($P < .005$) in feed efficiency over the entire feeding period for steers reimplanted with E_2 + TBA. The magnitude of these performance responses are similar to other published research results. There was no effect of reimplant scheme on performance of steers fed for an additional 14 or 28 days (68 or 82 days after reimplanting). Because the proposed payout time of TBA in Finaplix-S is 60 to 65 days, that was not a surprise.

Reimplanting with E_2 + TBA vs E_2 alone resulted in heavier ($P < .001$) carcass weights (Table 1). Ribeye area was only slightly larger, but adjusted fat thickness was .04 in. greater ($P < .03$) for E_2 + TBA steers. Ratios of fat to lean, expressed as either depth or area of subcutaneous fat to ribeye area, did not differ. These results, which indirectly suggest proportionality in composition of gain, agree with previously reported carcass chemical composition work with E_2 + TBA (Huck et al., 1991 Cattlemen's Day Report). It may be that implants in general, and E_2 + TBA in particular, enhance rate and efficiency of growth by extending the physiological growth curve (same composition at a heavier weight), rather than by any "nutrient partitioning" activity that favors lean tissue deposition at the expense of fat deposition.

Although feeding for an additional 14 or 28 days beyond a 65 to 70% Choice endpoint resulted in a linear increase ($P < .0001$) in final liveweight (Table 2), performance during the extra periods was expectedly low. As fed cattle approach finish weight, composition of gain changes to an increased proportion of fat deposition, resulting in poorer feed conversion. Analysis of data for the entire feeding period revealed linear reductions in daily gain ($P < .005$) and feed efficiency ($P < .0004$) with days on feed. Using a ration cost of $95/ton (as fed) and non-feed costs (interest, yardage, etc) of $.35/hd daily, the cost of gain was $.487, .507, and .522 per lb for steers fed for 111, 125 and 139 days, respectively. The added gain realized from feeding for an additional 14 or 28 days cost $77.03 or $74.62 per cwt, respectively, to produce. These results emphasize the fact that carrying cattle beyond normal finish weight can result in negative feeding margins, which reduce profitability or increase losses.

Feeding for an additional 14 or 28 days resulted in linear increases in hot carcass weight, ribeye area (all $P < .001$), adjusted backfat thickness ($P < .004$), and skeletal maturity ($P < .0005$). Dressing percentage ($P < .002$) and marbling score ($P < .05$) increased curvilinearly with additional days fed. The lower average marbling score for steers fed for an additional 28 vs 14 days may be partially explained by the fact that carcasses from that slaughter date apparently were not as well chilled as those from the two previous dates. Standard deviations for marbling score were 60, 69, and 66 degrees for steers fed for 111, 125, and 139 days, respectively, suggesting that variation within a slaughter group was relatively constant, and that the statistical distribution of marbling level was not affected by feeding for 14 or 28 additional days.

Chi-square statistics were used to evaluate the frequency of Choice grading and dark-cutting carcasses as affected by reimplant scheme and additional days on feed (Table 3). Additional days on feed tended ($P = .25$) to increase percentage Choice in this study, whereas reimplant scheme had no effect. Steers implanted with E_2 + TBA had a higher ($P < .05$) incidence of dark cutting carcasses, which was particularly pronounced in the first slaughter group (54 days after reimplanting). Pooled across reimplant scheme, the overall incidence was higher ($P < .03$) in the initial slaughter group than in subsequent slaughter groups. There were no differences in weighing, shipping, or slaughter procedures nor any discernible changes in environment between slaughter dates to account for these differences.

Table 1. Effect of Reimplant Scheme on Finishing Performance and Carcass Traits

Item	Reimplant Scheme E_2	E_2 + TBA	SE	P > F
No. pens	12	12		
No. steers	144	144		
Initial wt, lb[a]	702	702	.5	.82
Final wt, lb[a]	1111	1139	6	.003
Avg. days fed[b]	125	125		
Initial implant period (0-57d)				
Daily gain, lb	3.97	4.03	.06	.55
Daily feed, lb DM	20.0	20.4	.2	.18
Feed/gain[c]	5.03	5.05	.05	.69
Reimplant period (58-125d)				
Daily gain, lb	2.74	3.12	.05	.0001
Daily feed, lb DM	22.1	22.5	.2	.19
Feed/gain[c]	8.06	7.19	.09	.0001
Entire period (0-125d)				
Daily gain, lb	3.31	3.54	.05	.003
Daily feed, lb DM	21.1	21.5	.2	.17
Feed/gain[c]	6.37	6.06	.08	.005
Additional 14 or 28d				
Daily gain, lb	2.22	2.13	.20	.86
Daily feed, lb DM	20.9	21.1	.45	.77
Feed/gain[c]	9.52	9.90	.68	.77
Carcass traits				
Hot carcass wt, lb	707	723	3	.001
Dressing percent	63.6	63.4	.1	.25
Ribeye area, $in.^2$	12.9	13.0	.1	.38
Adjusted backfat, in.	.50	.54	.01	.03
Fat:lean ratio:[d]				
Method 1	.32	.33	.01	.16
Method 2	.040	.042	.001	.20
KPH fat, %	2.40	2.47	.05	.30
Yield grade	2.80	2.92	.06	.13
Marbling score[e]	5.22	5.24	.05	.77
Skeletal maturity	A^{49}	A^{50}	^{01}	.27

[a]Weights pencil shrunk 4%.
[b]Data pooled across slaughter dates; excludes 14-day pretrial step-up period.
[c]Calculated and analyzed statistically as gain/feed.
[d]Method 1 = Area of subcutaneous fat over ribeye ÷ ribeye area, Method 2 = Adjusted backfat thickness ÷ ribeye area.
[e]Marbling score: Sl^{50} = 4.5, Sm^{0} = 5.0; Sm^{50} = 5.5, etc.

Table 2. Effect of Additional Days on Feed on Finishing Performance and Carcass Traits

Item	Additional days fed, n			SE	P > F[a]	
	0	14	28		L	Q
No. pens	8	8	8			
No. steers	96	96	96			
Initial wt, lb[b]	701	702	703	.6	.10	.33
111-day wt, lb[b]	1093	1094	1094	6	.79	.86
Final wt, lb[b]	1093	1124	1158	7	.0001	.83
0-111 d						
Daily gain, lb	3.56	3.57	3.56	.05	.97	.88
Daily feed, lb DM	21.3	21.4	21.5	.2	.47	.88
Feed/gain[c]	5.98	5.98	6.03	.06	.61	.72
Additional 14 or 28 d						
Daily gain, lb	--	2.07	2.28	.20		
Daily feed, lb DM	--	20.6	21.4	.5		
Feed/gain[c]	--	10.07	9.33	.62		
Entire period						
Total days fed, n[d]	111	125	139			
Daily gain, lb	3.56	3.40	3.30	.05	.005	.65
Daily feed, lb DM	21.3	21.3	21.4	.2	.77	.82
Feed/gain[c]	5.98	6.25	6.47	.07	.0004	.68
Cost of gain, $/lb[e]	.487	.507	.522			
Carcass traits						
Hot carcass wt, lb	683	719	744	4	.0001	.31
Dressing percent	62.5	63.9	64.2	.1	.0001	.002
Ribeye area, in.^{2}	12.4	13.0	13.4	.2	.0001	.63
Adjusted backfat, in.	.48	.53	.55	.02	.004	.40
KPH fat, %	2.39	2.48	2.43	.06	.69	.28
Yield grade	2.80	2.90	2.88	.07	.43	.55
Marbling score[f]	5.07	5.35	5.27	.07	.036	.027
Skeletal maturity	A^{47}	A^{48}	A^{53}	^{01}	.0005	.23

[a]Probability values for linear (L) or quadratic (Q) effect of additional days on feed.
[b]Weights pencil shrunk 4%.
[c]Calculated and analyzed statistically as gain/feed.
[d]Excludes 14-d warm-up period.
[e]Using ration cost of $95/ton (as fed), $.35/hd/d yardage, interest, etc and $10/hd for processing, medicine, etc.
[f]Marbling score: Sl^{50} = 4.5; Sm^{0} = 5.0; Sm^{50} = 5.5, etc.

Table 3. Effect of Reimplant Scheme and Additional Days on Feed on Carcass Quality Grade, Yield Grade, and Incidence of Dark Cutting

		Reimplant scheme							
		E_2			E_2 + TBA			$P > F^b$	
Item	ADOF[a]:	0	14	28	0	14	28	RS	ADOF
Reimplant to slaughter, d		54	68	82	54	68	82		
Pct. Choice & Prime		65	69	73	69	73	77	.78	.25
Yield grade (YG):								.68	.53
YG 1, %		19	12	13	11	9	11		
YG 2, %		43	42	38	46	38	39		
YG 3, %		36	46	43	41	49	43		
YG 4, %		2	0	6	2	4	7		
Dark cutters, %		8	2	0	25	2	0	.05	.03

[a]ADOF = additional days on feed.
[b]Chi-square probabilities for effect of reimplant scheme (RS) and DOF, respectively.

INTERRELATIONSHIP BETWEEN COPPER AND BOVINE HEALTH

R. L. Larson, J. D. Arthington, and L. R. Corah

Summary

Trace mineral nutrition is important to production efficiency and animal health. Trace mineral imbalances may be the roots of many diagnosed or undiagnosed problems in a herd. The low cost of a complete mineral analysis when compared to production losses encourages its use in the evaluation of any bovine herd in which trace mineral imbalances are suspected.

A systematic gathering of information on mineral intake, antagonist intake, and serum and tissue values is necessary in order to make a diagnosis and a rational treatment decision. It is important to understand the complex interactions between minerals so that supplementation with one element does not make a complicated situation worse. Because of the many interactions between nutrients and the cost of mineral supplements, recommending use of higher levels of trace minerals in a ration or supplement without a complete diagnosis is economically and nutritionally unjustified.

(Key Words: Copper, Trace Minerals, Immune Function.)

Introduction

The effects of trace mineral imbalances on production and health are becoming better understood, but the information is still far from complete. Because, as their name implies, trace minerals are needed only in small amounts, dietary supplies are usually adequate. But direct or induced trace mineral deficiencies do occur and may be primary underlying problems in infectious or metabolic diseases. Suspected trace mineral problems should be investigated not as a single element problem, but as an imbalance problem involving several minerals. Generally, the trace elements that may be deficient are: cobalt, copper, iodine, manganese, selenium, and zinc. This article will focus on copper deficiencies and the manifestations of this deficiency.

Copper Functions and Signs of Deficiency

Copper is essential for hemoglobin formation and for iron movement. Copper is the rate-limiting element in ceruloplasmin synthesis. Ceruloplasmin is necessary for the oxidation of iron, permitting it to bind with the iron transport protein, transferrin. Ceruloplasmin levels have been shown to be reliable indicators of copper status in cattle. At blood copper levels as low as .3 ppm, ceruloplasmin is virtually absent. Copper is essential in many enzyme systems. By knowing the function of these enzyme systems, the clinical signs seen with copper deficiency are readily explained. The involvement of copper in immune function is well recognized. It is an integral part of the Cu/Zn - superoxide dismutase (SOD) enzyme. This enzyme is the primary scavenger of toxic oxygen radicals, which are produced as a result of normal cellular respiration. Cu/Zn - SOD reduces these radicals to hydrogen peroxide, protecting the body against oxidative damage. Indications of reduced Cu/Zn - SOD activity from copper deficiency may be most evident in cattle under shipping, weather, or handling stress.

Copper deficiencies can be manifested in a variety of disease conditions. One may see reduced fertility in cows and heifers; decreased conception rate, lack of estrus, and fetal re-

sorption. Bulls may have poor quality semen. Iron deficiency anemia and cardiovascular problems occasionally occur in copper-deficient individuals. Ataxia, inability to suckle, incoordination, stiff gait, and other central nervous system signs have been reported in young calves when dams were copper deficient. Slow growth rate or low milk production are commonly seen in copper-deficient animals. Connective tissue pathologies can include improper bone development resulting in fractures, heel cracks, sole abscesses, or foot rot. The most consistent physical finding we have encountered is abnormal hair pigmentation because of decreased tyrosinase activity, resulting in poor conversion of tyrosine to melanin. Red cattle become yellow and black cattle become grey or red tinged, particularly around the eyes, on the tips of the ears, and on the flank. Impaired immune response, manifesting itself as poor response to vaccination, severe parasitism and failure to respond to treatment, has been reported in cattle diagnosed as copper deficient.

Causes of Copper Deficiencies

The causes of trace mineral imbalances are often complex. Among the factors to consider are breed, frame size, and growth rate of the animals and their sources of feed and water. Simmentals may require twice as much copper as Angus. Probably more important than breed is production potential. Cattle of any breed that are heavy milking or fast growing may require higher levels of trace minerals than animals not pushing their genetic potential.

Many times, copper deficiencies are not caused by a primary shortage of copper, but by antagonists to copper absorption or utilization. Probably the best documented copper antagonist is molybdenum. High molybdenum is usually associated with alkaline soil. Liming the soil increases molybdenum uptake by plants, and legumes generally accumulate more molybdenum than grasses. Pasture molybdenum levels are lowest in winter, rising in the spring and peaking in the early fall. More important than actual copper and molybdenum levels is the ratio of these two elements. The dietary Cu:Mo ratio should ideally be between 6:1 and 10:1. Borderline levels are 2 to 3:1 and toxic levels of molybdenum are below 2:1.

High (20 to 30%) protein feeds can reduce copper availability through binding of sulfur-containing amino acids. Sulfur levels of 500 ppm can decrease copper availability by up to 50 percent. This problem is most evident in cows grazing lush spring pastures. It is suggested that for each .05% unit increase of sulfur above the .2% baseline, one should add 5 ppm of copper to the already existing requirement of 8 ppm of copper in the diet. According to the literature, copper deficiencies are most likely in these dietary circumstances: (1) low Cu:Mo ratio, 2:1 or less; (2) Cu deficiency, below 5 ppm; (3) high protein, 20-30% protein in fresh forage; and (4) in some areas, high iron concentrations in forages and water.

Diagnosing Copper Deficiencies

The diagnosis of trace mineral imbalances requires a systematic accumulation of information pertinent to trace mineral interactions and availability.

(1) Water samples should be taken from all sources, and special attention should be paid to copper, nitrate, and sulfate-sulfur levels. Also check iron, calcium, and zinc levels because of their interactions with copper.

(2) Feed samples should be taken, and phosphate, nitrate, copper, molybdenum, iron, and zinc levels evaluated. Total dietary protein should be evaluated for excesses. Forages containing < 3 ppm of copper (DM basis) are considered deficient, whereas 3 to 6 ppm is considered marginal. Feeds containing 8 ppm or more are considered adequate.

(3) Plasma samples for enzyme activity determination should be taken in dark blue top vacutainer tubes with heparin.

(4) Liver copper appears to be a reliable indicator of copper status. Take a softballsized sample at necropsy or slaughter. Biopsies taken from at least 10 head with a Tru-Cut biopsy needle are appropriate for live animals.

(5) Ceruloplasmin synthesis responds to copper availability. Copper content of blood can be estimated by the oxidase activity of ceruloplasmin. A mean value of 69 µg/100 ml of ceruloplasmin-bound copper is reported in cattle.

Dietary Requirement and Treatment

The minimum recommended level of copper is 8 to 10 ppm (DM basis) total diet. In a free-choice trace mineral or salt mix, a level of .1 to .5% copper is required, assuming consumption of 40 g/head/day.

Production levels must be considered when evaluating NRC recommendations for trace mineral supplementation. In situations of high milk production, rapid growth or stress, NRC recommendations are probably not adequate and must be increased. Many minerals, nitrate, sulfate, protein, and plant estrogens are known to reduce copper utilization and must also be accounted for.

Four routes of copper supplementation are available: injection, mineral mix, water source and copper needles in a bolus. Injections raise copper levels quickly and bypass the effect of other elements in the gut. Copper glycinate and copper EDTA are two common injectables. However, injectable products can cause injection site reactions, toxicities, and hemolysis.

Copper supplementation in salt can be in the form of sulfate, chloride, carbonate, acetate, or oxide. These forms vary in the amount of inorganic copper they contain and also in the copper's bioavailability. The mineral mix route is convenient but cannot assure adequate or uniform consumption by individual animals.

Metering devices can be utilized to place deficient elements into the water supply. This route can be effective, if it is the only source of water.

Copper oxide needles in a gelatin capsule are placed in the reticulum where they release of water.

Copper oxide needles in a gelatin capsule are placed in the reticulum where they release copper to be stored in the liver. Serum copper levels will not rise to high levels following bolus administration, but liver levels rise significantly and the effect is a long residual one (> 6 months).

Work at Washington State University indicates that no single level of supplementation was adequate in all copper-deficient herds. In some herds, an annual injection and in others, three or more injections per year were required to maintain copper levels. With copper supplementation in salt, .5% copper sulfate produces adequate copper in some herds, and in others, 3% was necessary to maintain copper levels.

Trace minerals chelated to amino acids are being touted as an answer to trace mineral deficiencies. The standard chelate involves the combination of a mineral with two or more amino acids, forming a stable, neutrally charged, biochemical ring compound. Because of their neutral charge, it is claimed that chelated minerals are not bonded into insoluble forms in the digestive tract. However, very little research has shown a positive effect in cattle production. Chelated mineral supplements are much more expensive than their inorganic counterparts and any benefits must be weighed against the cost.

Before any treatment of trace mineral imbalances is undertaken, one should understand the interactions with other minerals and be careful not to replace an existing problem with another deficiency or toxicity. Identifying and removing, if possible, any antagonists are also necessary for treatment of mineral imbalances.

THE EFFECTS OF SLOW-RELEASE COPPER BOLUSES ON COW REPRODUCTIVE PERFORMANCE AND CALF GROWTH

J. D. Arthington, R. L. Larson, and L.R. Corah

Summary

Two Kansas cow/calf herds known to be copper deficient were utilized to examine the effect of slow-release copper boluses. In herd I, 34 spring-calving cows and calves were divided into a treated and control group at 3-4 months following calving. In herd II, 1106 fall-calving cows and 172 calves were divided into a treated and control group at 3-4 months following calving. In both herds, cow liver and serum samples were collected and assayed for copper and iron. Cows in herd II were also examined for various reproductive parameters. Calf ADG was monitored over a 42-day treatment period in herd I, and a comparison of calf weaning weights was made in herd II. We concluded that copper boluses elevated liver copper levels. However, no effect on reproductive performance was noted, and calf performance was adversely affected.

(Key Words: Copper, Iron, Beef, Weight Gain, Reproduction.)

Introduction

The need for emphasis on bovine trace mineral nutrition is becoming more evident in Kansas. As we continue to push our animals toward their genetic potential, trace mineral imbalance starts to become a major player. One particular trace mineral, copper, is an integral part of many physiological functions affecting cattle performance. Indeed, as we examine the present status of Kansas beef herds, copper deficiencies appear to be much more common than previously suspected. Copper deficiencies can result from feedstuffs low in copper (primary deficiency), or feedstuffs high in compounds that interfere with copper absorption, such as molybdenum and sulfur (secondary deficiency). Classic symptoms of copper deficiency include altered hair coat color, greying of hair around the eyes and ears, difficulty in shedding winter hair, calf scouring, delayed estrus, and embryonic death.

Many products have been developed to prevent and treat copper deficiencies. One new product recently marketed is a slow-release bolus containing copper oxide needles[1]. These trials were conducted with two Kansas cow/calf herds with the objective of examining the effect of copper oxide administered as a slow-releasing bolus on cow liver copper and iron status, cow reproductive performance, and calf performance. The two herds were selected based on their known history of being copper deficient.

Experimental Procedures

Herd I

Copper bolus effect on cow and calf ADG was examined. Thirty-four springcalving cows and calves were divided into a treated (bolused administered; n = 18) and a control (n = 16) group. At the start of the trial, cows assigned to the treated group received two boluses, whereas calves received one. Copper and iron status were determined by liver and serum samples collected on days 0, 64, and 106 of the trial. Liver samples were collected by liver biopsy

[1]Cuprax® Pitman-Moore Company, Mundelein, Illinois 60060.

technique using Tru-Cut Biopsy needles[2]. Blood samples were collected from the jugular vein. Liver and blood samples from cows in herd I were analyzed by atomic absorption methods to determine copper and iron levels.

Herd II

Bolus effects on cow reproductive parameters and calf ADG were examined. Fall calving cows were divided, three months after calving, into treated (n = 276) and control (n = 830) groups. Liver and serum samples were collected on days 0, 97, and 154 of the trial.

Results and Discussion

Herd I

Data are presented in Table 1. Although not statistically significant, bolus administration appeared to increase liver copper levels, whereas liver copper appeared to decrease in the non-treated cows. Liver iron levels tended to be lower (P = .068) in the treated group, indicating an increase in the biological activity of copper. Serum copper values did not respond to bolus treatment.

Calf ADG was determined after a 42-day treatment period. The treated calves tended (P = .063) to have a lower ADG compared to the control (1.79 vs 2.11 lb/d).

Herd II

On days 97 and 154 of sampling, bolus treatment elevated (P < .05) liver copper levels (Table 1). Similar to the results in herd I, serum copper showed no response to bolus treatment throughout the trial. AI pregnancy rate, AI first service conception rate, and number of inseminations per female did not differ (P > .10) between treatment groups.

Bull calves in this herd were divided into a treated (n = 56) and a control group (n = 43). Weaning weights were heavier (P < .05) for control (780.6 lb) compared to treated (749.7 lb). Heifer calves were also divided into a treated (n = 36) and control group (n = 37). Heifer weaning weights also tended (P = .093) to be heavier for control (721.1 lb) compared to treated (690.2 lb).

In both herds, supplementing copper oxide via slow-releasing boluses tended to increase liver copper and decrease liver iron. However, it did not appear to alter cow reproductive performance. Copper boluses also appeared to adversely affect ADG and weaning weights of calves.

[2]Baxter Tru-cut biopsy needles, Baxter Healthcare Corporation, Valencia, CA 91355-8900.

Table 1. Copper and Iron Status of Herd I

	Day	Treated (ppm)	Non-Treated (ppm)
Liver Copper	64	17.3	13.4
	106	24.1	8.1
Liver Iron	64	462.8[a]	524.0[b]
	106	490.8[a]	661.8[b]
Serum Copper	0	.550	.526
	64	.502	.420

[ab]Row means tend to differ (P < .07)

Table 2. Copper and Iron Status of Herd II

	Day	Treated (ppm)	Non-Treated (ppm)
Liver Copper	0	162.3	195.6
	97	323.8[a]	173.6[b]
	154	291.2[a]	187.0[b]
Liver Iron	0	461.8	435.8
	97	599.6	671.4
	154	423.4	548.4
Serum Copper	0	.712	.738
	97	.632	.653
	154	.568	.588

[ab]Row means differ ($P < .05$)

EFFECTS OF SOURCE AND LEVEL OF ENERGY OR PROTEIN SUPPLEMENTATION ON NITRATE TOXICITY IN CATTLE[1,2]

M. W. Smith, M. R. Blanding, L. R. Corah, and D. A. Blasi[3]

Summary

Two experiments were conducted to investigate whether level or source of energy and protein supplementation would reduce the incidence or severity of clinical toxicity in cattle fed forages high in nitrate (NO_3). Heavily fertilized sudan hay with 40,000 to 50,000 ppm NO_3 was fed in both experiments. The percentage of total blood hemoglobin converted to methemoglobin by nitrate was used to compare treatment effectiveness. Energy supplementation at levels tested in Exp. 1 had no effect on methemoglobin concentration. In Exp. 2, all protein sources (wheat midds, urea, soybean meal) reduced the maximum methemoglobin levels and increased the rate of reconversion to normal hemoglobin.

(Key Words: Nitrate Toxicity, Energy, Protein.)

Introduction

Under certain conditions many forage plants, particularly the sorghum group, accumulate excess nitrate (NO_3). This can be hazardous to livestock when it is reduced to nitrite (NO_2) by microbes in the rumen. Nitrite is absorbed directly into the bloodstream, where it oxidizes the iron in hemoglobin (Hb) and converts it to methemoglobin (mHb), which is unable to carry oxygen. Clinical signs may begin when 40 to 50% of the Hb is converted to mHb. Death from lack of oxygen can occur if mHb levels reach 70 to 90%. The reduction of NO_3 to NO_2 is carried out by an enzyme, nitrate reductase, present in certain ruminal microbes. Alteration of ruminal conditions to those either unfavorable to the NO_3-reducing microbes or to the enzyme itself might protect the animal from toxic effects. We attempted to prevent nitrite accumulation by lowering the rumen pH with energy supplementation or by influencing rumen flora activity by adding alternative nitrogen sources.

Experimental Procedures

In Exp. 1, seven ruminally cannulated, mature, crossbred cows were rotated through a 7×7 Latin Square design in which milo, wheat or soy hulls were fed at 2 and 4 lb along with a non-supplemented control group. Supplements were fed 1 hour before baseline sampling and forage feeding. After the initial samples were taken, high-nitrate sudan (40,000 to 50,000 ppm NO_3) was fed ad libitum. Rumen fluid and whole blood were subsequently collected every 2 hours for 10 hours. Forage intake was equalized after 4 hours by placing ground sudan directly into the

[1]The authors are grateful to Jennifer Bradford and Dr. Ben Brent for their hard work and expertise in blood methemoglobin analysis.

[2]Special thanks to John Arthington, Charlie Peters, Bob Larson, Sandra Utter, and Gary Fike for their assistance with data collection.

[3]Extension Livestock Specialist, South Central Kansas.

rumen via the cannula. Any cows displaying severe toxicity symptoms were treated with intravenous methylene blue. The characteristics measured in Exp. 1 were peak methemoglobin (mHb %), hours to peak (peak h), and ruminal pH. Curves showing rate of mHb increase and subsequent decrease were plotted for the duration of the experiment.

In Exp. 2, protein supplementation was examined utilizing seven mature, non-fistulated, crossbred, beef cows, also in a 7 × 7 Latin Square. Wheat midds, milo/urea (16% CP), and milo/soybean meal (16% CP) at 2 and 4 lb levels per head daily were compared again to a non-supplemented control group. All feed not consumed after 4 hours was weighed back. For this experiment, mHb %, peak h, and intake were measured and mHb curves were plotted.

Results and Discussion

In Exp. 1, there were no treatment effects on % mHb or peak h (Table 1) or in mHb curves for the energy sources and levels tested. No ruminal pH differences were detected. In Exp. 2, however, 4 lb milo/urea significantly lowered both mHb % and peak h (P = .01) compared to the control group. When 4 lb wheat midds was fed, mHb % was also decreased (P = .08). All protein sources tested lowered the mHb curve compared to the control group (Figure 1). This decrease appeared to be dose-dependent, with greater reductions seen in the 4-lb than the 2-lb groups for each treatment (Figure 2). No significant differences in forage intake were observed in Exp. 2.

Three cows in Exp.1, one control and two in the 4 lb soy hulls group, developed toxicity symptoms requiring medical intervention. All three were given 300 ml of a 1% methylene blue solution I.V. and complete recovery was apparent within one half hour of treatment. The effectiveness of methylene blue was demonstrated by the control cow, whose mHb level dropped from 73% to 0.5% in 30 minutes. No animals in Exp.2 reached high enough mHb levels to show clinical signs of toxicity.

We conclude that energy supplementation from the sources and at levels tested did not reduce the toxic effects of high nitrate forage. Protein supplementation, however, might prove to be a viable method of protecting cattle from nitrate toxicity. More work needs to be done before specific recommendations can be made.

Table 1. Effects of Energy or Protein Supplementation on Blood Methemoglobin Levels

Exp. 1	Control	Milo grain, lb		Wheat grain, lb		Soy hulls, lb	
		2	4	2	4	2	4
Peak mHb, %	45.1	45.9	35.8	45.9	36.8	52.8	58.1
Peak, h	8.9	8.9	8.4	8.9	7.8	8.2	8.9
Exp. 2	**Control**	**Milo/SBM, lb**		**Milo/urea, lb**		**Wheat midds, lb**	
		2	4	2	4	2	4
Peak mHb, %	30.0	31.9	20.1	21.5	14.1[a]	29.0	19.2[b]
Peak, h	6.6	6.3	5.7	6.9	4.6[a]	6.3	6.3

[a]Differs (P = .01) from control.
[b]Differs (P = .08) from control.

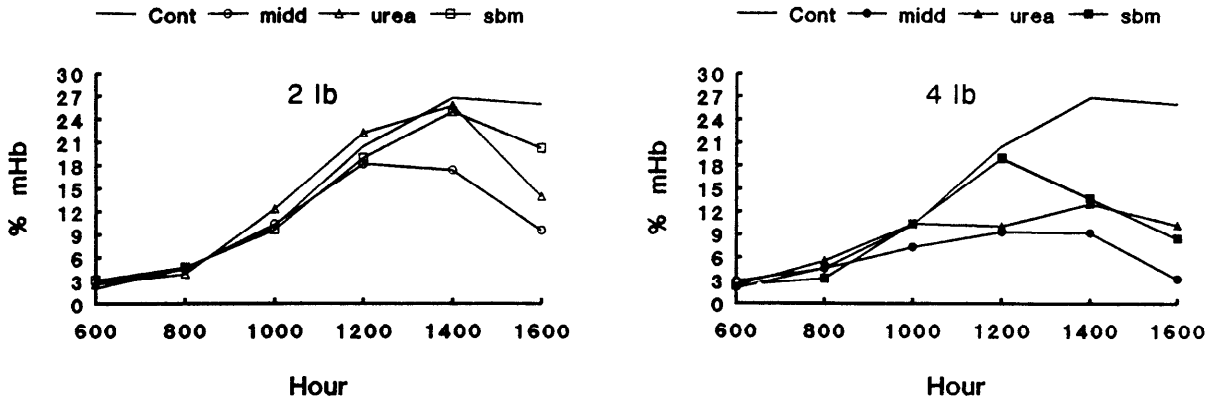

Figure 1. Effects of Source of Protein Supplementation on Blood Methemoglobin Levels - Exp. 2.

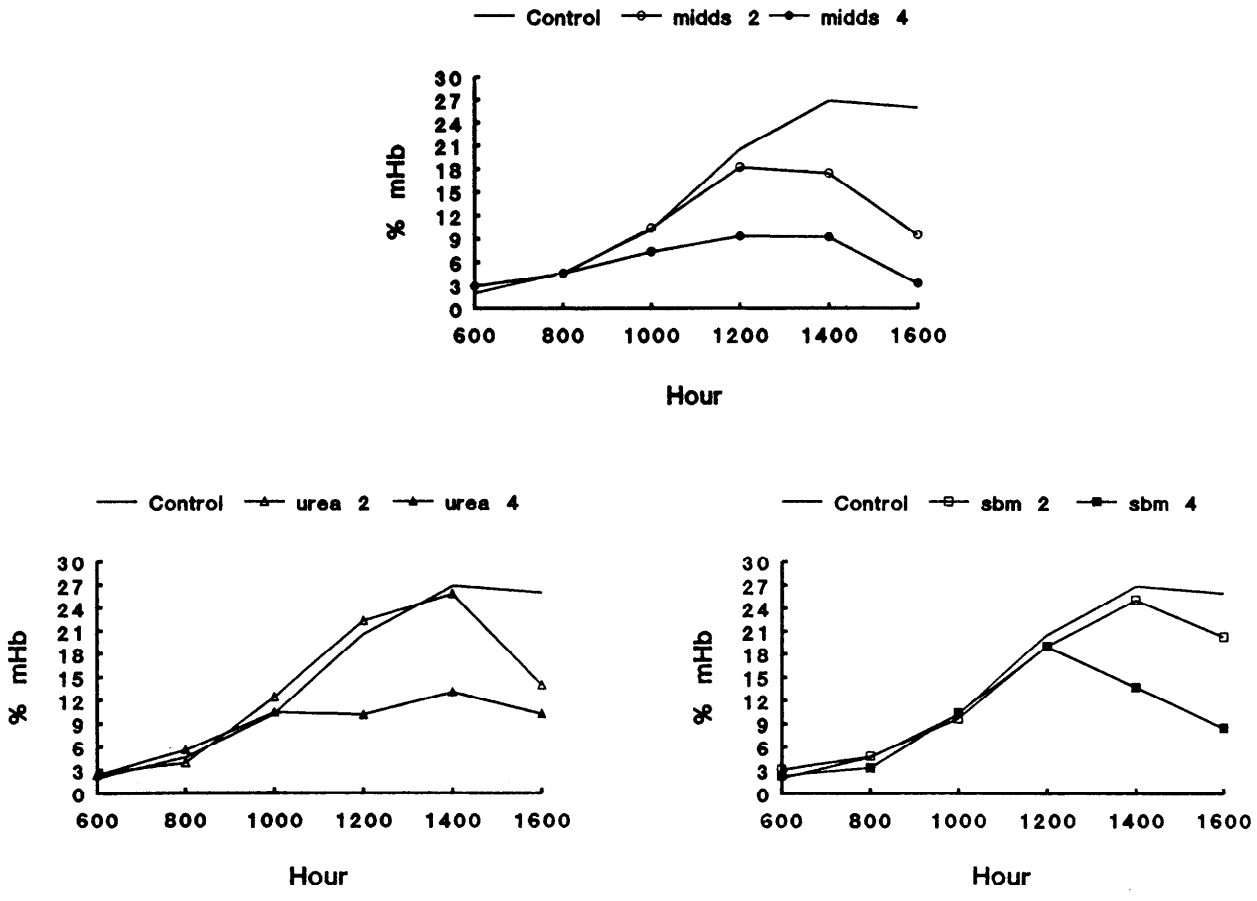

Figure 2. Effects of Level of Protein Supplementation on Blood Methemoglobin - Exp. 2.

VARIATION IN THE QUALITY OF FORAGE GRAZED BY PREGNANT/LACTATING BEEF COWS AT KEY PERIODS IN THE YEAR[1]

E. S. Vanzant, R. C. Cochran, and T. A. Stanley

Summary

Seven ruminal and esophageally fistulated crossbred beef cows were used to monitor changes in chemical composition of tallgrass-prairie forage selected during November of 1989 and January, March, June, and August of 1990. Quality of forage selected by beef cows was lowest during the period just before calving (cows calved in early February) but had begun to improve by the March sampling (postpartum period) and reached its peak during June sampling period (breeding season). Observed variability in the fiber and protein components of grazed forage highlights the dynamic nature of forage quality and emphasizes the importance of using such information when assessing the nutritional adequacy of range diets.

(Key Words: Beef Cows, Range, Forage, Protein, Fiber, Selection.)

Introduction

To satisfactorily meet the nutrient needs of grazing beef cows, one must be aware of the balance between nutrient input (i.e., forage quality and forage intake) and the cow's changing nutrient requirements. By knowing the nutrient profile of the forage, periods that deserve special nutritional consideration are highlighted and a producer can develop supplementation strategies or special rations that address unique requirements. However, without reliable information regarding levels of forage intake and quality of diet selected, such calculations have little value. Because information was limited regarding seasonal variation in intake, diet selection, grazing behavior, and digestive physiology of pregnant/lactating beef cows grazing tallgrass prairie, we designed an experiment in which those factors were monitored at critical stages in a beef cow's production cycle. The current paper reports seasonal variation in the chemical composition of grazed forage.

Experimental Procedures

Seven mature, Angus × Hereford cows with esophageal and ruminal fistulas were used to monitor seasonal changes in quality of forage selected. Cows were synchronized with prostaglandin and pasture-mated to a single bull. They calved in early February over a period of approximately 2 weeks. All cows grazed a common pasture of tallgrass-prairie forage. Samples of grazed forage were collected via the esophageal fistulas during five 3-4 day periods, as follows (stage of production cycle in parentheses): 11/2 to 11/4/89 (mid-prepartum); 1/24 to 1/26/90 (late prepartum); 3/29 to 3/31/90 (early postpartum/early lactation); 6/14 to 6/16/90 (breeding/mid-lactation); 8/19 to 8/22/90 (early prepartum/late lactation). To minimize regurgitation effects on esophageal collections, cows were gathered during the evening on the day before each collection and withheld from grazing (with access to water) until early morning. Samples of grazed forage were collected in the early morning during a grazing period of approximately 30 minutes.

[1]Appreciation is expressed to Gary Ritter, Wayne Adolph, and the student workers at the Range Research Unit for their invaluable assistance in conducting this trial.

Collection bags were lined with plastic to allow collection of both grazed forage and saliva. Samples were placed on ice, transported to the laboratory, frozen immediately, and freeze-dried later. The pasture used for sample collection was burned during late April.

Results and Discussion

During January, protein concentration was lowest ($P < .05$) (Table 1) and the percentage of the crude protein (CP) that was unavailable to the animal (acid detergent insoluble nitrogen = ADIN) was highest ($P < .05$). Similarly, the amount of fiber that was indigestible (indigestible acid detergent fiber = IADF) was highest ($P < .05$) during this period, as were ash-free acid detergent fiber (ash-free ADF) and ash-free neutral detergent fiber (ash-free NDF). Acid detergent lignin (ADL) is an indigestible component of forages that is believed to limit the extent to which forages can be digested. The ADL content was also highest ($P < .05$) during the fall/winter sampling periods. The warm-season perennial grasses that dominate the tallgrass prairie typically are in the early stage of their growth cycle in late March. However, some temperate species (for example, Kentucky bluegrass) can grow actively during that period. During the late-March sampling period, enough new growth was available and selected that a rise ($P < .05$) occurred in CP concentration and declines ($P < .05$) occurred in ash-free ADF, ash-free NDF, ADL, ADIN, and IADF, compared with the late-January sampling period. A beef cow's nutrient requirements are typically highest during that period (early postpartum/early lactation). In spite of improvements in late-March forage quality compared with late January, quality of the diet available and selected remained below that necessary to meet nutrient requirements. In general, the highest forage quality (highest CP and lowest fiber) was selected during June ($P < .05$). Similarly, this period was characterized by the lowest ($P < .05$) IADF and a low concentration of ADIN. Compared with the June samples, grazed forage quality declined significantly during late summer (August). Further declines would be expected following cessation of growth and with continued weathering. The variability in chemical composition of forage selected by grazing beef cows agrees with research reported for other forage types and highlights the importance of factoring in changes in forage quality when attempting to assess the nutritional adequacy of range beef cows.

Table 1. Seasonal Variation in the Chemical Composition of Forage Selected by Esophageally Fistulated Beef Cows Grazing Tallgrass Prairie at Different Times of the Year

	Month					
% of OM	November	January	March	June	August	SE
Crude protein	8.27[f]	5.82[g]	8.73[fi]	14.01[h]	9.40[i]	.2
Ash-free ADF[a]	41.64[f]	46.85[g]	43.16[h]	39.05[i]	41.03[f]	.48
Ash-free NDF[b]	65.65[f]	75.47[g]	71.78[h]	67.28[f]	66.71[f]	.87
ADL[c]	7.06[f]	7.15[f]	5.56[g]	4.55[g]	5.39[g]	.42
IADF[d]	14.71[f]	17.36[g]	12.30[h]	8.06[i]	12.44[h]	.71
ADIN, % of total N[e]	17.67[f]	21.22[g]	16.79[f]	12.64[h]	10.63[h]	.77

[a]Ash-free ADF = ash-free acid detergent fiber. [b]Ash-free NDF = ash-free neutral detergent fiber. [c]ADL = acid detergent lignin. [d]IADF = indigestible acid detergent fiber. [e]ADIN = acid-detergent insoluble nitrogen. [f,g,h,i]Means within a row without common superscripts differ ($P < .05$).

INFLUENCE OF LEVEL OF SUPPLEMENTAL ALFALFA HAY ON THE PERFORMANCE OF BEEF COWS GRAZING WINTER BLUESTEM RANGE

E. S. Vanzant and R. C. Cochran[1]

Summary

One hundred thirteen pregnant Hereford × Angus cows were used to study the effect of increasing levels of supplemental alfalfa hay on performance when grazing winter bluestem range. Although no differences were observed in reproductive performance, increasing the amount supplemental alfalfa from approximately .5% up to 1.0% of body weight resulted in increased weight gain and reduced condition loss in cows and increased weaning weight in calves. However, time spent grazing was significantly decreased in those groups receiving larger amounts of supplemental alfalfa.

(Key Words: Protein Supplementation, Alfalfa Hay, Beef Cows, Winter Range.)

Introduction

Previous reports (KAES Reports of Progress 514, 539) have documented the benefits of protein supplementation for pregnant beef cows grazing winter tallgrass prairie. When fed to provide similar amounts of crude protein, alfalfa hay and soybean meal/grain sorghum supplements elicited similar performance responses in beef cows (KAES Report of Progress 567). Because alfalfa hay is more bulky and fibrous than concentrate supplements, it occupies more of the available ruminal space and, therefore, could reduce intake of grazed forage (KAES Report of Progress 623). However, some question remains as to the optimum amount of alfalfa hay to feed as a protein supplement. Our objective in this experiment was to determine the effects of different amounts of supplemental alfalfa hay on the performance of pregnant beef cows grazing winter tallgrass range forage.

Experimental Procedures

One hundred thirteen pregnant Hereford × Angus cows (avg initial wt = 1106 lb; avg initial body condition = 5.42; 1-9 scale) were randomly assigned to one of three supplemental levels of alfalfa hay (19.4% crude protein; 47.9% neutral detergent fiber): 1) .48% BW/hd daily (about 5.3 lb); 2) .72% BW/hd daily (about 7.9 lb); or 3) .96% BW/hd daily (about 10.5 lb), DM basis. Supplementation with the three levels of alfalfa began on November 27, 1990 and continued until each cow calved (average calving date = March 7), after which each cow was fed 9.4 lb/hd/day alfalfa DM (10 lb/hd/day as-fed) until sufficient new grass growth was available (mid-April). Cows grazed pastures dominated by big bluestem (*Andropogon gerardii*), indiangrass (*Sorghastrum nutans*), and little bluestem (*Andropogon scoparius*). Cows were weighed and scored for body condition on days 0 (November 27), 30, 59, 87, 101 (within 48 h of calving), 158 (beginning of breeding season), and 333 (weaning) following an overnight stand without access to feed or water. In January and February, collar-mounted vibration recorders were used to measure the grazing time of 6 cows from each treatment.

[1]The authors thank Mr. Wayne Adolph, Mr. Gary Ritter, and the student workers at the cow-calf research unit for their dedicated assistance in conducting this experiment.

Results and Discussion

Cow gained increased with increasing alfalfa level over the first month of the experiment (Figure 1; linear, P = .01). However, level of supplemental alfalfa did not affect subsequent weight changes (P > .10) through calving. The reason for the lack of weight response after the first month is unclear, but it is probably different in ruminal fill. Similar treatments applied to beef steers in a confinement trial (KAES Report of Progress 623) resulted in either no change or a drop in ruminal fill with increasing levels of alfalfa. By calving, cows fed the highest alfalfa level had lost 119 lb from their initial weight, whereas cows on the lower two levels lost an average of 153 lb. From calving to breeding, cows fed the highest level of alfalfa lost the most weight (quadratic, P = .06), causing their cumulative weight change to be similar (P > .10) to that of the other two groups. No treatment differences occurred for weight change from breeding to weaning (P > .10).

Cows fed the lowest level of alfalfa tended (quadratic, P = .13) to lose more condition than those fed higher levels of alfalfa over the first month of supplementation and lost more (linear, P = .06) condition over the second month (Figure 2). No treatment differences (P > .10) occurred over subsequent periods through breeding, after which cows previously fed the lowest level of alfalfa gained the most (linear, P = .03) condition. Cumulative condition changes were similar for all treatments by weaning time. Cumulative cow body condition changes at calving increased in direct proportion (P = .02) to increasing alfalfa. However, all groups had lost sufficient body condition to be below an average body condition of 5 at calving, suggesting the potential for reduced reproductive performance.

However, in spite of the differences in body condition at calving (relative to initial condition), reproductive performance was acceptable and unaffected (P > .10) by treatment. Overall pregnancy rate was 92.9%, with 63.4, 26.7, and 9.9% of those pregnant being bred in subsequent thirds of the 60 d breeding season. Calf birth and weaning weights increased in a curvilinear fashion (quadratic; P = .04) with increasing alfalfa (birth weight = 78, 83, and 82 lb; weaning weight = 492, 491, and 517 lb for low, moderate, and high levels of alfalfa, respectively).

Treatment effects on total grazing time were similar (P > .10) for the January and February measurement periods and decreased in direct proportion (P = .03) to increasing alfalfa hay (6.3, 4.9, and 5.0 hd/day for low, moderate, and high levels of alfalfa, respectively). This suggests that the higher levels of alfalfa hay were substituting for intake of grazed forage, which is substantiated by confinement studies with steers (KAES Report of Progress 623).

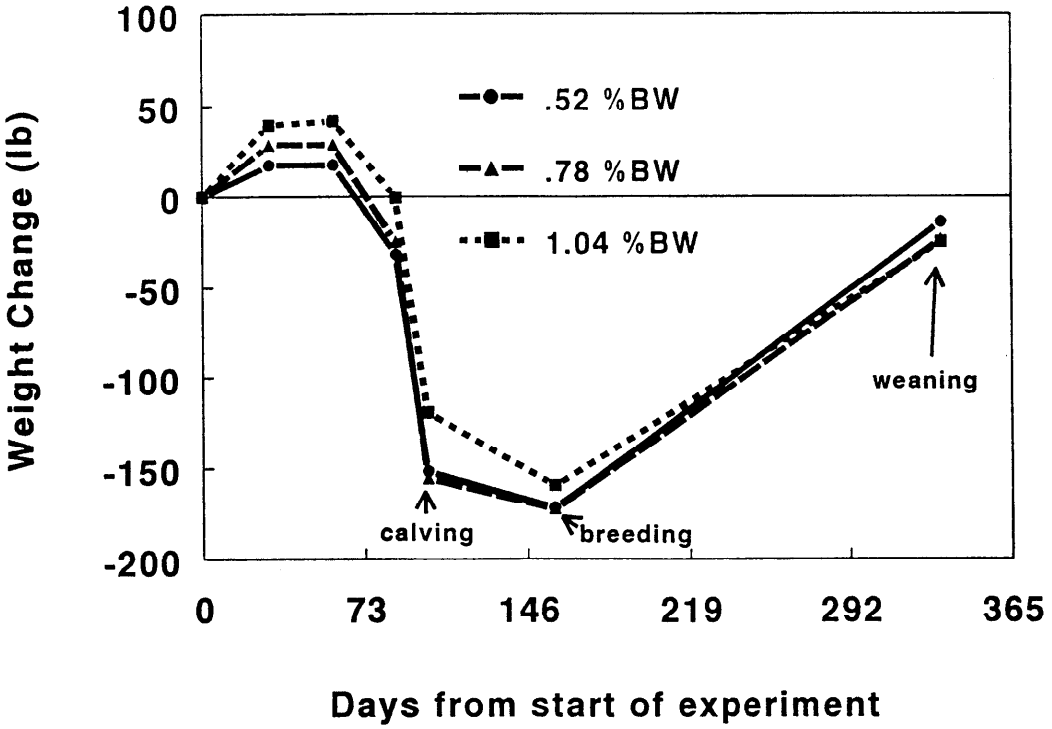

Figure 1. Influence of Level of Winter Alfalfa Supplementation on Weight Change of Cows Grazing Bluestem Range (day 0 = November 27; avg initial weight = 1106 lb).

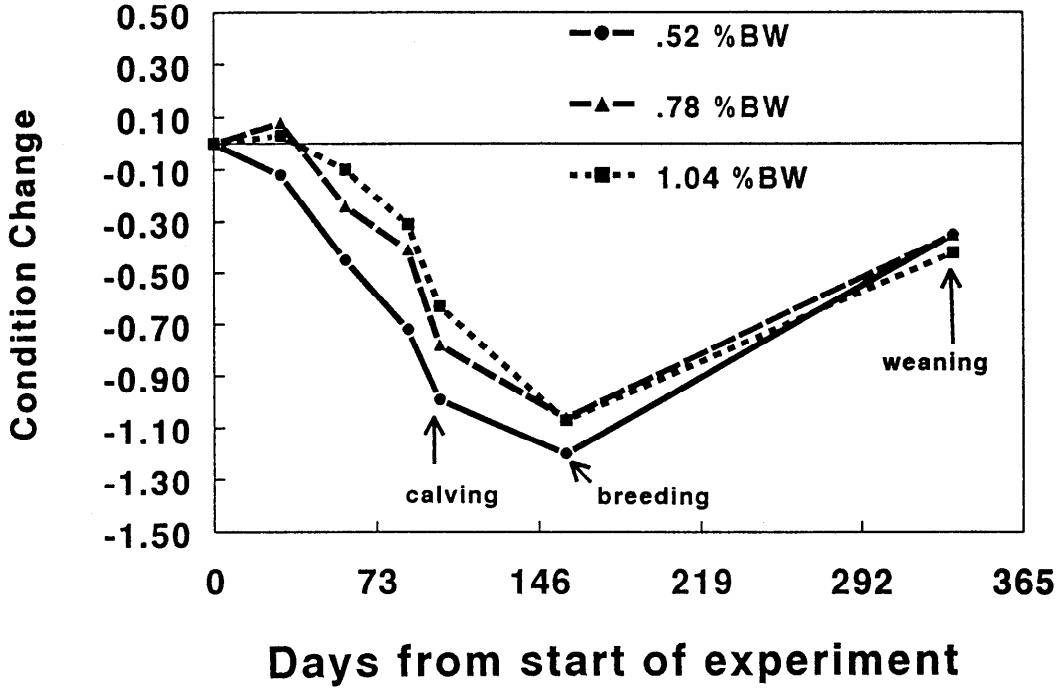

Figure 2. Influence of Level of Winter Alfalfa Supplementation on Condition Change of Cows Grazing Bluestem Range (day 0 = November 27; avg initial control = 5.4 on 1-9 scale).

INFLUENCE OF FREQUENCY OF ENERGY SUPPLEMENTATION ON UTILIZATION OF EARLY-SUMMER, TALLGRASS PRAIRIE FORAGE[1]

J. L. Beaty, R. C. Cochran, B. A. Lintzenich, and E. S. Vanzant

Summary

Fifteen ruminally cannulated beef steers were used in a pasture supplementation experiment to determine the effects of frequency of energy supplementation on intake and digestion of tallgrass prairie forage during early to mid-summer. Steers grazed a common pasture and were assigned to the following treatments: no supplement (control); 4 lb rolled sorghum grain/head/day; 9.3 lb grain/head/3 times weekly. Steers in the two supplemented groups consumed the same amount of sorghum grain/head/week. In general, supplementation was not harmful ($P = .17$) to forage intake. However, providing supplement 3 times weekly tended ($P = .11$) to depress forage intake compared with daily supplementation. Although supplementation tended ($P = .07$) to cause selection of less fiber in the diet, total forage digestion tended ($P < .07$) to be depressed by supplementation. However, total diet organic matter digestibility was not significantly altered by treatment, probably because of the impact of the highly digestible supplement. Based on trends in intake and grazed forage selection, achieving optimal benefit from supplementation of cattle grazing relatively high-quality forage appears more likely when its provided daily rather than 3 times weekly.

(Key Words: Summer Range, Energy Supplement, Sorghum Grain, Forage Intake, Forage Digeston.)

Introduction

Previous research at KSU reported improved performance of intensive-early stocked steers when supplemented with up to 4 lb/head daily of rolled sorghum grain. In order for early-season supplementation of stockers to be practical on a large scale, it may be necessary to offer supplements less frequently than daily or provide supplement via self-feeders. However, the influence of these methods of supplementation on performance when steers are grazing high quality pasture is not known. Therefore, this experiment was conducted with the objective of evaluating intake and digestion of tallgrass prairie forage during early to mid-summer when steers were supplemented at different frequencies with rolled sorghum grain.

Experimental Procedure

Fifteen ruminally cannulated Angus × Hereford steers (average initial weight 892 lbs) grazed a single tallgrass prairie pasture from June 13, 1991 through July 17, 1991. Steers were randomly assigned to one of three treatments: no supplement (control); 4 lb rolled sorghum grain/head/day; 9.3 lb grain/head/3 times weekly. Weekly grain intakes in the two supplemented groups were equal. Supplemented steers were gathered at noon to minimize disruption of active grazing periods (e.g., early morning and late evening) and were fed their supplement individually. Control steers were not gathered. Whenever supplement was refused, it was placed in the

[1]Appreciation is expressed to Mr. Gary Ritter, Mr. Wayne Adolph, and the student workers at the Range Research Unit for their assistance in conducting this trial.

rumen via the cannula. Generally that occurred with only one steer. All steers had unrestricted access to salt and water throughout the trial.

Steers were adapted to their supplement for 12 days before diet sampling was initiated. Samples of grazed forage were collected via ruminal evacuation during the subsequent 5-day period. Fecal output was measured by total fecal collection during the 7-day period following diet sampling. Indigestible acid detergent fiber content was determined on forage, supplement, and feces in order to calculate forage organic matter and fiber digestion. Estimated digestibility was combined with measured fecal output to determine forage organic matter intake.

Results and Discussion

Although forage intake was largely unaffected ($P = .17$) by supplementation per se, reducing the frequency of supplementation from daily to 3 times weekly depressed forage intake (Table 1). Because forage intakes were not greatly different for supplemented vs. unsupplemented steers, total diet organic matter (OM) intake increased from the addition of the supplementation. In addition, total diet OM intake was greater ($P = .11$) for the steers supplemented daily than the group supplemented 3 times weekly. Fecal output measurements supported those observations.

Neutral detergent fiber content (NDF) in the forage tended to be lower ($P = .07$) for the supplemented groups compared with controls. Within the supplemented groups, content of NDF in the forage also tended to be ($P = .09$) lower with daily supplementation. In spite of slight reductions in fiber concentration in forage selected by supplemented steers, calculated forage digestion tended ($P = .07$) to be lower for supplemented than control steers. No differences were evident in forage digestion between the two supplemented groups. Although slight differences in forage digestion were apparent among the treatment groups, total digestion was similar for all groups, suggesting that the total diet OM digestion in the supplemented steers was improved via the highly digestible supplement.

Although both supplementation treatments tended to slightly depress fiber digestion, supplementing steers daily appeared to have no impact on forage intake and may have slightly decreased the concentration of fiber in the forage selected. In contrast, supplementation 3 times weekly depressed forage intake and tended to result in steers selecting a diet with higher concentration of fiber compared with daily supplementation. It appears that daily supplementation (or possibly self-feeding) would be preferable to less frequent supplementation, when grain is provided to stockers grazing relatively high-quality forage.

Table 1. Effect of Supplementation Frequency on Organic Matter (OM) Intake and Digestion

Item	Supplementation treatment			Contrasts[a]	
	7	3	0	7Xvs3X	SvsNS
Forage OM Intake, % BW	2.0	1.7	2.0	P = .11	P = .17
Total OM Intake[b], % BW	2.4	2.2	2.0	P = .11	P = .06
Fecal OM Output, % BW	0.81	0.74	0.69	P = .06	P = .02
Ash-free NDF[c] in grazed forage (% of OM)	68.3	71.1	72.3	P = .09	P = .07
Forage OM Digestion, %	61.7	61.0	65.8	P = .77	P = .07
Total OM Digestion, %	65.9	65.7	65.8	P = .94	P = .99
Weight Change, lb	44.0	33.6	34.8	P = .31	P = .64

[a]7Xvs3X = "Daily" vs "Three" (3-times weekly) supplementation comparison; SvsNS = Supplementation (average of the daily and 3-times weekly groups) vs "Control" (no supplementation) comparison.
[b]Total intake = forage intake plus supplement intake.
[c]NDF = Neutral Detergent Fiber.

USE OF LOW-LEVEL GRAIN SUPPLEMENTATION IN AN INTENSIVE-EARLY STOCKING PROGRAM: INFLUENCE ON DAILY GAIN AND FORAGE PRODUCTION

R. C. Cochran, C. E. Owensby[1], E. S. Vanzant, R. T. Brandt, Jr., and L. M. Auen[1]

Summary

A 4-year experiment was conducted to evaluate the effect of increasing amounts of grain supplementation on steer gains and forage production in pastures managed under an intensive-early stocking system. Average daily gain tended to increase in direct proportion to increasing level of sorghum grain supplementation (2.19, 2.43 and 2.59 lb/day for the control, 2 and 4 lb/day supplement levels, respectively). The amount of grass remaining in the pastures at the end of the grazing season (approximately July 15) also increased in direct proportion to increasing sorghum grain supplementation. Forage remaining in the pastures at the end of the growing season (approximately October 1) tended to respond in a similar manner.

(Key Words: Intensive-early Stocking, Supplementation, Sorghum Grain, Milo.)

Introduction

Grazing livestock are generally supplemented in an attempt to address nutritional inadequacies in the basal forage diet. Most supplementation programs are employed when forage quality is low. Under such conditions, grain supplementation elicits poor results because of depression of fiber digestion and intake, unless the grain-based supplement contains adequate natural protein from some other feedstuff (a minimum of 20% total protein is typically recommended). However, low levels of grain supplements do not appear to elicit those negative responses when offered daily to cattle grazing high-quality forages. Stocker cattle managed under an intensive-early stocking program graze forage during its period of highest nutritive value, but sometimes forage supply may be limited. Therefore, low-level grain supplementation in an intensive-early stocking program might enhance productivity and(or) help stabilize carrying capacity, which can fluctuate with changes in the forage supply. Because information was unavailable regarding the impact of low-level grain supplementation on animal and plant response under intensive-early stocking, a 4-year trial was conducted with the objective of monitoring average daily gain and changes in forage production when intensive-early stocked steers were supplemented with increasing levels of sorghum grain.

Experimental Procedures

Crossbred beef steers were randomly assigned to six, 60-acre pastures during each of the 4 years. Average initial weights and numbers of steers used were; 1988: 554 lb, n = 240; 1989: 627 lb, n = 210; 1990: 590 lb, n = 216; 1991: 524 lb, n = 246. Stocking rate was based on the initial weight of the steers (.273 acres/100 lb of initial body weight) in order to ensure similar stocking rates among pastures and across years. Pastures were randomly assigned to three treatments (two pastures/treatment): no supplementation (control) and 2 or 4 lb rolled sorghum grain supplement per head. Supplemented groups were bunk-fed daily at approximately 1:00 to

[1]Department of Agronomy. Thanks to Mr. Gary Ritter, Mr. Wayne Adolph, and the student workers at the Range Research Unit for their invaluable assistance in conducting this trial.

2:00 p.m. All pastures were burned in late April, then steers grazed the pastures from early May through mid-July. Weights were taken after an overnight stand without feed or water at trial initiation, in mid-June, and at trial termination. Conversion efficiency (lb feed/lb extra gain) was calculated by dividing the quantity of supplement fed by the amount of gain above the unsupplemented steers. All steers were implanted during initial processing and had unlimited access to a Bovatec®/mineral mixture during the entire trial. Consumption of the mixture was not different ($P > .10$) among treatments and averaged .16 lb/day (approximately 115 mg Bovatec/head/day). Available forage production was measured in the pastures at the end of the grazing period (July 15) and at the end of the growing season (October 1) by clipping 10, .5 sq meter frames at random locations within the two major range sites in each pasture (loamy upland and breaks).

Results

The total gained by steers in all treatment groups differed among years ($P < .01$); however, response to supplementation was consistent throughout the four years. During the early portion of the grazing period (May to early June), supplementation did not significantly influence steer gains (Table 1), but average daily gain during the latter part of the period (early-June to mid-July) increased ($P = .07$) in direct proportion to increasing level of supplement. Response to supplementation over the entire grazing period displayed a similar trend ($P = .16$). The efficiency with which supplement was converted to additional gain followed the same pattern as daily gain. When averaged over the entire grazing period, 9 to 10 lb of grain were required for each additional lb of gain above the control group.

Grass and forbs remaining in the pasture at the end of the grazing period increased in direct proportion ($P < .01$) to increasing level of grain supplementation. At the end of the growing season, grass left in the pastures tended to increase ($P = .11$) with increasing level of supplementation. Quantity of forbs remaining was not different among treatments.

Table 1. Influence of Level of Grain Supplementation on Daily Gain and Forage Available in Pastures at Mid-July and Early October (Four-year Average)

Item	Supplement Level, lb/d			P-value	
	0	2	4	Linear	quadratic
Average daily gain, lb/d					
May to early-June	2.48	2.61	2.79	.33	.90
Early-June to Mid-July	1.90	2.25	2.39	.07	.53
May to Mid-July	2.19	2.43	2.59	.16	.86
Available Grass, lb/acre					
Mid-July	1105	1285	1398	< .01	.54
Early-October	1773	1888	2052	.11	.87
Available Forbs, lb/acre					
Mid-July	438	442	468	.65	.85
Early-October	496	474	461	.55	.94

EFFECT OF SUPPLEMENTAL GRAIN SORGHUM AND OVERSEEDING WITH LADINO CLOVER ON GRAZING AND SUBSEQUENT FEEDLOT PERFORMANCE OF STEERS EARLY-INTENSIVELY GRAZED ON *ACREMONIUM COENOPHIALUM* - INFECTED TALL FESCUE PASTURES

***K. P. Coffey*[1], *J. L. Moyer*[1], *L. W. Lomas*[1], *and F. K. Brazle*[2]**

Summary

Eighty mixed breed steers (avg. wt. 560 lb.) were used to evaluate the effect on grazing gain and subsequent feedlot performance of different management options for steers early-intensively grazing *Acremonium coenophialum*-infected tall fescue pastures. Steers were allotted to pastures of infected fescue pastures or infected fescue overseeded with ladino clover and received no supplement or were offered grain sorghum at .25% of their body weight. Neither supplementation nor overseeding affected grazing or feedlot performance. However, grain supplementation on overseeded pastures reduced subsequent feedlot feed efficiency ($P < .10$). These management options did not substantially affect grazing or subsequent feedlot performance by steers early-intensively grazing infected fescue pastures.

(Key Words: Tall Fescue, *Acremonium coenophialum*, Ladino Clover, Grain Sorghum.)

Introduction

Most of tall fescue in southeast Kansas and the southeastern U.S. is infected with the endophytic fungus, *Acremonium coenophialum*. Cattle grazing infected tall fescue typically show toxicity symptoms that include poor performance and intolerance to heat. Although many management options have been tried to alleviate the toxicity, few have proven successful. Previous work at the Southeast Kansas Experiment Station (SEKES) has shown that approximately 70% of the performance reduction may be offset by overseeding ladino clover in infected pastures. However, those data were collected on cattle grazing from April until November. We were uncertain how ladino clover would contribute to gains of steers grazing in spring.

In another study, feeding grain sorghum (.25% of body weight) to steers grazing infected fescue improved pasture gain without reducing subsequent feedlot performance. However, grain sorghum supplementation for steers grazing fescue-ladino clover pastures has not been evaluated. Our objectives were to determine the effects of grain sorghum supplementation and ladino clover overseeding on grazing and subsequent feedlot performance by steers early-intensively grazing infected tall fescue pastures.

Experimental Procedures

Eighty mixed breed steers grazed eight 5-acre pastures at the Mound Valley Unit of the SEKES during 1990 and 1991. Steers were vaccinated against IBR, BVD, PI_3, BRSV, Leptospirosis (5 strains), pinkeye and 7-way blackleg, dewormed, and then allotted to one of the experimental pastures. Five additional steers were included to establish a stocking rate of 2 head/acre; double the typical stocking rate. Steers grazed the pastures from April 25 to June 20, 1990 and from March 29 to June 18, 1991.

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We used four 70% infected, tall fescue pastures and four infected pastures that were overseeded with ladino clover. All pastures received a fall application of 40 lb N, 40 lb P_2O_5, and 40 lb K_2O per acre, and infected pastures received an additional 80 lb N/acre in January of each year.

At the end of the grazing period, steers were dewormed, implanted with Synovex S®, and placed in feedlot pens with pasture replicates maintained. Steers were fed 80% ground grain sorghum, 15% corn silage, and 5% protein supplement[3] (DM basis) for 179 days in 1990 and 154 days in 1991. Beginning and ending pasture and feedlot weights were taken following a 16 hr shrink. At the end of the feedlot period, steers were slaughtered at a commercial plant, and carcass data were collected following a 24 hr chill.

Results and Discussion

Differences were detected between years, but interactions between year and forage type or supplementation were significant ($P < .10$) only for carcass backfat and rib eye area. Therefore, data were pooled across years.

Ending pasture and feedlot weights, and gains and subsequent feedlot DM intakes were not affected by either supplementation or clover overseeding (Table 1). However, control steers that had grazed overseeded pastures were more efficient in the feedlot than their supplemented counterparts. Feedlot feed efficiency of steers grazed on infected pastures was not affected by supplementation. Rib eye areas and yield grades from control steers were intermediate between those from steers supplemented on overseeded pastures and those supplemented on infected pastures, with those that had grazed overseeded pastures having larger rib eye areas and lower yield grades. Other carcass components were similar among combinations.

In previous work at SEKES, steers grazing overseeded pastures gained more during the grazing period than those grazing infected pasture. After a feedlot period, their carcasses also had greater backfat and higher yield and quality grades. That trend was not repeated in this experiment.

However, the grazing period of the previous study was over 200 days in each of 3 years; the ladino clover had more time to exert its benefit. In the present study, the grazing period may have been too short for the ladino clover to provide an advantage. Higher stocking rates in the present study also may have contributed to the differences.

Limited amounts of supplemental grain sorghum previously have improved pasture gain of steers spring-grazing tall fescue, without impairing subsequent feedlot performance. We saw no grazing gain improvement from supplementation in this experiment, but feeding grain sorghum to steers grazing overseeded pastures reduced subsequent feedlot feed efficiency.

Therefore, neither of the management options we evaluated appeared to substantially affect grazing gain on fescue pasture or subsequent feedlot performance.

[3]49% crude protein supplement containing 400 g/ton monensin.

Table 1. Effect of Supplemental Grain Sorghum or Overseeding with Ladino Clover on Grazing and Subsequent Feedlot Performance and Carcass Characteristics of Steers Early-Intensively Grazing *A. coenophialum*-Infected Tall Fescue Pastures

	Fescue-Ladino clover		Fescue	
Item	Control	.25% BW Milo	Control	.25% BW Milo
Pasture phase				
No. head	20	20	20	20
Initial wt., lb.	560	560	560	560
Final wt., lb.	627	640	633	624
Total gain, lb.	67	80	73	64
Daily gain, lb.	1.03	1.19	1.11	1.00
Feedlot phase				
Initial wt., lb.	627	640	633	624
Final wt., lb.	1200	1170	1173	1160
Total gain, lb.	572	530	540	536
Daily gain, lb.	3.51	3.25	3.32	3.29
Daily DM intake, lb.	22.8	24.3	23.8	23.2
Feed/gain	6.60[b]	7.63[a]	7.30[ab]	7.18[ab]
Carcass data				
Hot carcass wt., lb.	735	729	726	716
Dressing %	61.3	62.2	61.9	61.5
Backfat, in.	.41	.36	.41	.46
Rib eye area, in.[2]	13.7[ab]	14.3[a]	13.5[ab]	12.8[c]
Quality grade[1]	9.7	10.0	10.2	10.0
Yield grade	2.5[ab]	2.2[b]	2.5[ab]	2.8[a]

[1]9 = Select$^+$; 10 = Choice$^-$.
[a,b,c]Row means differ ($P < .10$).

SYNCHRONIZATION OF ESTRUS IN YEARLING BEEF HEIFERS WITH THE MGA®/PROSTAGLANDIN SYSTEM: I. EFFECT ON INDUCEMENT OF PUBERTY AND CONCEPTION RATES[1,2]

L.R. Corah, J.R. Yaeger[3], J.C. Whittier[4], J.C. Meiske[5], K.C. Olson[3], and D.J. Patterson[6]

Summary

We evaluated the estrous response and fertility of yearling beef heifers after treatment with melengestrol acetate (MGA) and prostaglandin $F_2\alpha$ (PG). The 304 heifers, at three locations, were allotted to two treatments: nonsynchronized controls and those receiving .5 mg MGA per head daily for 14 days followed by a 25 mg PG injection 17 days after the end of MGA feeding (MGA/PG). Heifers in the control and MGA/PG groups were artificially inseminated 12 hours after observed estrus for 21 days or 6 days after PG, respectively. Conception rate at first service and overall pregnancy rate did not differ ($P > .10$) between MGA/PG and control heifers (64% vs. 50% and 49% vs. 38%, respectively). However, the MGA/PG system effectively induced puberty and synchronized estrus, allowing more ($P < .009$) heifers to become pregnant early in the breeding season (49%) compared with nonsynchronized controls that were inseminated on spontaneous estrus (14%).

(Key Words: Beef, Heifer, Puberty, MGA, Estrous Synchronization.)

Introduction

Numerous researchers have evaluated melengestrol acetate (MGA) as a tool to synchronize estrus in beef cattle. Early studies showed a decrease in fertility at first estrus after feeding MGA for 14 to 20 days. Subsequent studies shortened the MGA feeding period and combined PG administration after MGA feeding. Workers in Colorado successfully synchronized estrus by feeding MGA for 14 days and administering PG 16 to 17 days after MGA withdrawal, with no apparent reduction in fertility.

The objectives of this study were to: 1) determine the ability of the MGA/PG estrous

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[1]This research resulted from cooperative efforts of the North Central Region Committee for Cow-Calf Nutrition and Management (NCR-87).

[2]Appreciation is extended to The Upjohn Company for providing Lutalyse® and MGA-200® for this experiment. Authors are grateful to Donagene Jaeger, David McAttee, Arman Miller, and Randy Anderson for assistance with data collection, and to Dr. J.R. Chenault of the Upjohn Company for statistical consultation.

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[4]Animal Science Department, University of Missouri.

[5]Animal Science Department, University of Minnesota.

[6]Department of Animal Science, University of Kentucky.

synchronization system to induce puberty in prepuberal heifers and 2) compare the reproductive performance of yearling beef heifers exposed to the MGA/PG system and inseminated on synchronized estrus to that of untreated heifers inseminated on spontaneous estrus.

Experimental Procedures

This experiment was conducted at three locations in two states with crossbred, yearling, virgin, beef heifers. The numbers of heifers used at each location were as follows: 168 head at Hays, KS; 79 head at Manhattan, KS; and 57 head at Spickard, MO.

Treatments. Heifers at each location were blocked by age and weight and assigned randomly to one of two treatments: 153 nonsynchronized control heifers and 151 heifers that received .5 mg MGA per head daily for 14 days followed by a single injection of 25 mg PG (Lutalyse®) administered 17 days after the last day of MGA feeding (MGA/PG). After PG injection, heifers were observed twice daily for signs of behavioral estrus for the next 21 days. Control and MGA/PG heifers were exposed to AI for 21 days and 6 days, respectively. Heifers were inseminated approximately 12 hours after observed estrual behavior. No more than two technicians or two AI sires were used at each location.

Supplements. A similar supplement, with or without MGA, was fed to both treatment groups at each location. Heifers were managed as a single group at each location throughout the trial, except during the 14-day MGA feeding period.

Blood Sampling. Blood samples were collected from all heifers on 4 dates: 1) 10 days before MGA feeding, 2) on the day MGA feeding started, 3) 10 days before PG injection, and 4) on the day of PG injection. Serum progesterone concentrations greater than 1 ng/ml or sampling dates 1 or 2 and 3 or 4 were used to determine whether heifers were puberal at the beginning of the experiment or at the beginning of the breeding season, respectively. Heifers that attained puberty during the period from the start of MGA feeding until PG injection were indentified by an increase in serum progesterone to at least 1 ng/ml on sampling dates 3 or 4.

Results and Discussion

Attainment of Puberty. A greater proportion ($P < .02$) of MGA/PG heifers that were prepuberal before MGA attained puberty during the MGA feeding period and before PG injection compared to control heifers during the same period (Table 1). This suggests that MGA induced puberty in a number of nonpuberal heifers. The fertility of those attaining puberty is shown in Table 2.

Estrous Response. The proportion of MGA/PG heifers that displayed estrus within 6 days after PG injection was greater ($P < .001$) than the proportion of controls that showed estrus during the same period (Table 3). The response during 6 days also was influenced ($P = .03$) by location. The percentages of heifers that displayed estrous within 6 days at each location were 53.6, 44.1, and 54.7% for Hays, Manhattan, and Spickard, respectively.

The proportions of heifers classified as puberal (based on progesterone concentration) that failed to exhibit estrus after 6 days for MGA/PG or after 21 days for control were 17.1 and 15.3%, respectively. This lack of estrous response may have resulted from poor heat detection, ovulation unaccompanied by estrus, or failure of the progesterone analyses to classify puberal status correctly. This study could not explain the high proportion of heifers not displaying estrual behavior.

Fertility Response. Estrous synchronization of heifers with the MGA/PG system did not affect ($P > .30$) first service conception rate at 6, 14, or 21 days following treatment compared to control heifers (Table 3). Pregnancy rate of MGA/PG heifers inseminated within 6 days after PG was greater ($P = .02$) than that of controls during the same period, but location effect also was significant ($P < .01$).

There was a numerical, but nonsignificant (P = .31), increase in first service conception rate of MGA/PG heifers compared to controls (Table 3). This same trend has been reported by other researchers.

Table 1. Effect of Feeding MGA for 14 Days on Attainment of Puberty in Yearling Beef Heifers

	Control[a]		MGA/PG		
Puberty status	No.	%[b]	No.	%[b]	P[c]
Cycling before MGA feeding	92/153	63.8	92/147	70.2	.74
Cycling before PG injection	111/153	74.9	123/147	86.2	.25
Attained puberty during or after MGA feeding	25/61	44.9	40/55	72.0	.02

[a]Control = heifers received no treatment, MGA/PG heifers received .5 mg MGA per head for 14 days.
[b]Least squares means.
[c]Statistical probability of a treatment effect.

Table 2. Reproductive Response of Heifers Attaining Puberty during Exposure to MGA for 14 Days

	Control[a]		MGA/PG[a]		
Response	No.	%[b]	No.	%[b]	P[c]
Displayed estrus	18/25	79.1	33/40	71.4	.60
First service conception rate	9/18	58.3	22/33	77.0	.50
Pregnancy rate	9/25	50.7	22/40	54.3	.90

[a]Control = heifers received no treatment and were exposed to AI for 21 days; MGA/PG heifers received .5 mg MGA per head for 14 days and PG 17 days after MGA and were exposed to AI for 6 days.
[b]Least squares means.
[c]Probability of a treatment effect.

Table 3. Effect of MGA/PG System on Synchronization of Behavioral Estrus and Fertility Rates in Yearling Beef Heifers

	KSU Manhattan location				All locations				
	Control[a]		MGA/PG[a]		Control		MGA/PG		
Item	No.	%	No.	%	No.	%[b]	No.	%[b]	P[c]
Observation period:			Behavioral estrus						
0 to 6 days after PG[d]	7/41	17.1	27/38	71.1	39/153	24.7	114/147	76.8	.001
0 to 21 days after PG	37/41	90.2	27/38	71.7	108/153	75.7	114/147	76.8	.92
Insemination period:			First service conception rate						
0 to 6 days after PG	4/7	57.1	22/27	81.5	22/39	58.5	76/114	64.2	.69
0 to 21 days after PG	20/37	54.1	22/27	81.5	56/108	50.0	76/114	64.2	.31
			Pregnancy rate						
0 to 6 days after PG	4/41	9.7	22/38	57.9	22/153	14.0	76/147	48.7	.009
0 to 21 days after PG	20/41	48.7	22/38	57.9	56/153	37.7	76/147	48.7	.29

[a]Control heifers received no treatment and were exposed to AI for 21 days; MGA/PG heifers received .5 mg MGA per head for 14 days and PG 17 days after MGA and were exposed to AI for 6 days.
[b]Least squares means.
[c]Statistical probability of a treatment effect.

SYNCHRONIZATION OF ESTRUS IN YEARLING BEEF HEIFERS WITH THE MELENGESTROL ACETATE®/PROSTAGLANDIN $F_{2\alpha}$ SYSTEM: II. TIMED INSEMINATION[1,2,3]

R. L. Larson, L. R. Corah, and S. V. Viker

Summary

Inseminating heifers 72 hr after the PG injection in the melengestrol acetate/ prostaglandin $F_{2\alpha}$ (MGA®/PG) estrous synchronization system, without regard to behavioral estrus, tended to improve (P = .2) the percent of heifers pregnant to artificial insemination (AI) when compared to synchronized heifers bred 12 h after they were first detected in estrus. In the timed inseminated treatment, heifers exhibiting behavioral estrus 48 to 72 h after PG tended to have a higher (P < .12) conception rate to AI than heifers showing estrus within 48 h after PG. For situations in which the number of heifers conceiving to AI is more economically important than first service conception rate, or when labor restrictions make estrous detection impossible, timed insemination at 72 h after PG in the MGA/PG system shows promise as a management option.

(Key Words: MGA/PG, Heifers, Timed Mating, Conception Rates.)

Introduction

Artificially inseminating beef heifers to bulls selected according to expected progeny differences (EPDs) helps to minimize dystocia and obtain superior replacement females. Estrous synchronization allows a producer to decrease the number of days committed to an AI program and also to optimize labor requirements at calving time. But a serious problem in that system is the amount of time and expertise required to accurately detect estrus. We investigated the merits of timed insemination following the MGA/PG system of estrous synchronization to determine its effects on first service conception rate and percent of heifers becoming pregnant to AI.

Experimental Procedures

Yearling heifers (n = 576) were allotted randomly to two treatments. At each of three commercial ranch locations, all heifers received melengestrol acetate (MGA) (.5 mg/hd/d) for 14 d, with prostaglandin $F_{2\alpha}$(Lutalyse®) injected 17 d after the conclusion of MGA feeding. At the time of PG injection, serum was collected for progesterone analysis. All heifers with progesterone concentrations above 1 ng/ml were classified as puberal.

At each location, the heifers were artificially inseminated (AI) by two or three inseminators to three AI sires. Sire and inseminator were distributed equally between the two treatments. Heifers were bred either 1) 12 h after first detected in estrus or 2) 72 h after PG

[1]The authors express their appreciation to Don Kruger and Tom Harrington for their expert assistance in artificially inseminating the cattle.

[2]Partial financial assistance was provided for this project by Select Sires, Inc. Plain City, Ohio.

[3]Appreciation is expressed to the three cooperating ranches: Matador Cattle Co., Wichita, KS; Clint Huntington, Eureka, KS; and Randy Mills, Florence, KS.

injection. First service conception rates were determined by rectal palpation 45 to 70 d after AI.

Results and Discussion

Of the total heifers in the study, 31.0% of those bred 12 h after first detected estrus became pregnant to AI compared to 36.3% in the timed insemination group (P = .13)(Table 1).

Based on concentrations of progesterone, 66% of the heifers were puberal, with no differences between treatments. Of those puberal heifers, 65.2% showed estrus and were bred 12 hrs later; 65.6% of those bred conceived. Of those bred 72 hr after PG, 52.8 had shown estrus and 62.1% of those bred conceived. Of the heifers classified as puberal but not showing behavioral estrus, 43.0% conceived to the timed insemination (Table 2).

In the timed inseminated treatment, heifers showing behavioral estrus within 48 h after PG had a 49.0% pregnancy rate compared to 64.4% (P = .13) for those in estrus 48 to 72 h after PG. Table 3 indicates that a few (7.7%) heifers with low progesterones, thus not considered cycling, conceive to AI.

These experiments demonstrate that timed insemination 72 h following estrous synchronization with MGA/PG may increase the percent of heifers pregnant to AI.

Table 1. Expression of Estrus and AI Pregnancy Rate of All Heifers

	Insemination treatment	
Item	12 h after estrus	72 h after PG
No.	287	289
% Showing estrus	47.7	39.1
% Pregnant to AI	31.0[a]	36.3[b]

[ab]Row means tend to differ (P = .13).

Table 2. Expression of Estrus and AI Pregnancy Rates of Heifers Considered Puberal

	Insemination treatment	
Item	12 h after estrus	72 h after PG
No.	187	195
% Showing estrus	65.2	52.8
% Pregnant to AI		
if they showed estrus	65.6	62.1
if they didn't show estrus	0[a]	43.0
of total	42.7[b]	51.8[c]

[a]By design, heifers in this group were not inseminated if they did not show behavioral estrus.
[b,c]Row means tend to differ (P = .2).

Table 3. Expression of Estrus and Pregnancy Rates of Heifers Not Considered Puberal

	Insemination treatment	
Item	12 h after estrus	72 h after PG
No.	100	94
% Showing estrus	16.0	10.6
% Pregnant to AI	9.0	6.4

SYNCHRONIZATION OF ESTRUS IN YEARLING BEEF HEIFERS WITH THE MGA®/PROSTAGLANDIN $F^2\alpha$ SYSTEM: III. TIMED INSEMINATION AFTER 72 HOURS OF ESTROUS DETECTION[1,2]

R. L. Larson and L. R. Corah

Summary

The percentage of heifers conceiving to artificial insemination (AI) following melengestrol acetate/prostaglandin $F_2\alpha$(MGA®/PG) estrous synchronization can be increased by mass insemination of all heifers not showing estrus by 72 h after PG. Inseminating at 12 h after estrus detection all heifers showing estrus within 72 h after PG; then inseminating those not detected in estrus by 72 h after PG as a group increased the proportion of heifers conceiving to AI by 10.8%.

(Key Words: MGA/PG, Heifers, Timed Mating, Conception Rate.)

Introduction

Earlier experiments conducted by KSU scientists have shown that mass insemination following MGA/PG estrous synchronization is an effective method of increasing the number of heifers conceiving to AI. These earlier trials also indicated that timed insemination was most effective in heifers that displayed estrus beyond 48 h after PG. By combining estrous observation and insemination 12 h after first detected estrus with timed insemination 72 h after PG, we hoped to maximize the number of heifers settling to AI in a 3 d breeding period. Also of interest was the association of serum progesterone concentration at the time of PG injection with subsequent estrous behavior and AI conception rate.

Experimental Procedures

A total of 251 heifers at two commercial ranches received melengestrol acetate (MGA) (.5 mg/head/d) for 14 d with prostaglandin $F_2\alpha$ (Lutalyse®) injected 17 d after the end of MGA feeding. At the time of PG injection, serum was collected and later analyzed for progesterone concentration. Heifers were observed for estrous activity and inseminated 12 h after first being detected in estrus during the first 72 h following PG. At 72 h, all heifers that had not exhibited estrus were mass inseminated. Bulls were turned with the heifers 7 to 14 days after mass mating for 45 to 75 days. First service conception rate was determined by rectal palpation 50 to 100 days after AI.

Results and Discussion

Table 1 shows the benefits of combining estrous detection for 72 h with mass insemination of the heifers failing to show estrus by that time. By adding mass insemination to conventional estrous detection, we were able to get an additional 10.8% of the heifers to settle to AI. Conception rates to AI were higher ($P < .05$) in heifers that were detected in estrus in both ranches, (72.5% versus 50.0%). This was expected, because the non-

[1]Appreciation is expressed to Select Sires, Inc., Plain City, Ohio for partial financial assistance and to the Upjohn Co., Kalamazoo, Michigan for providing prostaglandin.

[2]Appreciation is expressed to the two cooperating ranches: Gary Johnson, Dwight, Kansas, and Jack and Alan Grothusen, Ellsworth, Kansas.

responding group also included non-puberal heifers and those not responding to synchronization. But the group of heifers that were not detected in estrus also must have included individuals that were puberal and ovulated in a time period coinciding with the synchronization period, because 50.0% of these heifers settled to the AI breeding.

Only 82.9% of the heifers were puberal at the start of the breeding season (Table 1), when we used > .9 ng/ml serum progesterone as a cut-off point. In those heifers not detected in estrus, more became pregnant to AI if they had serum progesterone concentrations greater than .75 ng/ml at PG administration ($P < .05$). In heifers that displayed estrus, serum progesterone was not related to conception. Possibly the most surprising finding is that 37.5% of heifers not detected in estrus and also having < .75 ng/ml progesterone conceived to AI.

In conclusion, we found acceptable conception rates for heifers not detected in estrus but mass inseminated at 72 h following PG.

Table 1. AI Pregnancy Rate of All Heifers

	Ranch A	Ranch B	Overall
No. of heifers	178	73	
Total AI conception rate	69.1%	64.4%	67.7%
Overall pregnancy rate	96.6%	90.5%	95.2%
Puberal (> .9 ng/ml progesterone)	86.5%	73.9%	82.9%
AI conception rate for heifers showing estrus	72.3%	73.1%	72.5%
AI conception rate for heifers not showing estrus	58.3%	31.3%	50.0%
No. of heifers not detected in estrus that settled to AI	22 (12.4%)	5 (6.8%)	10.8%
AI conception rate for heifers detected in estrus with P concentration:			
< .75 ng/ml	100.0% (4/4)	77.8% (7/9)	84.6%
.75 - 1.5 ng/ml	63.6% (14/22)	71.4% (10/14)	66.7%
> 1.5 ng/ml	72.0% (85/118)	69.2% (18/26)	71.5%
AI conception rate for heifers not detected in estrus with P[1] concentration:			
< .75 ng/ml	50.0% (8/16)	12.5% (1/8)	37.5%
> .75 ng/ml	65.0% (13/20)	50.0% (4/8)	60.7%

[1]P = progesterone.

INFLUENCE OF SOURCE AND AMOUNT OF DIETARY PROTEIN ON THE PERFORMANCE AND REPRODUCTIVE FUNCTION OF FIRST-CALF HEIFERS[1]

W. C. Rusche, R. C. Cochran, L. R. Corah, J. S. Stevenson, and D. L. Harmon[2]

Summary

Increasing the amount of dietary protein above the NRC requirement increased weight gain of nursing first-calf heifers. Feeding a protein source with higher ruminal escape potential and increasing protein in the diet both improved calf gains. No significant changes in reproductive function or milk production were observed from either source or amount of dietary protein.

(Key Words: Beef Cows, Protein, Escape Protein, Reproduction, Milk.)

Introduction

Prolonged postpartum anestrus, particularly in first-calf heifers, is a major obstacle to optimum reproductive efficiency in beef herds. Research at other universities has shown positive effects on return to estrus by increasing dietary protein from a source with high ruminal escape (bypass) potential. Our objectives were to determine the effects of source and amount of dietary protein on the performance and reproductive function of suckled first-calf beef heifers.

Experimental Procedures

Forty Angus × Hereford 2 year-old first-calf heifers with an average weight of 788 lbs and body condition score (BCS; 1 = emaciated, 9 = obese) of 4.5 were stratified by calving date and allotted randomly to four dietary treatments. Treatments were arranged as a 2 × 2 factorial experiment with nursing heifers receiving either 100 or 150% of the NRC minimum requirement for dietary crude protein, primarily either from soybean meal/urea (low escape = L) or corn gluten meal/bloodmeal/urea (high escape = H) resulting in four treatments: 100-L, 100-H, 150-L, and 150-H. Compositions of the diets are shown in Table 1. Diets were formulated to be isocaloric and met the NRC minimum net energy standard. Diets were fed individually for 100 days or until cows were observed in standing estrus. Days on trial did not differ among treatments and averaged 97 days. Cows were weighed and body condition was scored again at calving. At trial completion cows were fed their normal diets at mid-afternoon, allowed access to water overnight, and weighed and scored for body condition the following morning. Calves were kept with their dams overnight and weighed at the same time as the cows. Serum samples for progesterone analysis were collected three times weekly. Concentration of luteinizing hormone (LH) was determined in blood serum collected every 12 minutes for 6 hours via an indwelling jugular catheter approximately 35 days after calving. At approximately 61 days postcalving, each cow and her calf were separated overnight, and cows were milked mechanically the following morning to estimate daily milk production. Cows were palpated by experienced technicians for pregnancy

[1]The authors would like to thank Gary Ritter, Wayne Adolph, Charlie Peters, Kendall Lock, Scott Kleinschmidt, and Eric Wolf for their assistance in conducting this experiment.

[2]Presently at the University of Kentucky, Lexington.

determination and fetal aging after exposure for 60 days to fertile bulls.

Results and Discussion

Increased protein in the diet above NRC requirement tended (P = .09) to increase weight gain of cows but source of protein had no effect (Table 2). Cows fed greater amounts of dietary protein had a positive, though non-significant, change in body condition score. Both increased dietary protein and use of a protein source with higher ruminal escape potential increased calf gains (P = .003 and .05, respectively). This response may be partially explained by corresponding numerical improvements in milk production. Mean concentration of LH tended to be lower (P = .12) in cows fed higher escape protein sources. Days required postcalving for serum progesterone to exceed 1 ng/ml, LH pulse frequency, LH pulse amplitude, and estimated fetal age were all unaffected by dietary treatment (Table 3). Conception rate of the 100-L group was numerically, but not statistically, lower than that of the other dietary groups. When protein was fed to meet the calculated NRC requirement, a protein source with higher ruminal escape potential improved calf performance. Increasing the amount of dietary crude protein enhanced both cow and calf gains.

Table 1. Diet Compositions (100% Dry Matter Basis)

Feedstuff	100-L	100-H	150-L	150-H
Prairie Hay	57.81	57.87	55.68	55.92
Corn	33.76	35.60	24.76	30.06
Soybean Meal	6.05		17.33	
Corn Gluten Meal		2.35		6.69
Bloodmeal		1.69		4.86
Molasses	1.42	1.42	1.43	1.44
Urea	.49	.49	.50	.50
Salt	.22	.22	.22	.22
Monocalcium phosphate	.11	.22		.17
Limestone	.11	.11	.06	.11
Trace mineral premix	.03	.03	.03	.03
Cow intake/day:				
Lb dry matter	18.34	18.32	18.18	18.10
Lb crude protein	2.23	2.07	3.08	2.96

Table 2. Effects of Source and Amount of Dietary Protein on Cow and Calf Performance

					P-values[a]		
Item	100-L	100-H	150-L	150-H	A	S	A × S
Initial weight	770	814	790	776			
Cow gain, lb/day	.62	.55	.68	1.06	.09	.36	.17
Initial BCS[b]	4.72	4.55	4.50	4.30			
BCS change	–.17	–.05	+ .15	+ .05	.23	.96	.53
Calf gain, lb/day	1.23	1.32	1.43	1.69	.003	.05	.34
Milk production, lb/day	10.4	11.4	11.2	13.0	.27	.21	.72

[a]Statistical probability of a treatment effects due to protein amount (A), source (S), or interaction (A × S).
[b]BCS = body condition, 1 to 9 scoring system.

Table 3. Effects of Source and Amount of Dietary Protein on Reproductive Characteristics

					P-values[a]		
Item	100-L	100-H	150-L	150-H	A	S	A × S
Serum LH conc., ng/ml	.79	.69	.80	.69	.91	.12	.96
LH pulse frequency/6 hr	.60	.40	.56	.30	.73	.29	.90
LH pulse amplitude, ng/ml	1.17	1.28	1.54	.87	.53	.27	.86
Days to P_4 > 1 ng/ml[b]	88	84	81	86	.60	.98	.30
Conception rate, %	56	80	90	80	.24	.83	.24

[a]Statistical probability of a treatment effect due to protein amount (A), source (S), or interaction (A × S).
[b]Days required postcalving for serum progesterone to exceed 1 ng/ml, indicating normal estral activity.

EFFECTS OF NIACIN[1] AND ASPIRIN ON SERUM PROLACTIN AND BODY TEMPERATURE OF HEIFERS FED ENDOPHYTE-INFECTED TALL FESCUE[2,3]

R. L. Larson and L. R. Corah

Summary

Feeding niacin to cattle consuming endophyte (*Acremonium coenophialum*)-infected tall fescue elevated their serum prolactin concentrations to levels similar to those of heifers fed hay containing a low content of endophyte. Heifers fed high-endophyte hay, with or without aspirin, had lower serum prolactin concentrations than heifers fed low-endophyte fescue hay ($P < .1$). Compared to control cattle fed high-endophyte hay, neither niacin nor aspirin lowered morning or evening body temperatures during the period August 16 to September 4. Feeding aspirin did not lower body temperature or increase prolactin concentration in animals fed high-endophyte fescue forage. Some benefit was seen when niacin was added to the diet, as evidenced by higher ($P < .01$) prolactin concentrations; however body temperature was not lowered.

(Key words: Fescue, Niacin, Aspirin, Prolactin, Body Temperature.)

Introduction

Tall fescue is one of the most important cool-season grasses in the United States. Cattle grazing endophyte-infected fescue typically exhibit a number of symptoms, including reduced feed intake, weight gain, and milk production; higher rectal temperatures and respiratory rates; and reduced serum prolactin concentrations. The elevated body temperature appears to be due to an inability to dissipate body heat. Niacin has vasodilatory activity and can increase heat dissipation in some animal species. Aspirin reduces body temperature by inhibiting prostaglandin synthesis, so may also help alleviate the high body temperature induced by endophyte-infected fescue. Serum prolactin concentrations are much lower in cattle suffering endophyte toxicosis than in animals fed low-endophyte hay. This difference in serum prolactin concentration can be used as an indication of endophyte toxicosis.

Experimental Procedures

To evaluate niacin and aspirin as potential aids in minimizing the effects of endophyte toxicosis, 20 beef heifers, stratified by weight and previous treatment, were allotted to one of four treatments: low-endophyte fescue hay, (70%) endophyte-infected hay, endophyte-infected hay plus 2 gm of niacin daily, and endophyte-infected hay with 91 mg/lb body weight/day aspirin. All heifers were fed 4 lb of concentrate with or without the niacin or aspirin. Body temperatures were measured twice daily at 5:30 am and 3:30 pm, and blood

[1]Niacin (99% nicotinic acid) - Lonza Inc.

[2]Appreciation is expressed to Don Kruger and Warren Rusche for assistance in conducting the experiment.

[3]Appreciation is expressed to Steve Blum and Lonza, Inc. for partial funding of the trial; to Dr. Rob Stuart, Stuart, Inc. for assistance in experimental design; and Dr. Jim Higgins for statistical assistance.

samples were taken three times weekly from July 31 to September 4, 1990 for radioimmunoassay of serum prolactin concentrations. Data were analyzed for the entire trial and then separately for the period from August 16 through September 4, 1990 when the environmental temperature reached over 90°F on 16 of the 20 days and over 100°F on 7 days. Refer to Figure 1 for maximum daily environmental temperatures during the trial.

Results and Discussion

Neither aspirin nor niacin lowered morning or evening body temperatures from August 16 through September 4 of cattle fed high-endophyte fescue (Figure 2). Heifers fed niacin had evening body temperatures that were not different from those of low-endophyte fed heifers, but heifers receiving aspirin had higher evening temperatures than corresponding control heifers ($P < .05$). Heifers fed low-endophyte fescue had higher serum prolactin concentrations (Figure 3) than either the control heifers fed high-endophyte fescue or the heifers fed aspirin ($P < .05$). Heifers fed low-endophyte fescue and heifers fed high-endophyte fescue and niacin had similar serum prolactin concentrations.

Feeding aspirin had no effect on body temperature and serum prolactin concentration of heifers fed high-endophyte fescue forage. But feeding niacin tended to increase prolactin.

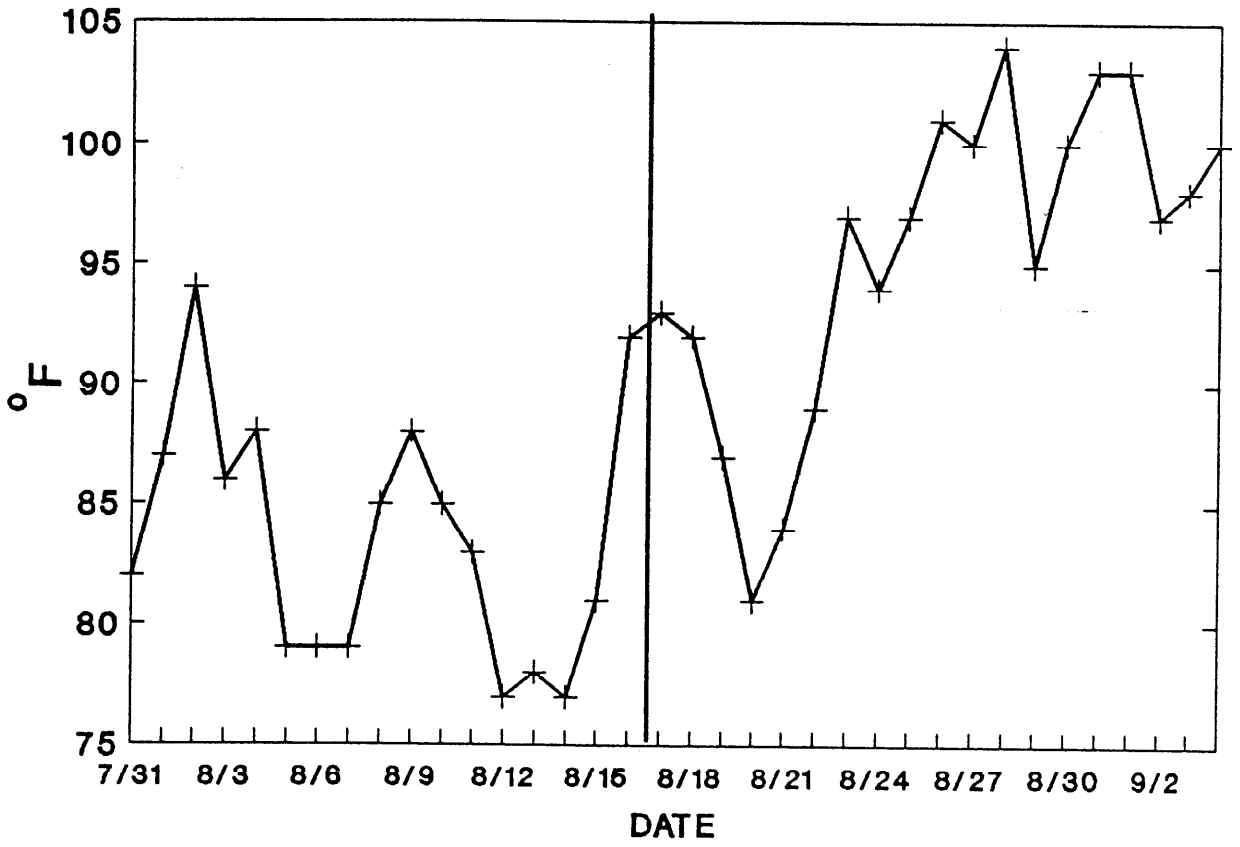

Figure 1. Plot of Maximum Daily Environmental Temperatures for the Experimental Period July 31 through September 4, 1990. (Note especially the period of high daily temperature from August 16 through September 4).

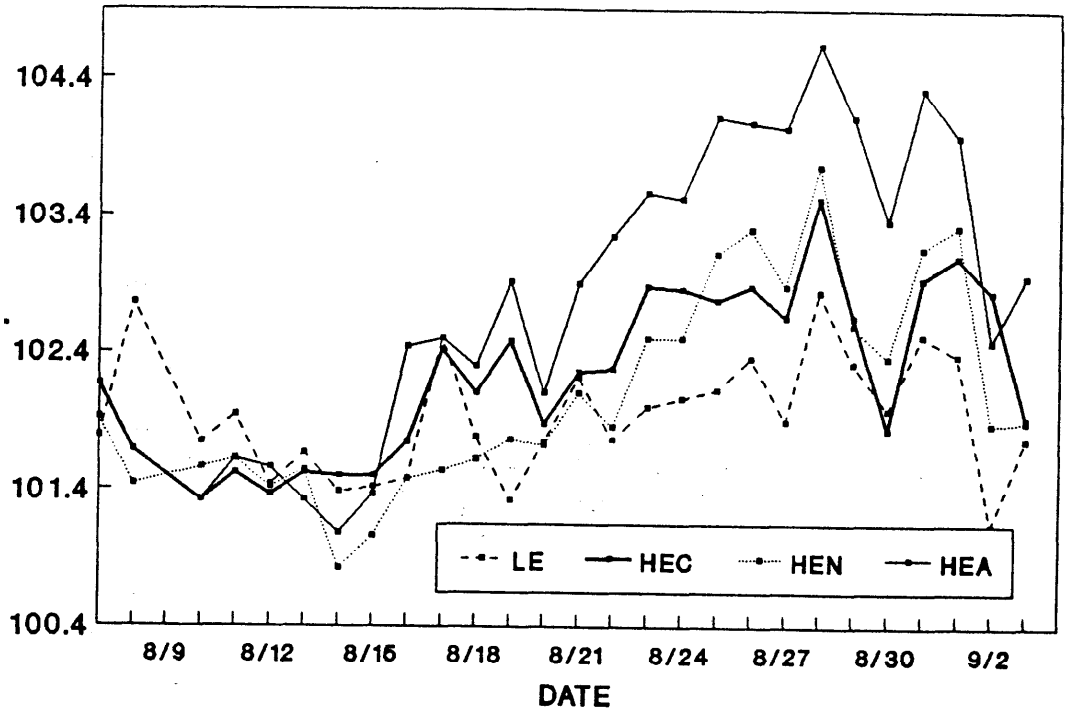

Figure 2. **Daily Body Temperatures of Heifers from August 7 through September 4, 1990. LE - low-endophyte hay; HEC - high-endophyte hay, control; HEA - high-endophyte hay supplemented with aspirin; HEN - high endophyte hay supplemented with niacin.**

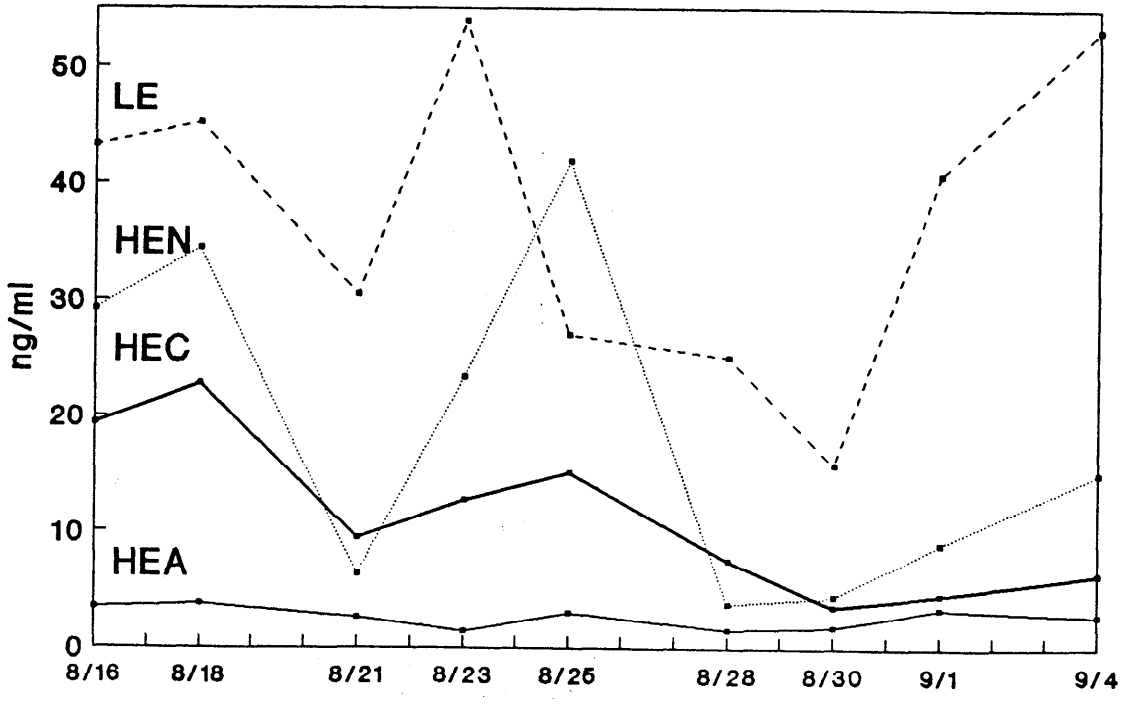

Figure 3. **Serum Prolactin Concentrations of Heifers from August 16 through September 4, 1990. See Figure 2 for treatment abbreviations.**

EFFECT OF DEWORMING WITH IVOMEC® ON REPRODUCTIVE PERFORMANCE OF YEARLING BEEF HEIFERS[1]

R. L. Larson, L. R. Corah, M. F. Spire[2], and R.C. Cochran

Summary

To determine the effect of deworming fall-born yearling heifers on reproductive parameters, 78 heifers were allotted to a either Ivomec® or control treatments. The heifers were dewormed in June and October when they were approximately 7 and 11 months old, respectively. Ivomec effectively lowered fecal egg counts from treated heifers compared to controls. In these heifers that were maintained on a marginal plane of nutrition, deworming not only improved weight gains but also hastened onset of puberty and improved conception rate during a 60-day breeding season. The positive effect of Ivomec on these reproductive characteristics could not be explained by increased weight gain alone, because the correlation between weight gain and puberty was not significant.

(Key Words: Beef Heifers, Deworming, Puberty.)

Introduction

Internal parasites are important economic burdens to the beef cattle industry. They can reduce virtually every production parameter. The recent advent of broad spectrum dewormers such as Ivomec (ivermectin) offers the potential of improving production efficiency through control of internal and external parasites. Although numerous studies have demonstrated the efficacy of ivermectin for internal and external parasite control, few trials have evaluated ivermectin's effects on reproductive characteristics of replacement heifers. This study was designed to investigate the effects of deworming with Ivomec on heifer weight gain, body condition score, uterine/ovarian score, pelvic area, age at puberty, and conception rate during a 60-day breeding season.

Experimental Procedures

The trial was initiated in June, 1990 to determine the efficacy of deworming with ivermectin on production characteristics of 78 fall-born, weaned, beef heifers. The replacement heifers were stratified by weight and allotted to 10 native grass pastures on June 20 (day 1). Five pasture replicates of eight animals per pasture were injected subcutaneously with ivermectin (90 µg/lb body wt), whereas five pastures of eight heifers each served as untreated controls. The treated heifers received a second dose of ivermectin on October 10 (day 113).

The heifers were weighed on day 1 after being held off feed and water overnight and again at 28-day intervals until the trial concluded on January 15, 1991. On each weigh date, fecal samples were collected from the

[1]Authors sincerely appreciate the assistance of Don Kruger, Gary Ritter, and Wayne Adolph in conducting this trial. Appreciation is also expressed to Dr. M.G. Scroggs for his assistance and to MSD AgVet for partial funding of the trial. We are grateful to John Floyd and Floyd Mills, Sedan, KS for providing cattle for the study.

[2]KSU Department of Clinical Sciences.

same representative heifers. Fecal sample analysis was done at Texas A&M University.

At the time of re-deworming (day 113), the heifers were evaluated for body condition score (1 = thin; 9 = fat), pelvic measurement (Rice pelvimeter), and uterine/ovarian score. To determine the onset of cyclicity, jugular blood samples were collected at 10-day intervals from August 15 (day 57) until December 26 (day 190) and analyzed for progesterone utilizing conventional radioimmunoassay techniques. When serum progesterone exceeded 1 ng/ml, heifers were considered puberal. At the conclusion of the fall grazing period (Nov 7), two breeding groups were established by combining the five dewormed replicates into one pasture and the five control replicates into an adjacent pasture. Each breeding group of 39 heifers was exposed to two bulls, which had passed a breeding soundness examination. The breeding period ran from November 16 to January 15 (days 150 to 210), with the bulls rotated between the two breeding groups every 7 days. To determine pregnancy rates, the heifers were palpated 45 days after the end of the breeding season.

Rainfall during the summer of 1990 was below normal, so available summer and fall forage was reduced. Moreover, tallgrass prairie typically is low in protein and energy during the fall and winter. This grazing situation resulted in marginal nutritional development of heifers and is not unusual for cattle raised in the Kansas Flint Hills or other areas of tallgrass prairie. The heifers had free-choice access to a salt/phosphorus mineral mix during the entire trial. Starting in September, all heifers were fed a 20% protein supplement (whole soybeans/dehydrated alfalfa) at 3.5 lbs/heifer, three times a week. At the start of the breeding season, this was increased to 6.0 lbs/heifer/day.

Results and Discussion

Ivomec lowered ($P < .01$) fecal egg counts following treatment on both day 1 and day 113 compared to controls. There appeared to be an environmentally induced period of suppressed fecal egg counts in both treatment and control groups during July and August, a pattern also observed in the southern United States. Both treatment and control groups exhibited a marked rise in fecal egg counts in September. More than 90% of identified larvae were *Cooperia*, except for the mid-July collection, which exhibited a rise, although not statistically significant, in *Ostertagia*.

Table 1. Weight Change and Body Condition Score

Item	Control	Treatment
Number	39	39
Weight change		
Starting weight	492.8	484.4
Fall weight, day 113	610.2	611.7
Period 1 gain, day 1 to 113	117.4[a]	127.3[b]
Pre-breeding weight, day 141	591.2	613.0
Period 2 gain, day 1 to 141	98.4[c]	128.7[d]
Post-breeding weight, day 210	640.1	645.6
Period 3 gain day 1 to 210	147.3[a]	161.2[b]
Body condition scores*		
Yearling, day 122	4.3[c]	4.5[d]
Post-breeding, day 210	5.1[c]	5.3[d]

*1-9, 1 = thin, 9 = obese.
[ab]$P = .09$.
[cd]$P < .01$.

As shown in Table 1, deworming significantly improved weight gain. Most of the Ivomec response occurred during the first 28 days after each deworming ($P < .05$). The observed weight gain response was corroborated by an increase ($P < .0l$) in body condition score of the Ivomec-treated heifers. The numerical difference (.2) in body condition scores between treatments corresponded to 15 to 16 lb, which was in line with actual weight changes.

It is important to note that the overall daily gain (.70 vs .77 lb/day for control and dewormed heifers respectively) during the 210-day trial reflected marginal nutrition, which could have impacted the deworming response and probably explains the poor pregnancy rates discussed later.

Deworming significantly increased yearling pelvic area by 7.5%, but had no effect on the uterine/ovarian score. At one year of age, 33.3% more treated heifers (Figure 1) were puberal than controls (56% vs 31%). Because time of puberty is influenced by age, weight, and breed, the facts that only 71.8% of the control animals attained puberty by the end of the trial and that their body condition scores were low reflected the minimal level of nutrition.

The criterion used to determine puberty was reaching 1 ng/ml of serum progesterone. This criterion was not met by 12.8% of heifers, with a majority of these failures in the control group. Once heifers reach 1 ng/ml of progesterone, values in excess of 2 ng/ml reflect normal estrus cycles. In this trial, 33.3% of the heifers attained 1 ng/ml but did not achieve 2 ng/ml. Those heifers were reclassified (Figure 2) as having questionable pubertal status. None of the heifers in the questionable (below 1 ng/ml) classification became pregnant. Deworming increased ($P < .05$) pregnancy rates from 25.6% in control heifers to 56.4% in Ivomec heifers. Among those with serum progesterone levels above 2 ng/ml, pregnancy rates were 84.6% for dewormed heifers and 71.4% for control heifers.

Because weight is a key factor influencing onset of puberty, it is of interest to note that in both the dewormed and control groups, the correlations between puberty and initial weight, weight gain, or pre-breeding weight were not significant. The correlations actually approached zero and were lower in the dewormed than in the control heifers, indicating that the early gain responses to Ivomec were not associated with onset of puberty.

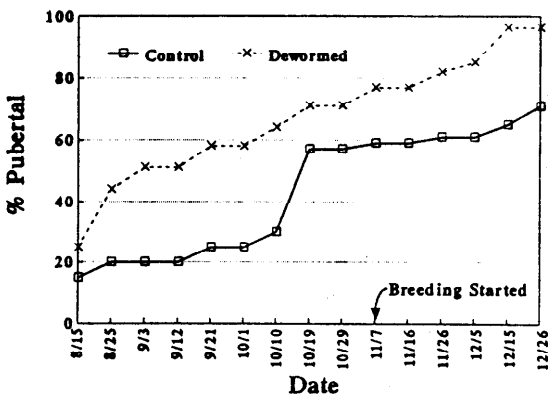

Figure 1. Percent Puberal Heifers, Using 1 ng/ml Serum Progesterone as Indication of Puberty.

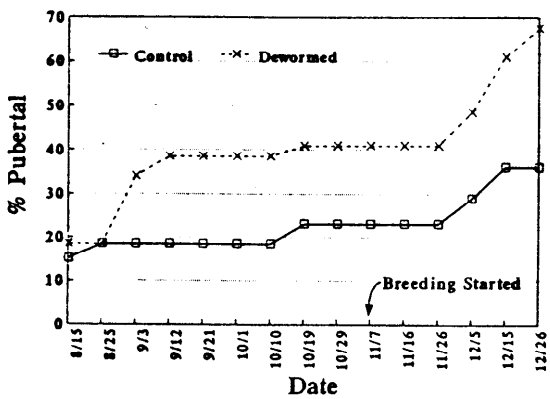

Figure 2. Percent Puberal Heifers Using 2 ng/ml Serum Progesterone as Indiction of Puberty.

PRODUCTION AND MARKETING FACTORS INFLUENCING FED CATTLE PRICES

T. Schroeder[1], J. Mintert[1], R. Jones[1], and F. Brazle[2]

Summary

An analysis of more than 1400 pens of cattle marketed during 1990 examined the influence of several cattle traits and marketing factors on fed cattle prices. Cattle quality grade had an important impact on packer bids and feedyard asking prices. However, both feedyard asking and packer purchase prices reflected less than 25%, on average, of estimated wholesale value differentials. Other factors, including estimated dressing percentage, finish uniformity, cattle weight, number of head purchased, presence of heiferettes, and cattle type had significant price impacts. Feedyards generally received what they asked for cattle; 65% of the pens sold for their asking prices. Price signals for differences in cattle "quality" are not fully transmitted to cattle feeders.

(Key Words: Cattle Marketing, Cattle Prices, Cattle Values.)

Introduction

Many segments of the cattle industry are concerned that fed cattle prices do not adequately reflect differences in beef end-use values. Our study was designed to explore how fed cattle are priced in southwestern Kansas. The objective was to quantify the market value of several characteristics affecting fed cattle transaction prices and to compare those characteristics to aggregate market values and feedyard asking prices.

How fed cattle are priced is important because pricing on averages instead of adjusting prices to reflect changes in beef end-use values sends incorrect production signals to cattle feeders. Poor transmission of prices from the retail market back to cattle feeders can lead to both production of products consumers find undesirable and use of inefficient production practices. Important in identifying impediments to value-based marketing is determining the extent to which fed cattle are priced "on the average" and to estimate the current market value of specific animal traits.

Experimental Procedures

Data were collected on 810 pens of steers (99,219 head) and 566 pens of heifers (67,119 head) marketed from May through November of 1990 from 13 feedyards in southwestern Kansas. The feedyard asking price, individual packer bids, sale date, transaction (sale) price, and cattle delivery date were recorded for each pen. Numerous animal traits relevant to sale prices were also collected. Live cattle characteristics included average weight, percentage of cattle expected to grade USDA Choice and Select, expected dressing percentage, estimated percentage of yield grade 4 cattle in the pen, finish uniformity, and weight uniformity. Other factors included number of cattle procured from the feedyard that day by the same packer, number of days cattle were on feed, number of brands on cattle, presence of bulls or heiferettes, cattle breed and type, buying

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[2]Extension Livestock Specialist, Southeast Kansas.

packer, the feedyard, distance from feedyard to buying packer, and number of bids made per pen. Summaries of selected data are shown in Table 1.

Results and Discussion

Several cattle and pen traits had significant impacts on transaction and asking prices. The influence of specific traits on price were examined separately for steers and heifers. Estimated dressing percentage influenced steer prices but had no discernable effect on heifer prices. Steer transaction prices increased $0.23/cwt, and asking prices increased $0.37/cwt for each 1% increase in expected dressing percentage. Steers sold in pens that had uniform finish averaged $0.35/cwt above those from nonuniform pens. Discounts for nonuniform cattle may reflect increased packer costs in sorting nonuniform cattle or carcasses. Finish uniformity did not influence heifer price differentials.

Large volume feedyards received slightly higher average prices than smaller volume yards. The number of cattle purchased from a feedyard by a particular packer during a day had a modest, but statistically significant, price influence. For each additional 500 head of cattle purchased per transaction by the packer, transaction price increased by $0.02/cwt for steers and $0.05/cwt for heifers. This could reflect the reduced packer transaction costs associated with purchasing a large number of cattle from one location. The number of head purchased by any individual packer did not influence asking prices.

The presence of heiferettes in a pen of heifers reduced transaction and asking prices by $0.26/cwt and $0.30/cwt, respectively. The presence of bulls and staggy steers in pens did not influence steer prices. Pens of plainer quality steers received discounts of $2.46/cwt. Number of days on feed, number of brands per head, and weight uniformity of cattle did not influence prices. Some of these factors may have been accounted for in other variables studied. For example, number of days on feed and percent of cattle in a pen expected to grade Choice are usually related.

Figure 1 illustrates the impact of weight on price received. Highest prices were paid for steers weighing from about 1060 to 1230 lbs and for heifers weighing 980 to 1080 lbs. Discounts for heavy cattle could reflect packers' concerns about buying carcasses that are too large for standard boxed beef packaging. Discounts for lighter weight cattle are probably related to increased slaughtering costs per pound.

Price effects of the percentage of cattle grading Choice are shown in Figure 2. Asking prices increased by about $0.08 to $0.10/cwt, and transaction prices increased by $0.07 to $0.08/cwt for each 10% increase in number of cattle expected to grade Choice. This indicates that cattle quality grade affects price. However, premiums for Choice grade cattle, or analogously, discounts for Select grade cattle, were considerably smaller than estimated wholesale beef value differences. For example, using the average estimated dressing percentage of steers of 63.4% and the average USDA carcass Choice to Select grade cutout price spread during the study period of $6.85/cwt, the wholesale beef value of a 10% increase in the number of cattle grading Choice was $0.43/cwt. Thus, the estimated live value differential attributed to cattle quality grade was less than 25% of the estimated wholesale value change.

Table 1. Summaries of Prices and Selected Pricing Factors for Fed Cattle in Western Kansas, May to November 1990

	Steers			Heifers		
Variable	Average	Minimum	Maximum	Average	Minimum	Maximum
Transaction price, %/cwt	77.32	72.50	82.00	76.94	71.00	82.00
Asking price, %/cwt	77.48	72.50	82.00	77.12	72.00	82.00
Estimated % Choice	54.0	40.0	80.0	53.6	40.0	70.0
Estimated dressing percent	63.4	62.5	64.0	63.3	62.5	64.0
Estimated yield Grade 4, %	1.2	.0	4.0	1.1	.0	5.0
Delivery weight, lb	1198.8	953.0	1416.0	1058.6	902.0	1303.0
No. of cattle purchased, single transaction	678.6	47	2489	580.1	58	2489
No. of cattle per pen	122.5	29	792	118.7	23	780
No. of bids per pen	1.8	1	9	1.7	1	9

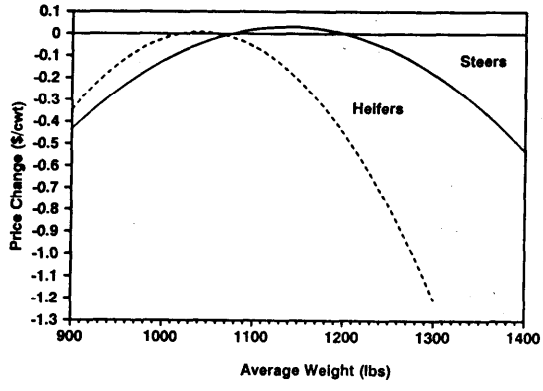

Figure 1. Estimated Price Changes Associated with Varying Cattle Weight Relative to Base Heifer Weight of 1060 lb and Base Steer Weight of 1200 lb.

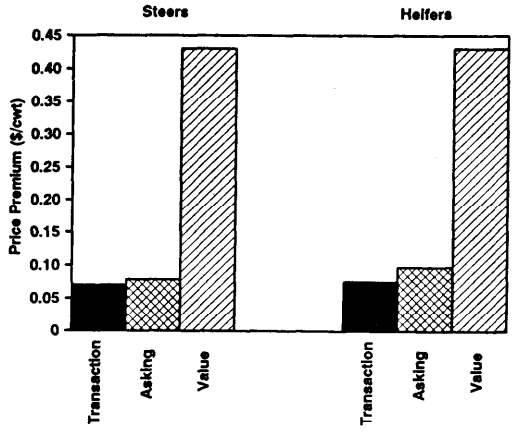

Figure 2. Estimated Transaction Price, Asking Price, and Packer Value Differentials of a Ten Percent Increase in the Number of Cattle Grading Choice, at Average Choice and Select Boxed Beef Carcass Prices.

FACTORS AFFECTING VARIABILITY IN FEEDLOT STEER PROFITS

M. Langemeier[1], T. Schroeder[1], and J. Mintert[1]

Summary

This study examined the relative importance of price and animal performance factors on cattle finishing profitability. Using data from a single feedlot, sale prices, feeder prices, and corn prices explained 90 to 95% of the variation in steer profits. About 50% of the variability was explained by fed cattle prices alone. Because sale, feeder, and corn prices have a large impact on profits per head, cattle feeders should attempt to manage the risks associated with these three factors.

(Key Words: Cattle Finishing Profitability, Sale Prices, Feeder Cattle Prices.)

Introduction

Net returns to cattle feeders vary tremendously over time. Estimated quarterly average returns for finishing yearling steers in Kansas are shown in Figure 1. Estimated returns per head ranged from a loss of $115 to a profit of $120 between 1981 and 1991. Profits often varied by $50 to $100 per head from one quarter to the next.

What factors contribute to the wide fluctuations in profits over time? Several factors are important in explaining that variability. Feeder and fed cattle prices; the cost of grain, hay and supplement; interest rates; daily gain; feed conversion; and death loss all impact cattle finishing profitability. However, some of these factors are of relatively greater importance. This study used fed cattle closeouts from a western Kansas feedlot to estimate the relative importance of price and cattle performance factors on finishing profitability.

Experimental Procedures

Feedlot performance, feed costs, and sale prices were obtained from a western Kansas feedlot's monthly closeouts covering over 2600 pens of steers (540,000 head) placed on feed during the 10-year period from 1980 to 1989. Other data used in the analysis included estimates of corn prices, hay prices, interest rates, feeder prices, and yardage fees. This information was used to calculate monthly average cattle performance, costs, prices, and profits. Table 1 summarizes the monthly performance, cost, and profit information for four categories of steer placement weight. All costs and returns in Table 1 were adjusted for inflation during the period and are expressed in 1989 dollars. Because of seasonality and trends in feeder weights, placement data were not available for all the weight categories during some of the months. Data were available for 106 of the 120 months during the study period.

Profits per head are a function of input prices, performance factors, and sale prices. Specific variables included corn prices, hay prices, interest rates, and feeder cattle prices in the input price category and daily gain, feed conversion, and death loss in the performance category. Regression analysis was used to determine the relative contribution of each variable to the factor in steer profits over time.

[1]Department of Agricultural Economics.

Results and Discussion

About 98% of the variability in profits per head over time was explained by sale prices, feeder prices, corn prices, interest rates, feed conversion, and daily gain. Feeder prices, corn prices, interest rates, and feed conversion were negatively related to profits, whereas sale prices and daily gain were positively related to profits. Hay prices and death losses did not have a significant influence on profits. Hay prices were probably insignificant because hay represents a minor portion of the feed cost in high concentrate rations. Death loss was probably insignificant because, on a monthly basis, it was relatively stable over the study period. Of course, death loss would be a more important factor in individual pen comparisons.

The relative contribution of sale prices, feeder prices, corn prices, interest rates, feed conversion, and daily gain to the variability in steer profits over time is presented in Table 2. Sale prices had the largest effect on profits over time. Overall, changes in fed cattle prices explained about 49 to 53% of the variation in cattle feeding profits. Feeder cattle prices explained another 23 to 27% of the profit risk. Corn prices tended to have less influence on profits per head as placement weight increased. For 600-to 700-pound steers, corn prices explained about 22% of the variation in profits, whereas they accounted for only about 15% of the variation for 800- to 900-pound steers. Interest rates, feed conversion, and daily gain explained about 2 to 8% of the variation in steer profits over time.

Based on the results in Table 2, it is evident that placement weight of cattle has a pronounced effect on the relative importance of performance and cost factors to profits. For lighter weight cattle, profit variability was heavily influenced by feed price. Profits for cattle placed on feed at heavier weights were more heavily impacted by feeder costs and daily gains.

Table 1. Average Costs, Returns, and Performance by Placement Weight for Steers in Western Kansas, 1980-1989[a]

	Steer placement weight			
Item	600 to 700#	700 to 800#	800 to 900#	All Weights
Days on feed	151	124	122	137
Average daily gain, lb	3.02	3.09	3.14	3.08
Feed/gain[b]	8.55	8.81	9.09	8.81
Death loss, %	0.78	0.51	0.43	0.57
Feeder cost, $/hd	557.37	617.43	680.10	612.35
Feed cost, $/hd	265.20	247.94	233.42	251.70
Interest, $/hd	24.55	23.44	22.79	23.95
Other costs[c], $/hd	17.54	16.70	16.09	16.86
Total costs, $/hd	864.66	905.54	952.40	904.86
Gross returns, $/hd	900.26	933.25	972.58	932.03
Profit, $/hd	35.60	27.71	20.18	27.17

[a]All costs and returns are expressed in 1989 dollars. Data for steers placed in the following months were not available: 2/81, 8/81, 3/82, 9/82, 1/83, 2/83, 3/83, 4/83, 2/85, 3/85, 6/86, 12/88, 1/89, and 2/89. All data provided by a western Kansas commercial feedyard.
[b]Feed conversion is expressed on an as-fed basis.
[c]Other costs include processing and yardage.

Table 2. Percent of Variation in Steer Finishing Profits Explained by Various Factors

	Placement Weight			
Factor	600 to 700#	700 to 800#	800 to 900#	All Weights
Sale price	48.9	52.8	49.2	50.7
Feeder price	22.5	26.8	25.6	27.2
Corn price	21.9	16.1	14.8	16.7
Interest rate	1.5	0.6	0.9	1.2
Feed conversion	3.2	1.8	3.5	2.0
Daily gain	-0.1	0.2	4.2	0.3
Total explained variation	97.9	98.3	98.2	98.1
Unexplained variation	2.1	1.7	1.8	1.9

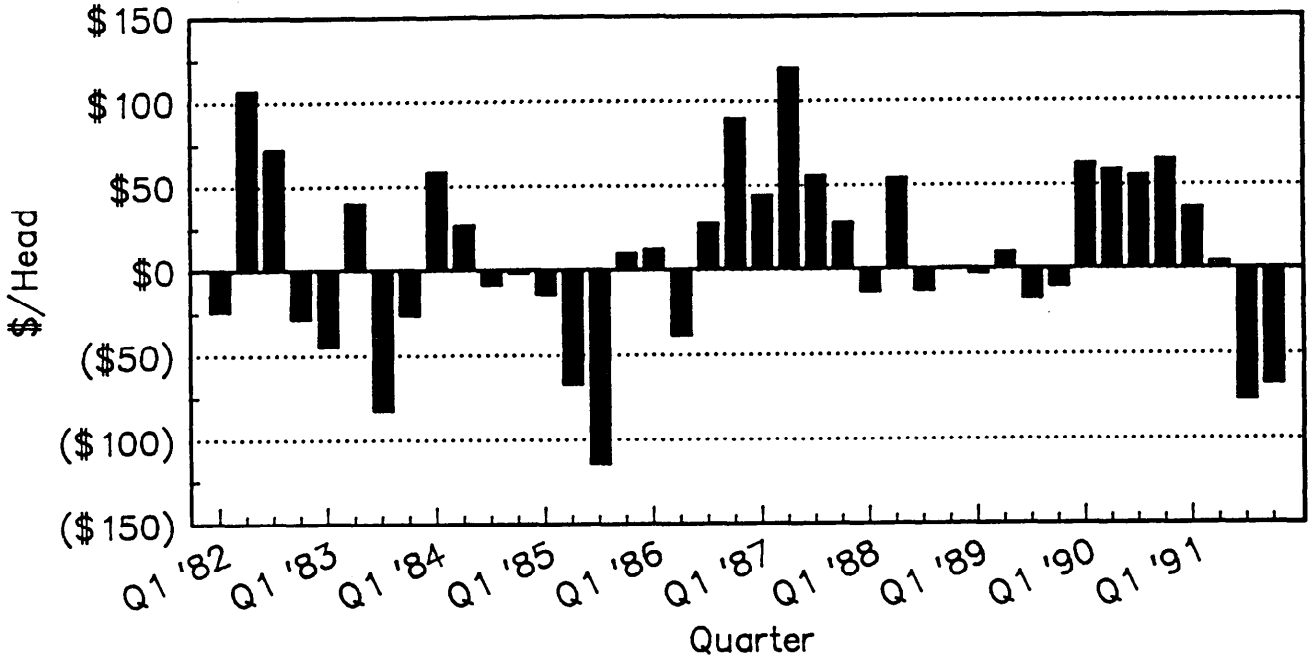

Figure 1. Quarterly Returns for Finishing 750-Pound Steers in Kansas.

SHORT-RUN IMPACT OF CAPTIVE SUPPLIES ON FED CATTLE PRICES[1]

J. Mintert[2], T. Schroeder[2], R. Jones[2], and F. Brazle[3]

Summary

Factors affecting western Kansas fed cattle prices during May through November 1990 were investigated. In particular, the impact of changes in captive cattle supplies on cash prices was examined. The term captive cattle supplies refers to cattle procured by a packer well in advance of slaughter. Captive supplies take one of three forms: 1) packer-owned cattle, 2) cattle procured on forward contracts, and 3) cattle procured under formula price (or marketing) agreements. Captive supplies were defined as cattle procured under forward contracts or formula price agreements, because data on packer-owned cattle were unavailable. Over the May through November 1990 period as a whole, the presence of captive cattle supplies was associated with an average reduction in western Kansas cash market transaction prices of about $0.15/cwt.

(Key Words: Cattle Marketing, Cattle Prices, Captive Supplies.)

Introduction

A cash fed cattle price model was developed to explain the variation in prices of individual pens of fed cattle as a function of each pen's quality characteristics, market conditions, and the level of captive supplies. Important quality factors included animal weight, finish uniformity, percentage of cattle expected to grade Choice and Select, estimated dressing percentage, percentage of cattle expected yield grade 4, number of brands, sex, breed type, and the number of cattle purchased by the packer from the feedyard on the same day. In addition, distance from the packer to the feedyard and the identity of the packer purchasing the cattle were included.

Market conditions refer to supply and demand in the local fed cattle market. To account for the impact of Choice and Select grade boxed beef prices on the demand for live cattle, an estimated carcass value of each pen was computed and included in the model. Inclusion of live cattle futures prices captured the impact of changing national cattle prices on local cash prices. Other short-run demand factors included in the model were local marketings of fed cattle, day of the week the cattle were sold, number of bids received on a pen of cattle during the week the cattle were sold, and number of days between sale date and the packer delivery date. Captive supplies, measured as the USDA estimate of formula and contract shipments from Kansas feedyards during the delivery week of each pen divided by total weekly Kansas slaughter, were also included in the model.

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[1]This research was supported by funds from the Research Institute on Livestock Pricing and the Kansas State Agricultural Experiment Station.

[2]KSU Department of Agricultural Economics.

[3]Extension Livestock Specialist, Southeast Kansas.

Experimental Procedures

Data were collected on individual sale transactions from 1407 pens of cattle representing 166,338 head from May 21 through November 24, 1990 from 13 feedyards in western Kansas. For each pen of cattle sold, a record was made of price bids, feedyard and animal quality characteristics, market conditions, and the level of captive supplies. The number of captive supply cattle shipped for slaughter each week from Kansas feedyards was collected from the USDA's Agricultural Marketing Service in Dodge City, Kansas. The percentage of Kansas cattle slaughter represented by formula and contract cattle during May through November of 1990 ranged from 2% to 15% of weekly slaughter volume.

Results and Discussion

The estimated price impacts of selected factors are presented in Table 1. The premiums and discounts represent average incremental price effects across all pens of cattle estimated using regression analysis. Each reported premium or discount is the isolated price impact of changing that pen characteristic while holding all other factors constant.

The level of captive supplies had a significant negative influence on price. During the May through November period, each 1% increase in contract and formula cattle shipments from Kansas feedyards as a percentage of total Kansas slaughter was associated with an average transaction price decline of $0.026/cwt. During the 6-month study, captive supplies averaged about 6% of Kansas steer and heifer slaughter. This level of captive supplies was associated with an average cash fed cattle price decline of approximately $0.15/cwt in western Kansas.

Because of variability in contracting activity during the study period, the fed cattle price model was reestimated for three shorter intervals to provide insight into the price impact of the level of captive supplies over different time periods. The periods examined were May to July, August to September, and October to November. During May through July, each 1% increase in captive supplies was associated with an average transaction price decline of $0.036/cwt. Captive supplies averaged greater than 9% of Kansas steer and heifer slaughter during late May through July, and were associated with an average price decline of approximately $0.34/cwt. Estimated price impacts of aggregate captive supplies during August-September and October-November were not statistically significant (Figure 1).

Limitations of Study

Several caveats about the results of this study should be mentioned. First, the results may be sensitive to the market conditions during the data collection period and to the western Kansas marketing region. The market structure, local supply and demand, and other factors unique to this time frame and area make it difficult to generalize from these results. Second, although detailed data were collected on cash market transactions, we have no knowledge of the cattle characteristics or of the prices received for captive supply cattle. Therefore, the net price effect of captive supplies across all cattle slaughtered is unknown. Finally, captive supplies during the study period varied from 2 to 15% of Kansas steer and heifer slaughter. The estimated price changes associated with shifts in captive cattle supplies should not be construed to apply to levels of captive supplies outside the range observed during the May through November period. For example, it would be inappropriate to use these results to estimate the price impact arising from 50% of Kansas steer and heifer slaughter coming from captive supplies, because captive supplies were never that large during the data collection period.

Table 1. Premiums and Discounts Associated with Various Pen Traits, Western Kansas, May to November, 1990

Pen Trait	Estimated Price Impact $/cwt
Day of the week cattle were sold:	
Monday	Base
Tuesday	-0.04
Wednesday	-0.31
Thursday	-0.37
Friday	-0.49
Additional bid	0.07
Additional day between sale and delivery	0.01

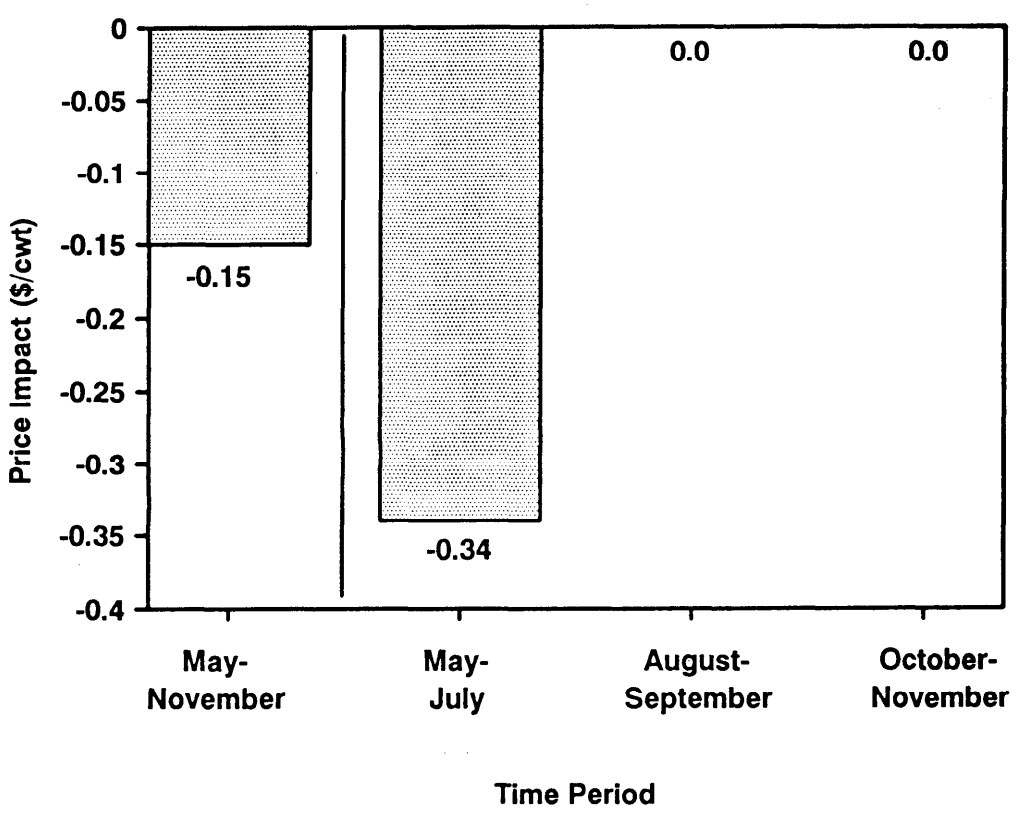

Figure 1. Estimated Average Impact of Captive Cattle Supplies on Western Kansas Fed Cattle Transaction Prices, May through November 1990.

COMPARISON OF FEEDING CALVES VS. YEARLINGS

D. T. Hickok, R. R. Schalles, M. E. Dikeman, and D.E. Franke[1]

Summary

Data from the 207 crossbred steers used in this study indicate that when calves are placed in the feedlot on a finishing ration at weaning, they will have better feed efficiencies, greater lifetime ADGs, lighter carcass weights, and equal carcass qualities compared to those placed as yearlings. In recent times, heavy carcass weights have been rather common in the industry. Every over-weight steer had a desirable weight at one time, and this study shows that they would have produced a desirable carcass if managed correctly.

(Key Words: Cattle, Management, Performance, Carcass, Systems.)

Introduction

The advent of boxed beef and portion control has placed a premium on uniformity of slaughter weights and caused discrimination against large carcasses. Today's fast growing cattle can meet packer specifications if they are placed in the feedlot as weaning calves. This study was designed to compare feedlot and carcass traits of steers started on a finishing ration as weaning calves (accelerated system) vs. growing calves and placing them on a finishing ration as yearlings (conventional system).

Experimental Procedures

Crossbred steers were produced from 2-, 3-, and 4-breed rotational crossbreeding systems involving Angus, Hereford, Charolais, and Brahman breeds at Louisiana State University, Baton Rouge. Half of each cow breed group was bred to Gelbvieh bulls as a terminal cross. Calves were born between Jan. 31 and April 14 and weaned at an average age of 185 days. At weaning, steer calves were randomly assigned, within breed groups, to either a calf or yearling management system. After an approximately 3 wk conditioning period, 45 calves were shipped to KSU in 1989 and 64 in 1990 to constitute the calf management system. The 44 steers in 1989 and 54 in 1990 assigned to the yearling management system were grazed during the winter at Baton Rouge on rye grass pasture and shipped to KSU in early May of the following year. Steers in both management groups were group-fed for 18 to 21 days, while the energy density of the ration was increased to 75% concentrate (DM basis). Steers were then sorted into pens of 5 or 6 head and the ration was increased to 90% concentrate (DM basis) over the next 3 wk. Cattle remained on that ration until slaughter. The ration consisted of cracked corn, soybean meal, vitamin and mineral supplement, and sorghum silage. Half of each breed group within each management system was slaughtered when the ultrasound-measured backfat was between .3 and .4 in., and the other half was slaughtered with backfat between .5 and .6 in. Carcass data were collected after 24 hr in the cooler.

Three alternative slaughter end points within management systems were evaluated; 1) constant days on feed, 2) constant adjusted carcass backfat, and 3) constant slaughter weight. Data were analyzed using least

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squares analysis of variance. The model included the fixed effects of year and management group. In addition, the regressions of weaning age; the alternative slaughter point within management; and the percentage Hereford, Charolais, Brahman, and Gelbvieh were included.

Results and Discussion

The calves went on feed at an average age of 228 days. They averaged 224 days on feed, were slaughtered at 1083 lb, and had .43 in. of adjusted carcass backfat. The yearlings were started on feed at an average age of 444 days, were fed for 131 days, and were slaughtered at 1262 lb with .45 in. adjusted carcass fat thickness. The results were very similar when evaluated at all three slaughter end points. Consequently, only the results of a constant adjusted fat thickness are presented in Table 1.

Compared to yearlings, calves gained about 190 lbs in 91 more days on feed. Their ADG on feed was about 0.22 lb/day less than that of yearlings. However, they required 1.8 lb less TDN per lb of gain ($P < .05$), equivalent to 2 lb of corn. That was because of the lighter average weight maintained in the feedlot. The lifetime ADG was greater for the calves, because they were slaughtered an average of 126 days younger with only 178 lbs less weight.

There was no significant difference in dressing percentage, so carcass weight reflected slaughter weight. The yearlings had 1 sq. in. more ribeye area than the calves, again reflecting heavier weights. The calves tended to have more marbling and higher quality grades than the yearlings, but the differences were not statistically significant. Actual backfat, yield grade, and percentage of kidney, pelvic, and heart fat were not different between management systems.

Table 1. Feedlot and Carcass Merit of Calves vs. Yearlings at the Same Adjusted Carcass Backfat[a]

	Management System	
Trait	Calf	Yearling
Slaughter wt, lb	1083[z]	1262[y]
Gain, lb	536[y]	384[z]
Age, days	452.2[z]	578.0[y]
Fed, days	223.9[y]	133.0[z]
Feedlot ADG, lb	2.45[z]	2.67[y]
TDN during finishing, lb	3120[y]	2523[z]
Feed/gain	5.92[z]	7.687[y]
Lifetime ADG, lb	2.23[y]	2.04[z]
Carcass wt, lb	671[y]	776[z]
Dressing percent	61.90[z]	61.47[z]
Ribeye area, sq. in.	12.5[z]	13.5[y]
Marbling score[b]	319.6[z]	310.5[z]
Actual carcass backfat, in.	.38[z]	.40[y]
Kidney, pelvic, heart fat, %	2.6[z]	2.6[z]
Yield grade	2.64[z]	2.76[y]

[a]Adjusted Backfat means were .43 in. for the calf management group and .45 in. for the yearling management group. [b]Slight = 200, Small = 300, and Modest = 400, etc..
[y,z]Means in the same row with different superscripts are different ($P < .05$).

INFLUENCE OF LIMITED CREEP FEEDING ON PRE- AND POST-WEANING PERFORMANCE OF SPRING BORN CALVES[1]

F. K. Brazle[2], G. L. Kuhl, C. E. Binns[3], K. O. Zoellner, L. R. Corah, and R. R. Schalles

Summary

Spring-born suckling beef calves were offered salt-limited creep feeds containing either high protein, high energy, or energy plus Bovatec® from August 15 to October 15 in a 3-year study. Creep feeding improved (P < .01) daily gain over controls, but no differences were attributable to creep composition.

Daily creep feed consumption was somewhat less for the protein fed group, resulting in improved feed conversion compared to the energy-based supplement, with the energy plus Bovatec creep feed intermediate in efficiency.

Creep feeding improved 53-day postweaning gains (P < .01). Overall, limited creep feeding boosted both pre- and postweaning performance, with no difference in gain among the three types of creep rations studied.

(Key Words: Limited Creep Feeding, Protein Energy, Suckling Calves, Native Grass, Bovatec.)

Introduction

The milk production of spring-calving cows grazing native grass pastures decreases in late summer, which coincides with the decreased nutritional value of native grasses. Therefore, suckling calves may be nutritionally limited below their genetic gain potential. Thus, creep feeding offers a way to improve weaning weights.

By definition, a limited creep feeding program restricts either the amount of feed, the length of time feed is offered during the season, or both. Research has shown that "full" creep feeding is often economically unattractive because of poor feed conversion and/or excessive calf condition at weaning, which may reduce market value.

In contrast, limited creep feeding of suckling calves appears to be more cost effective because of improved feed conversion. The objective of this study was to evaluate the pre- and post-weaning performance of spring-born calves receiving salt-limited protein, energy, or energy plus Bovatec creep feeds vs. noncreep supplemented calves.

Experimental Procedures

In the spring of 1986, 180 Angus, Hereford, and Angus-Hereford crossbred cows were allotted by age and breed to three groups. In late summer, the three groups of cow-calf pairs were assigned randomly to three 60-day nutritional treatments: 1) noncreep-fed control, 2) 16% crude protein energy-based creep

[1]Appreciation is expressed to Farmland Industries, Inc., Kansas City, MO for providing creep feeds.

[2]Extension Livestock Specialist, Southeast, Kansas.

[3]Currently in veterinary practice in Wetmore, Kansas.

feed, or 3) 16% crude protein, energy-based creep feed plus Bovatec (68 mg/lb).

Similarly, in late summer of 1987 and 1988, the three groups of cows and calves were assigned to three treatments: 1) noncreep-fed control, 2) 16% crude protein, energy-based creep feed, or 3) 36% crude protein creep feed. In mid-August of each year, the calves were weighed, allotted to treatment, and returned to three native tall-grass pastures with their dams. The cows and calves were rotated among pastures, so all treatment groups grazed each pasture for 20 days.

The creep feeds were self-fed in wind-vane feeders, fenced off for calf access only, and located in a cattle loafing area. Nutrient composition of the creep feeds is shown in Table 1. Corn gluten feed was the basic ingredient in each creep feed, with soybean meal or sorghum grain added to produce 16 or 36% crude protein supplements. Creep intake was monitored twice weekly, and salt content was increased as needed to limit daily intake to 1.5 to 2 lb/head. Salt levels ranged from 2 to 7% over the creep feeding period.

Calves were weaned, weighed after an overnight stand without feed, and shipped 120 miles to the KSU Beef Research Unit in mid-October for the post-weaning growing trial. Starting weights for the growing period were off-truck weights at the feedlot. The calves were fed a silage-based growing ration for an average of 53 days.

Results and Discussion

Calves consuming the limit-fed protein, energy, and energy plus Bovatec creep feeds gained faster ($P < .01$) than the noncreep-fed calves (Table 2). Type of creep diet had no effect on gain. Daily consumption of the energy and energy plus Bovatec creep rations was somewhat higher than that of the protein creep feed. This resulted in more efficient conversion ($P < .01$) of the protein feed than the energy feed to extra gain, whereas the energy plus Bovatec creep was intermediate. Calf body condition scores were similar among treatments at weaning.

There was no difference in post-weaning gain of calves previously fed the three creep rations. However, all limited creep-fed calves gained faster ($P < .01$) during the 53-day postweaning period than noncreep-fed calves (Table 3). The creep-fed calves tended to have better feed intake and feed utilization than controls. The creep-fed calves likely had an advantage in terms of preweaning rumen adaptation to processed feeds, which may have improved early postweaning performance.

The question of which limited creep feed is better — protein or energy — for cow/calf pairs grazing native range in late summer depends on relative feed efficiency and cost. Because limited creep feeding of calves improved both pre- and postweaning performance, economics could be favorable in most years. The biggest problems experienced with limited creep feeding of calves were the mechanics of monitoring intake and adjusting the salt level to maintain uniform desired consumption.

Table 1. Nutrient Composition of Creep Feeds[a]

Nutrient Content	Energy Creep Feed	Protein Creep Feed
Crude protein, %	16.00	36.00
Crude fiber, %	11.20	11.50
Estimated TDN, %	69.50	68.60
Calcium, %	.85	.85
Phosphorus, %	.85	.85

[a]Nutrient composition expressed on an air-dry (90% dry matter) basis.

Table 2. Effect of Limited Creep Feeding on Pre- and Postweaning Calf Performance

Items	Control	Protein Creep Feed	Energy Creep Feed	Energy + Bovatec Creep Feed
Preweaning performance				
Starting wt, lb	376	387	387	380
Daily gain, lb (60 days)	1.52[a]	1.80[b]	1.74[b]	1.76[b]
Body condition score (1 to 10)	6.20	6.30	6.30	6.10
Daily creep intake, lb DM	-----	1.10	1.40	1.36
Lb creep/extra gain	-----	4.00[a]	6.60[b]	5.20[ab]
Postweaning performance				
Daily gain, lb (53 days)	2.31[a]	2.49[b]	12.49[b]	2.49[b]
Daily intake, lb DM	12.54	13.00	13.00	12.76
Feed/gain	5.40	5.20	5.30	5.10

[ab]Least squares means in the same row with unlike superscripts are different ($P < .01$).

CAUSES OF DIARRHEA, PNEUMONIA, AND ABORTION IN 1991 CATTLE SUBMISSIONS TO THE KSU VETERINARY DIAGNOSTIC LABORATORY

R. K. Frank[1], M. W. Vorhies[1], and M. M. Chengappa[2]

Summary

Causes of diarrhea, pneumonia, and abortion in Kansas cattle submissions to the Kansas State University Veterinary Diagnostic Laboratory during 1991 were summarized. Antimicrobial susceptibility results for *Pasteurella haemolytica*, *Pasteurella multocida*, *Hemophilus somnus*, and *Salmonella* spp., the common causes of pneumonia and/or diarrhea in cattle with increasing antibiotic resistance patterns, were also summarized. The most commonly diagnosed causes of diarrhea in young calves (under 1 month of age) were coronavirus, *Escherichia coli*, and *Salmonella*. The three most common causes of diarrhea in 1 to 18 month-old cattle were BVD virus, coccidia, and *Salmonella*. Most respiratory submissions were 7- to 18-month-old cattle. *P. haemolytica* and *P. multocida* were the most commonly identified pathogens from these cattle. In 20% of the cases, more than one pathogen was identified. The most commonly diagnosed cause of abortion was bacterial infection (20%), but a cause was not identified in nearly 70% of abortion submissions.

(Key Words: Disease, Diagnosis, Diarrhea, Pneumonia, Abortion.)

Introduction

Enteric and respiratory diseases account for large economic losses to the cattle industry each year. Fetal wastage, including abortion, also significantly impacts cow herds. An accurate diagnosis of the cause of pneumonia, diarrhea, and abortion is essential for effective prevention and control of the various causes of these diseases.

Bovine respiratory disease or "shipping fever" is considered to result from a combination of viral and bacterial infections and stress. *Pasteurella haemolytica* is the most important pathogen in fatal cases and may cause respiratory disease in the absence of a predisposing virus. Other bacteria frequently contribute to pneumonia caused by *P. haemolytica*, once damage has begun.

Causes of fetal abortion may be classified as maternal or fetal. Maternal causes include physiologic changes caused by metabolic disease, hormonal imbalances, nutritional deficiencies or imbalances, environmental stresses or trauma, toxins, and infectious agents. Fetal and placental changes are usually due to infectious agents including bacteria, viruses, fungi, or protozoa.

The present summary was performed to demonstrate the relative importance of various causes of enteric, respiratory, and fetal wastage in Kansas cattle determined at the diagnostic laboratory level.

Experimental Procedures

Cattle diagnoses and age were summarized for cases of diarrhea, pneumonia, and abortion in cattle from computer records of submissions to the KSU Veterinary Diagnostic Laboratory for calendar year 1991. Specimens included

[1,2]KSU College of Veterinary Medicine, Departments of Veterinary Diagnosis and Laboratory Medicine, respectively.

carcasses or tissues submitted by practicing veterinarians throughout Kansas. Tissues submitted for bacterial culture or viral examination alone were not included in the present study. A diagnosis was made following light microscopic, bacteriologic, and virologic examination of tissues, and information was summarized in a computer database. Antimicrobial susceptibility studies were conducted using an automated Sensititre® system. Pathogenic bacterial isolates were classified as percentage susceptible, moderately susceptible, or resistant to the various antimicrobial agents.

Results and Discussion

Causes and numbers of submissions for diarrhea in cattle are summarized in Table 1 according to age. Most submissions for diarrhea were for calves less than 1 month old (117 cases). In 8.5% of these submissions, more than one pathogen was identified. The most common pathogens identified were coronavirus, *E. coli*, and *Salmonella* (22.2%, 13.7%, and 12.8% of submissions, respectively). Few of the *E. coli* isolates were K99 positive. Antibiotic susceptibility results for *Salmonella* isolates are summarized in Table 2. None of the antibiotics cleared by the Food and Drug Administration for use in cattle were effective against more than 39% of the *Salmonella* isolates. The three most common causes of diarrhea in 1- to 18-month-old cattle were BVD virus, coccidia, and *Salmonella*.

Causes and numbers of submissions for respiratory disease in cattle are summarized in Table 3 according to age. Most submissions for cases of pneumonia were from feedlot cattle 7 to 18 months of age. The two most commonly identified types of pneumonia in calves less than 1 month old were that caused by *P. multocida* and interstitial pneumonia (11.1% of submissions each). The latter was usually associated with septicemia (generalized bacterial infection from *Salmonella*, *E. coli*, etc.). In 1- to 6-month-old calves, *P. multocida* and *P. haemolytica* (24.4% and 20.0% of submissions, respectively) were the most commonly isolated pathogens. *P. haemolytica* and *P. multocida* also were the most commonly isolated pathogens in yearlings with pneumonia (29.2% and 17.7% of submissions, respectively). In 20% of the yearling cases, more than one pathogen was identified, including various combinations of bacteria and/or viruses. Antimicrobial susceptibility results for *P. multocida*, *Haemophilus somnus*, and *P. haemolytica* isolates from all 1991 bovine respiratory submissions are summarized in Table 2.

The three most commonly identified causes of bovine abortion were bacteria (approximately 20% of submissions), BVD virus, and IBR virus (Table 4).

Cases of diarrhea, pneumonia, or abortion with an idiopathic diagnosis were those for which no cause could be determined by routine laboratory testing. The primary reasons for no diagnosis were 1) submitting tissues from animals extensively treated with antibiotics or late in the disease process, 2) advanced postmortem change in submitted tissues, and 3) improper tissue collection and/or submission by the referring veterinarian. Even with extensive laboratory workup in abortion cases, the cause was not determined in nearly 70% of the cases, a finding similar to those of most other U. S. diagnostic laboratories.

[3]Radiometer America, Westlake, OH 44145.

Table 1. Causes of Diarrhea in Three Age Groups of Cattle for 1991 Diagnostic Laboratory Submissions

	Age Group					
	0 to 1 mo.		1 to 6 mo.		7 to 18 mo.	
Cause/Disease	N[b]	%[b]	N	%	N	%
Bovine virus diarrhea	4	3.4	3	23.1	12	41.3
Clostridium perfringens	10	8.5	0	0	1	3.4
Coccidiosis	2	1.7	2	15.4	10	34.5
Coronavirus	26	22.2	1	7.7	1	3.4
Cryptosporidium	11	9.4	0	0	0	0
E. coli 15	13.7	0	0	0	0	
Idiopathic[a]	25	21.4	4	30.8	3	10.3
Rotavirus	12	10.2	1	7.7	0	0
Salmonella	15	12.8	2	15.4	5	17.2
Viral 5	4.3	1	7.7	0	0	
Miscellaneous	6	5.1	0	0	2	8.0
Total diarrhea cases	117		13		29	

[a]Exact cause of the diarrhea could not be determined from submitted specimens.
[b]N = number of occurrences; % = percentage of cases with this diagnosis. Note that number of occurrences is not the same as number of cases because more than one pathogen was identified in some cases.

Table 2. Antimicrobial Susceptibility Results for *Haemophilus somnus, Pasteurella multocida, Pasteurella haemolytica*, and *Salmonella* spp. Isolated from Cases of Diarrhea and Pneumonia for 1991 at the KSU Veterinary Diagnostic Laboratory

	H. somnus				*P. multocida*				*P. haemolytica*				*Salmonella*			
Antimicrobial	S[a]	I[a]	R[a]	N[a]	S	I	R	N	S	I	R	N	S	I	R	N
Ampicillin	69	0	31	16	59	8	30	86	39	2	59	123	29	1	70	76
Amikacin[b]	100	0	0	3	57	21	21	28	82	6	9	33	100	0	0	23
Augmentin[b]	63	19	19	16	84	8	7	86	94	3	2	123	39	46	14	76
Ceftiofur[c]	54	0	38	13	64	15	17	59	71	3	21	90	4	9	87	54
Tetracycline	69	13	19	16	34	24	37	86	31	7	62	123	22	0	76	76
Cephalothin	31	25	38	16	66	9	21	86	77	7	15	123	63	5	32	76
Enrofloxacin[b]	81	13	6	16	88	5	6	86	91	3	4	123	97	1	1	76
Erythromycin	56	31	13	16	8	58	34	86	2	64	33	123	0	0	100	76
Gentamycin[b]	56	19	19	16	58	21	19	86	80	14	6	123	66	1	33	76
Penicillin G	50	19	19	16	29	41	30	86	8	33	59	123	0	0	100	76
Spectinomycin[b]	50	0	50	16	4	12	84	85	1	14	85	123	0	3	97	73
Neomycin	44	0	56	16	31	0	69	86	66	0	34	123	28	0	72	76
Sulfachlor-pyridazine	33	0	33	3	11	15	74	27	24	18	55	33	5	0	95	22
Sulfadi-methoxine	0	33	33	3	15	7	74	27	30	6	61	33	0	0	100	22
Trimethoprim/sulfa[b]	62	8	31	13	68	7	25	59	84	4	11	90	80	0	20	54

[a]S = % of isolates susceptible; I = % of isolates moderately susceptible; R = % of isolates resistant; N = Total number of isolates tested.
[b]Antibiotics not cleared by the FDA for systemic use in cattle.
[c]Ceftiofur (Naxcel®) was used at the 0.5 and 1.0 microgram levels. Thirty of the 90 *P. haemolytica* isolates were tested at the 1.0 and 2.0 microgram levels; 29 isolates were susceptible and 1 was resistant.

Table 3. Causes of Respiratory Disease in Three Age Groups of Cattle for 1991 Diagnostic Laboratory Submissions

	Age					
	0 to 1 mo.		1 to 6 mo.		7 to 18 mo.	
Cause/Disease	N[a]	%[a]	N	%	N	%
Actinomyces pyogenes	2	4.4	2	4.4	9	6.1
Atypical interstitial pneumonia	0	0	0	0	13	8.8
BVD virus[b]	0	0	1	2.2	6	4.1
BRSV[b] 1	2.2	1	2.2	9	6.1	
Haemophilus somnus	1	2.2	8	17.8	15	10.2
Idiopathic[c]	25	55.6	17	37.8	36	24.5
IBR virus[b]	0	0	0	0	5	3.4
Interstitial pneumonia	5	11.1	2	4.4	8	5.4
PI_3	1	2.2	2	4.4	3	2.0
Pasteurella[d]	2	4.4	1	2.2	5	3.4
Pasteurella haemolytica	2	4.4	9	20.0	43	29.2
Pasteurella multocida	5	11.1	11	24.4	26	17.7
Miscellaneous	1	2.2	3	6.7	1	0.7
Total pneumonia cases	45		45		147	

[a]N = number of occurrences; % = percentage of cases with this diagnosis. Note that number of occurrences is not the same as number of cases because more than one pathogen was identified in several cases. [b]BVD = bovine virus diarrhea; BRSV = bovine respiratory syncytial virus; IBR = infectious bovine rhinotracheitis. [c]Exact cause of the pneumonia couldn't be determined from submitted specimens. [d]Other than *P. haemolytica* and *P. multocida*.

Table 4. Causes of Abortion in Cattle for 1991 Diagnostic Laboratory Submissions

Cause/Disease	N[a]	%[a]
Idiopathic[b]	137	69.5
Bacteria	19	9.6
BVD virus[c]	8	4.1
IBR virus[c]	6	3.0
Chlamydia	5	2.5
Actinomyces pyogenes	4	2.0
Bacillus sp.	4	2.0
Escherichia coli	3	1.5
Viral 3	1.5	
Leptospirosis	2	1.0
Mycotic	2	1.0
Salmonella	2	1.0
Staphylococcus aureus	1	0.5
Streptococcus	1	0.5
Total 197		

[a]N = number of cases; % = percentage of total cases. [b]Cause of abortion could not be determined from the submitted tissues or fetuses. [c]BVD = bovine virus diarrhea; IBR = infectious bovine rhinotracheitis.

EFFECT OF LONG-ACTING PENICILLIN AND LEVAMISOLE® ON GAIN AND HEALTH OF STRESSED CALVES[1]

F. K. Brazle[2]

Summary

Two studies were conducted to determine the effect of long-acting penicillin and/or levamisole injected at arrival or levamisole injected on day 1 and/or day 7 on the health and gain of newly received, highly stressed, light weight calves. Levamisole injected at arrival reduced ($P < .05$) sickness of newly arrived calves during the first 5 days. However, it did not reduce overall sickness during the receiving period. Long-acting penicillin injected at arrival did not reduce sickness, but did improve ($P < .05$) gain of calves during the growing period. The combination of levamisole and long-acting penicillin or the combination of levamisole on day 1 and day 7 did not reduce morbidity in these highly stressed calves.

(Key Words: Antibiotic, Levamisole, Penicillin, Anthelmintic, Stocker Cattle.)

Introduction

Calves transported long distances normally have health problems caused by the stresses of weaning, marketing, co-mingling, and then shipping. Many health products have been tried on highly stressed calves to reduce morbidity.

Antibiotic injections have been used at arrival to reduce sickness of calves transported long distances. Although levamisole® is commercially marketed as an anthelmintic (dewormer), it has been shown to stimulate the immune system in laboratory animals. The objective of these experiments was to determine the effect of long-acting penicillin and levamisole on the incidence and severity of health problems in calves purchased in the southeastern United States and transported to eastern Kansas.

Experimental Procedures

In Trial I, 500 mixed-breed steer and bull calves (323 lb) were purchased over a 14-day period in the fall from Tennessee, Arkansas, and Mississippi. The calves were processed at arrival, and the bull calves were surgically castrated. All calves were vaccinated against IBR, BVD, PI_3, and blackleg (7-way), and treated for internal and external parasites with Ivomec®. During processing, the bulls and steers were uniformly allotted to the following treatments: 1) long-acting penicillin (injected subcutaneously at 2.0 ml/100 lb body wt), 2) levamisole (injected subcutaneously at 1.0 ml/100 lb body wt), 3) both long-acting penicillin and levamisole, and 4) unmedicated control.

In Trial II, 437 mixed-breed bull calves (308 lb) were purchased over a 12-day period in the fall from Tennessee and Mississippi. The calves were processed at arrival and surgically castrated. The calves were vaccinated against IBR, BVD, PI_3 and blackleg (4-

[1]Appreciation is expressed to Richard Porter, Reading, Kansas, for providing cattle and collecting performance and health data.

[2]Extension Livestock Specialist, Southeast Kansas.

way) and treated for internal and external parasites with Ivomec. The calves were allotted randomly to the following treatments: 1) levamisole on both day 1 and day 7 (injected subcutaneously at 1.0 ml/100 lb body wt), 2) levamisole on day 1 only, 3) levamisole on day 7 only, and 4) no levamisole, control.

During the receiving period, calves were treated when they appeared sick. In both studies, the calves were fed a forage diet of 1/2 alfalfa hay and 1/2 prairie hay, supplemented with .5 lb of a 40% protein pellet and 2.5 lb whole corn daily.

Results and Discussion

In Trial I, levamisole reduced ($P < .05$) sickness of newly received calves during the first 5 days (Table 1). However, no difference occurred among treatments in overall sickness or medication days required per animal purchased. The reduction in sickness for the first 5 days supports evidence that levamisole stimulates the immune system.

The use of long-acting penicillin improved ($P < .05$) gain during the extended growing period but did not reduce sickness or medications required per animal. This may have been caused by a reduction in cattle with chronic, severe lung damage.

In Trial II, levamisole injected on day 1 resulted in less ($P < .05$) sickness and a trend toward fewer medications required during the first 5 days (Table 2), but no difference was observed among treatments for overall sickness or medication requirements per animal purchased. Levamisole had no effect on calf gain. These results agree with the findings of Trial I.

In summary, neither levamisole or long-acting penicillin injected alone or in combination at arrival nor multiple injections of levamisole reduced the overall level of sickness in highly stressed calves. However, long-acting penicillin injected at arrival improved stocker gain during an 111-day growing period.

Table 1. Effect of Levamisole and Long-acting Penicillin on Gain and Health of Newly Received Calves (Trial I)

Item	Control	Levamisole	Penicillin	Penicillin + Levamisole
No. calves	125	125	125	125
Daily gain, lb				
Day 1 to 34	1.44	1.63	1.61	1.63
Day 34 to 111	2.06[a]	2.04[a]	2.15[b]	2.11[b]
Morbidity, %				
Day 1 to 5	27.50[b]	18.50[a]	26.50[b]	19.00[a]
Day 6 to 34	36.50	42.50	38.60	41.00
Day 1 to 34	64.00	61.00	65.10	60.00
Medication days/animal purchased:				
Day 1 to 5	.60[b]	.13[a]	.73[b]	.13[a]
Day 6 to 34	2.80	3.18	2.90	2.80
Day 1 to 34	3.40	3.31	3.63	2.93

[ab]Means in the same row with unlike superscripts are different ($P < .05$).

Table 2. Effect of Levamisole on Gain and Health of Newly Received Calves (Trial II)

Item	Control	Levamisole injected day1	Levamisole injected day7	Levamisole injected day1 & day7
No. calves	110	109	109	109
Daily gain, lb (day 1 to 30)	1.43	1.41	1.31	1.35
Morbidity, %:				
Day 1 to 5	11.5[b]	4.5[a]	10.7[b]	5.6[a]
Day 6 to 30	39.7	46.4	42.6	46.8
Day 1 to 30	51.2	50.9	53.3	52.4
Day 1 to 5	.14	.01	.18	.13
Day 6 to 30	2.64	3.04	3.16	2.55
Day 1 to 30	2.79	3.05	3.35	2.68
Mortality, %	1.2	1.0	3.1	3.6

[ab]Means in the same row with unlike superscripts are different ($P < .05$).

EFFECT OF PRESPONSE® ON THE GAIN AND HEALTH OF LONG-HAULED, NEWLY ARRIVED CALVES[1]

F. K. Brazle[2]

Summary

Five hundred mixed-breed steer and bull calves (246 lbs) were divided into two treatment groups, with one group receiving a new *Pasteurella haemolytica* vaccine (Presponse®) at arrival.

There was no difference between groups in terms of gain, mortality, or morbidity during the 32-day receiving study. The Presponse group required fewer (P < .09) medication days per animal purchased, resulting in $1.68 less drug cost per head than the control group.

(Key Words: Stocker Cattle, Pasteurella Vaccine, Presponse, Receiving Program, Stress.)

Introduction

Calves transported long distances typically exhibit high incidences of respiratory disease and other health complications.

Presponse is a new *Pasteurella haemolytica* vaccine in an inactivated, bacteria-free liquid containing leukotoxoid and bacterial surface subunit antigens, which stimulate toxin-neutralizing and bacterial-agglutinating antibodies. *Pasteurella haemolytica* infection is one of the major health problems of shipped calves. Therefore, the objective of this study was to determine if Presponse, when injected at arrival, would reduce sickness and improve gain of highly stressed, long-hauled calves.

Experimental Procedures

Five hundred mixed-breed steer and bull calves (246 lbs) were uniformly allotted based on sexual status to either a Presponse vaccination group or control group at arrival. The calves were purchased over a 10-day period from Tennessee, Kentucky, and Mississippi. All the calves were vaccinated on arrival against IBR, BVD, PI_3, and blackleg (7-way); treated for internal and external parasites with Ivomec®; and implanted with Synovex-S®. All bulls were surgically castrated at arrival.

The calves were fed a diet of 1/2 alfalfa and 1/2 prairie hay to appetite, supplemented with .5 lb of a 40% crude protein supplement and 2.5 lb of corn/day. Calves were treated when they appeared sick during the 32-day receiving period.

Results and Discussion

Presponse vaccination at arrival of long-hauled, light weight calves did not improve gain, or reduce mortality or morbidity. However, Presponse did reduce (P < .09) the number of medication days required per animal purchased, which resulted in $1.68 less drug treatment cost per animal.

Presponse vaccination has been shown to be effective when injected before the stress

[1]Appreciation is expressed to Richard Porter, Reading, Kansas, for providing cattle and collecting data.

[2]Extension Livestock Specialist, Southeast Kansas.

period on calves. Veterinary case studies in which calves were injected with Presponse 3 weeks before weaning showed consistent results. Therefore, vaccinating highly stressed calves with Presponse at time of arrival may not allow enough time for adequate protection to occur.

Table 1. Effect of Presponse on Gain and Health of Highly Stressed Calves

Item	Control	Presponse
No. calves	250	250
Daily gain, lb (32 days)	2.06	1.98
Mortality, %	5.20	5.70
Morbidity, %	83.80	85.30
Medication days/ animal purchased	6.14[b]	5.09[a]
Drug cost head, $	$10.76	$9.08

[ab]Means in the same row with unlike superscripts are different ($P < .09$).

EFFECT OF CASTRATION METHOD ON STOCKER HEALTH AND GAIN[1]

F. K. Brazle[2]

Summary

Two field trials were conducted to compare two different band-castration techniques with surgical castration of calves and yearlings. In Trial I, the bull calves were surgically castrated or banded with Elastrator® rubber rings and compared with calves purchased as steers. Purchased steers gained faster ($P < .05$) during the 33-day receiving trial than bulls castrated by either method, but no difference was observed in percentage of sick calves.

In Trial II, yearling bulls were surgically castrated or banded with the EZE® Bloodless Castrator device. Yearlings purchased as steers gained faster ($P < .05$) than EZE-castrated bulls during the 110-day trial. Bulls castrated by either method required more medications ($P < .07$) than steers. In both trials, there was no advantage to banding compared with surgical castration of bulls in terms of gain or health.

(Key Words: Castration, Banding, EZE Device, Stocker Cattle.)

Introduction

Surgical castration of bull calves and yearlings causes stress from blood loss and physical changes to the body. Research has shown that daily gain is reduced .5 lb during the first 28 to 30 days and by .15 to .25 lb during the following 30 to 150 days after surgical castration, depending on the age and weight of bulls.

Therefore, a castration method that would reduce stress on bull calves and yearlings would benefit many stocker operators. The objective of these two studies was to determine if banding bulls would minimize stress as indicated by reduced health problems or increased gain.

Experimental Procedures

In Trial I, 496 mixed-breed steer and bull calves (253 lb) were purchased from Tennessee and Mississippi over a 5-day period in the fall. The calves were allotted to three treatments: 1)calves purchased as steers, 2) calves purchased as bulls and surgically castrated, and 3) calves purchased as bulls and banded with Elastrator rubber rings.

The calves were vaccinated at arrival against IBR, BVD, PI_3, and blackleg (7-way); treated for internal and external parasites with Ivomec®; and implanted with Synovex-S®. The calves were also vaccinated subcutaneously with 500 U of tetanus antitoxin. The calves were offered a forage diet of 1/2 alfalfa and 1/2 prairie hay fed to appetite and supplemented with 2.5 lb of whole corn and .5 lb of a 40% protein pellet during the 33-day receiving study.

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[1]Appreciation if expressed to Richard Porter, Reading, Kansas, for providing the cattle and collecting performance and health data.

[2]Extension Livestock Specialist, Southeast Kansas.

In Trial II, 60 mixed-breed steers and bulls (660 lb) were purchased locally over a 10-day period. The yearlings were allotted to three treatments: 1) yearlings purchased as steers, 2) yearlings purchased as bulls and surgically castrated, and 3) yearlings purchased as bulls and banded with the EZE Bloodless Castrator device.

The cattle were vaccinated against IBR, BVD, PI_3, leptospirosis, and blackleg (4-way); treated for internal parasites with levamisole and external parasites with Lysoff®; and implanted with Ralgro®. The yearlings were vaccinated subcutaneously with 1500 U of tetanus antitoxin. The cattle were initially drylotted for 36 days and fed 3 lb of a 15% crude protein grain mix plus prairie hay fed to appetite. The steers then grazed native grass pastures for 74 days until July 2.

Results and Discussion

In Trial I, the purchased steers gained faster ($P < .05$) than either castrated group, but no difference in morbidity was observed (Table 1). In Trial II, steers gained faster ($P < .05$) than banded bulls, with knife castrated bulls intermediate in gain. Both castrated groups required more medications ($P < .07$) than yearlings purchased as steers (Table 2). Band-castration (Elastrator or EZE device) of bulls did not improve gain, morbidity, medications required or cost of medication over surgically castrated bulls in these studies.

Research has shown that bull calves or yearlings are more susceptible to stress than steers. Probably some time is required for hormone changes to occur before a newly castrated bull can respond to stress like a steer castrated early in life. This process may take weeks to occur.

Therefore, the reason for increased morbidity of bulls may be twofold. First, most stocker bulls probably have not received vaccinations to build immunity against certain viruses. Secondly, the temperament of young bulls may create more stress because of social problems. This may explain why bulls that are banded with the EZE device seem uncomfortable for a few hours after the procedure and then resume normal eating habits, yet have as much or more morbidity as surgically castrated calves or yearlings. Our treatment records show that sickness occurred in surgically castrated bulls within 3 to 4 days after arrival. However, 7 to 8 days passed before the EZE banded bulls became ill. However, banding bulls with either Elastrator rubber bands or the EZE Bloodless Castrator device did not reduce stress as indicated by either medications required or animal gain.

When properly used, the EZE device should not result in scrotal swelling. However, if the band is not tight enough, some swelling will occur. On improperly banded bulls, considerable time may pass before the scrotal sack drops off. In these individuals, gains can be greatly reduced and health problems increased. The best course of action with improperly banded calves is probably surgical castration.

[3]EZE Bloodless Castrator, Wadsworth Manufacturing, St. Ignatius, MT.

Table 1. Effects of Castration Method on the Gain and Health of Calves (Trial 1)

Item	Purchased steers	Surgically castrated bulls	Elastrator banded bulls
No. cattle	118	190	188
Daily gain, lb (33 days)	1.85[b]	1.63[a]	1.47[a]
Mortality, %	6.4	10.6	14.0
Morbidity, %	75	81	78
Medication days/ animal purchased	5.81	6.86	7.09
Drug cost/ head, $	10.43	12.37	12.52

[ab]Means in the same row with unlike superscripts are different (P < .05).

Table 2. Effects of Castration Method on the Gain and Health of Yearlings (Trial II)

Items	Purchased steers	Surgically castrated bulls	EZE Device banded bulls
No. cattle	20	20	20
Daily gain, lb (110 days)	2.05[b]	1.78[ab]	1.58[a]
Medication days/ animal purchased	.35[c]	1.45[d]	2.20[d]

[ab]Means in the same row with unlike superscripts are different (P < .05).
[cd]Means in the same row with unlike superscripts are different (P < .07).

EFFECT OF FEED ADDITIVES ON SHIPPING SHRINKAGE OF YEARLING HEIFERS

F. K. Brazle[1]

Summary

Two studies were conducted to determine the effect of feed additives on the transit shrink of yearling cattle. In Trial I, 146 mixed-breed heifers were offered a mineral mixture containing either Terramycin® or Bovatec®, or without additive while grazing native grass pastures. Shrinkage after 300 miles in transit was lower ($P < .09$) for Bovatec-fed heifers than the other groups. In Trial II, 60 mixed-breed heifers were offered free choice prairie hay, plus soybean hulls without additive or containing either Aureomycin®, Rumensin, or Bovatec®. Both ionophores tended to reduce live weight shrink following a 10-hour withholding of feed and water, but treatment differences were not significant ($P > .05$). The small shrinkage differences observed in these two trials would not justify changes in the weighing practices of feeder cattle.

(Key Words: Shrink, Antibiotic, Ionophore, Feeder Cattle.)

Introduction

Many factors, including distance from the scale, time of day the cattle are weighed, and the amount of grain fed, have been used to determine an acceptable pencil shrink on feeder cattle. However, the increasing use of ionophores and tetracyclines in cattle on forage diets may also affect shrink. Rumensin has been shown by Texas researchers to reduce gut fill in pasture cattle. Therefore, the objective of these studies was to determine if ionophores and tetracyclines affect the shrinkage of feeder cattle.

Experimental Procedures

In Trial I, 146 (517 lb) mixed-breed heifers were allotted randomly to three treatments: 1) Terramycin®, 422 mg/head/day; 2) Bovatec, 122 mg/head/day; 3) control. The heifers were grazed on native grass pastures (two pastures/treatment) for 84 days while the feed additives were fed in a mineral mixture. The heifers were co-mingled and weighed individually at 7 a.m. on July 15, then shipped 300 miles to a feedlot. The heifers were weighed individually upon arrival at the feedlot.

In Trial II, 60 mixed-breed (581 lb) heifers were allotted randomly to four treatments: 1) Aureomycin®, 296 mg/head/day; 2) Bovatec, 195 mg/head/day; 3) Rumensin, 165 mg/head/day; and 4) control. There were three pens of heifers per treatment with five head per pen. The heifers were fed 14.3 lb of soybean hulls per day plus free choice prairie hay for 10 days. The heifers were co-mingled and weighed individually at 7:30 a.m. Then, they were weighed every 2.5 hours over a 10-hour period. Between weighings, heifers were placed in a tight pen without feed or water to simulate shipment.

Results and Discussion

In Trial I, Bovatec-fed heifers shrank less ($P < .09$) than Terramycin or control cattle (Table 1). In Trial II, Rumensin and Bovatec-

[1]Extension Livestock Specialist, Southeast Kansas.

fed heifers experienced the least shrink (Table 2). However, differences among treatments in this study were not significant (P > .05).

Figure 1 shows the rate of shrink for all cattle in Trial II over the 10-hour period. The temperature ranged from 89 to 95 F during this period. The rate of shrink was about 1.4% per hour during the first 5 hours, then slowed to .68% by the end of the 10-hour period.

Table 1. Effect of Terramycin and Bovatec on Shrink of Feeder Heifers (Trial I)

Item	Control	Terramycin	Bovatec
No. heifers	44	56	46
Starting weight, lb	636	668	656
Trucking shrink, lb	38.1[ab]	39.7[b]	35.9[a]
Shrink, %	6.0[d]	5.9[d]	5.5[c]

[ab]Means in the same row not sharing the same superscript are different (P < .01).
[cd]Means in the same row not sharing the same superscript are different (P < .09).

Table 2. Effect of Feed Additives on Shrink of Feeder Heifers (Trial II)

Item	Control	Aureomycin	Bovatec	Rumensin
No. heifers	15	15	15	15
Starting wt., lb	658	676	649	666
Weight, shrink, %:				
7:00 a.m. to 9:30 a.m. (89 F)	2.28	2.64	2.32	2.18
9:30 a.m. to 12:00 p.m. (93 F)	2.65	2.48	2.67	2.57
12:00 p.m. to 2:30 p.m. (95 F)	2.25	2.34	2.21	2.14
2:30 p.m. to 5:00 p.m. (94 F)	1.88	1.57	1.66	1.75
Total shrink, 10 hours	9.07	9.04	8.87	8.66

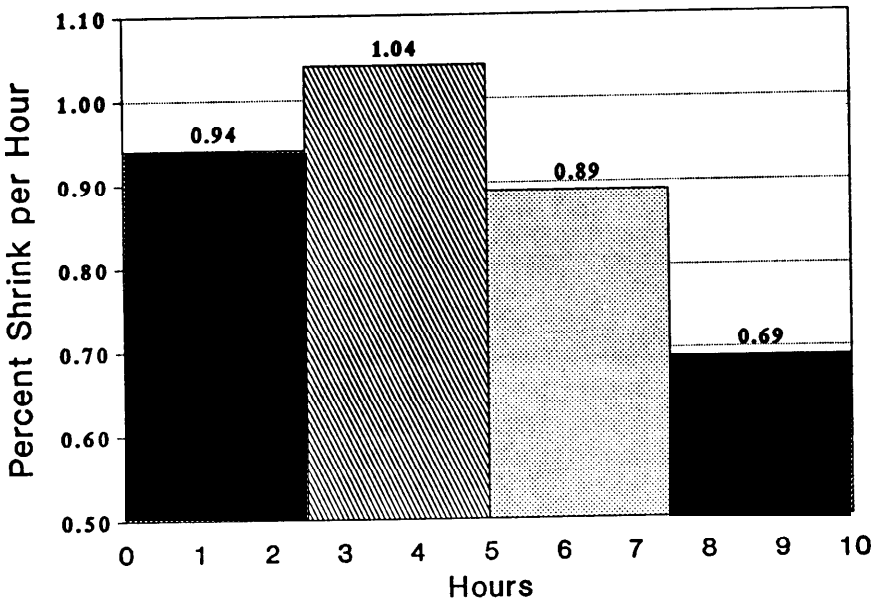

Figure 1. Rate of Shrink over a 10-hour Period in Feeder Heifers (Trial II).

PERFORMANCE AND CARCASS CHARACTERISTICS OF CULL BEEF COWS IMPLANTED WITH GROWTH PROMOTANTS AND FED A HIGH CONCENTRATE RATION

C. D. Cranwell, J. A. Unruh, D. D. Simms, and J. R. Brethour[1]

Summary

Open, cull beef cows fed a high concentrate ration for 28 or 56 days and implanted with Finaplix-H®, Synovex-H®, or both had improved gain and feed efficiency compared to controls (nonimplanted cows). Changes in ultrasound-measured backfat (12th rib) of implanted cows and controls were similar in both feeding periods. Marbling, fat color, and tenderness, as measured by Warner-Bratzler shear force, were not improved by feeding cows for 56 days compared to 28 days. However, lean color, dressing percent, and ribeye area were improved by feeding for 56 days. Numerical yield grade was lower ($P < .05$) in 28-day fed cows. Implanting with Synovex-H or Finaplix-H resulted in leaner carcasses with lower yield grades compared to controls. Ribeye area was increased by using Synovex-H compared to controls and Finaplix-H. These data indicate that the benefits in gain, feed efficiency, and carcass traits from implanting cull cows can be obtained by using either Synovex-H or Finaplix-H alone.

(Key Words: Cull Cow, Implant, Gain, Efficiency, Carcass.)

Introduction

If a beef cow fails to conceive, economics usually dictate culling her from the herd. An estimated 300,000 cull beef cows are sold annually in Kansas. Most are culled after weaning and are sold in thin condition after coming off late-season pasture. The potential exists for exploiting compensatory gain in these thin cows. However, little research has examined implant strategies for use while feeding thin, mature, nonpregnant, beef cows. Therefore, this project was designed to examine the effect of growth-promoting implants on live animal performance and carcass characteristics of cull beef cows fed a high concentrate ration.

Experimental Procedures

Forty-eight, predominantly British breed cows were stratified by weight and randomly assigned to an implant treatment, feeding period (28 or 56 days), and one of three replications (16 cows per replication).

All cows were nonpregnant and between 4 and 10 years old (as determined by mouthing) and had an average of .13 inch of ultrasound-measured backfat at the 12th rib. Treatments included: 1) nonimplanted (controls), 2) Synovex-H (200 mg testosterone + 20 mg estradiol benzoate), 3) Finaplix-H® (200 mg trenbolone acetate), or 4) both implants. Cows were fed in individual pens, systematically increased from a 56% to an 80% concentrate (DM basis) grain plus sorghum silage ration balanced to contain 11.9% crude protein, and full fed for either 28 or 56 days.

Weights were taken on 3 consecutive days at the beginning of the trial and on 2 days prior to each slaughter date. Differences between averaged weights were used to calculate gain and feed efficiency. Changes in external fat cover were monitored using ultrasound.

[1]Fort Hays Branch Experiment Station.

Cows were slaughtered at the Kansas State University meats laboratory. Carcass data collected included: USDA yield grade factors, marbling score, fat and lean color, and dressing percent. A steak was removed at the 12th rib for determination of Warner-Bratzler shear force.

Results and Discussion

Performance results are presented in Table 1. Implanting cull cows improved daily gain and feed efficiency compared to controls. Cows receiving both implants performed similarly to those receiving either implant alone. Implanted cows had greater ($P < .10$) daily gains at 28 days than controls. At 56 days, Finaplix-H implanted cows and those receiving both implants had greater ($P < .05$) gains than controls. Cull cow gains on all implant treatments were similar ($P > .05$) at 56 days. However, gain of Synovex-H implanted cows was not different ($P > .05$) from that of controls. Feed intake did not differ ($P > .05$) among experimental groups in either feeding period. However, implanted cows required less ($P < .05$) feed per pound of gain, with no difference ($P > .05$) among implant treatments. Ultrasound fat thickness changes were similar ($P > .05$) for all treatments at both 28 and 56 days.

Cull cow gain and feed efficiency of all experimental groups exceeded the authors' expectations. In an effort to minimize measurement error, multiple live cattle weights were taken to calculate gain. Actual unshrunk weights were used in the analysis. It is likely that mature cows eat more when changed from limited nutritional management to a high quality diet. Therefore, the reported gains would be skewed upward by increased fill. Nevertheless, differences in performance between control and implanted cull cows should be biologically significant.

The effects of implant treatment and days on feed on carcass traits are presented in Table 2. Yield grade and ribeye area were the only carcass traits affected by implanting. Cows implanted with Finaplix-H or Synovex-H had leaner carcasses with lower ($P < .05$) numerical yield grades than controls. Cows receiving both implants did not differ ($P > .05$) from controls or single-implant groups with respect to yield grade. Cows implanted with Synovex-H had larger ($P < .05$) ribeye areas than control and Finaplix-H-implanted cows. Cows given both implants had ribeye areas similar ($P > .05$) to both single-implant groups and controls. Statistical analysis did not allow separation of treatment groups within a feeding period; however, hot carcass weights from implanted cows appeared heavier than those from controls at 56 days. This is consistent with differences observed in daily gain during the same period.

Several differences in carcass traits (Table 2) were found between feeding groups (28 vs. 56 days). Dressing percentage, hot carcass weight, ribeye area, and adjusted fat thickness were greater ($P < .05$) in 56-day fed cows than in those fed for 28 days. As would be expected from an increase in fat thickness, cows fed for 56 days had higher ($P < .05$) numerical yield grades. Subjective lean color scores were lighter ($P < .05$) in cows fed for 56 days compared to 28 days. Warner-Bratzler shear value, marbling score, and fat color were not influenced ($P > .10$) by feeding period. Lengthening the feeding period increased fat thickness, ribeye area, and dressing percentage.

Gain and feed efficiency were improved dramatically by implanting thin cull beef cows prior to high grain feeding. Yield grade and ribeye area were also increased by implanting. Our data indicate that live animal performance and carcass traits respond to Finaplix-H or Synovex-H alone, and it is not necessary to use both implants simultaneously.

Table 1. Feedlot Performance of Implanted and Nonimplanted Cull Beef Cows Fed for 28 or 56 Days

Item	Control	Finaplix-H®	Synovex-H®	Both Implants
28 Days on Feed				
Daily gain, lb	3.9[c]	5.1[b]	5.3[b]	5.8[b]
Change in fat thickness, in.[a]				
Feed/gain	7.2[e]	5.5[d]	5.4[d]	5.0[d]
Daily Intake, lb DM	26.0	26.8	27.5	26.8
56 Days on Feed				
Daily gain, lb	3.5[e]	4.8[d]	4.5[de]	5.3[d]
Change in fat thickness[a], in.				
Feed/gain	9.0[e]	6.5[d]	6.8[d]	5.5[d]
Daily intake lb DM	29.3	29.5	30.1	29.2

[a]Change in ultrasound measured fat thickness at the 12th rib (inches).
[bc]Values in the same row without a common superscript are different (P < .10).
[de]Values in the same row without a common superscript are different (P < .05).

Table 2. Carcass Traits of Implanted and Nonimplanted Cull Beef Cows Fed for 28 or 56 Days

Item	28 Days of Feed				56 Days of Feed				Response	
Implant[a]:	C	F	S	B	C	F	S	B	Day[b]	Trt[c]
Dressing percent	51.4	49.3	51.9	50.6	53.7	53.1	54.6	54.7	*	NS
Yield grade	2.3	1.8	1.6	1.9	2.5	2.4	2.4	2.6	*	†[g]
Adjusted backfat, in.	.36	.19	.25	.29	.38	.41	.42	.46	*	NS
Ribeye area, in.[2]	11.2	11.0	12.7	11.9	11.6	12.5	13.1	12.4	*	†[h]
Hot carcass weight, lb	585	562	600	580	652	678	690	712	*	NS
Fat color[d]	3.7	3.6	3.0	4.0	2.6	2.8	1.8	2.4	NS	NS
Lean color[e]	6.2	6.0	6.2	6.3	4.0	4.4	4.7	4.5	*	NS
Warner-Bratzler shear, lb	11.7	9.9	10.6	11.9	11.2	10.1	11.2	10.6	NS	NS
Marbling score[f]	269	315	334	267	287	347	294	311	NS	NS

[a]C = Control, F = Finaplix-H®, S = Synovex-H®, B = Both Implants.
[b]* indicates a difference exists between feeding periods (P < .05) across treatment groups. NS indicates no significant difference (P > .05).
[c]† indicates a difference exists between specific implant treatments (P < .05) across feeding periods. NS indicates no significant difference (P > .05).
[d]Subjective score: 1 = bleached white, 8 = dark yellow.
[e]Subjective score: 1 = pale red, 4 = cherry red, 8 = very dark red.
[f]Marbling score: 200 = Slight[0], 300 = Small[0].
[g]C > F and C > S, P < .05.
[h]C < S and F < S, P < .05.

RECORD-KEEPING SYSTEMS FOR BEEF SAFETY AND FEEDLOT HEALTH

C. D. Cranwell and D. D. Simms

Summary

Three hundred nine feedlots were mailed questionnaires to ascertain the types of record-keeping systems currently being used to monitor health programs and FDA-specified treatment withdrawal times. Microcomputer systems were of special interest. Approximately one third of the feedlots responded. A majority with a one-time feeding capacity of more than 10,000 head were using a microcomputer record-keeping system, whereas most of those with fewer than 10,000 head used a manual, paper-based system. Those feedlots using computerized record-keeping systems had purchased their software package from one of five companies. Managers felt these software packages were adequate for billing customers, monitoring pharmaceutical inventory and withdrawal period, and aiding treatment diagnosis. Proper monitoring of animal inventory was indicated by some feedlots as a limitation of their particular software. Almost all feedlots using computer record-keeping systems indicated that fewer than five employees operate the system on a regular basis. Among feedlots using computerized systems, the scope of the particular software in use met the yards' perceived needs. Approximately 23% of responding feedlots regularly used blood or urine tests to verify proper drug withdrawal and clearance prior to shipping previously treated cattle.

(Key Words: Drug Withdrawal, Record Keeping, Microcomputer.)

Introduction

Meat safety is an increasingly important issue in the beef cattle industry. One important aspect of this issue is ensuring that beef is free from drug residues. This is partially a function of adhering to drug withdrawal periods specified by the FDA. Complying with these withdrawal periods requires good records of processing and health treatments. Traditionally, these record-keeping systems have been paper-based (manual card file). However, in the past few years, microcomputer-based systems have gained wide acceptance. Our goals were to assess the perceived adequacy of the systems, both paper-based and microcomputer-based, and to identify specific problems limiting the adequacy of these systems.

Experimental Procedures

The initial phase of this project included visits with feedlot managers and software vendors to identify the various systems in use. Feedlots varying in size were selected for personal visits to determine if certain types of systems were better suited to feedlots of specific sizes. Information from these initial visits was used to develop a questionnaire and solicit input from feedlots using microcomputer record-keeping systems. The questionnaire consisted of 10 questions related to software adequacy for monitoring drug withdrawals and general health record keeping. It was sent to 55 feedlots with computerized systems in Kansas and Nebraska. Another questionnaire was developed for feedlots using paper-based systems. One questionnaire of each type was sent to 254 Kansas feedyards. The feedlot mangers were asked to complete the one most

relevant to their operation. A breakdown of feedlot responses is presented in Table 1.

Results and Discussion

Microcomputer-Based Systems

Fifty-nine feedlots responding to the surveys were using computerized record-keeping systems. A breakdown of the one-time feeding capacity of these yards is presented in Table 2. Of feedlots indicating their capacity, 32% were more than 20,000 head, and 25% were fewer than 10,000 head. Fifty-six percent had been using their computer system for more than 1 year. Approximately 10% of those respondents used software customized for their feedlot. The others used an "off the shelf" package sold by one of five companies. Regardless of source, all programs were able to monitor pharmaceutical and animal inventories and provide aid in treatment diagnosis. Eighty-nine percent of the respondents indicated that their program provided adequate printouts for use in billing customers for health costs. Twenty-four percent of the feedlots backed up their record-keeping system by using blood or urine tests to verify proper drug withdrawal prior to shipping.

Cost of the system was the most frequently indicated disadvantage. Many yards reported that time involved in using the system was a disadvantage of microcomputerized system, despite the fact that 85% of respondents found that their microcomputer system required fewer manhours than the previous system. A few feedlots thought the program output was too long and could be condensed. Several respondents indicated that animal inventory control was a problem, because records had to be adjusted by the person treating the cattle. Feedlots pointing out this problem would have preferred inventory to be monitored in the office. Despite this shortcoming, very few respondents indicated any kind of problem closing out a pen.

Our feedlot visits and phone calls indicated that feedlot employees were very receptive to using microcomputers. This is also evidenced by the rapid transition time to these computerized systems. Almost all feedlots indicated transition can take place effectively in less than 3 months. Many managers indicated that conversion was complete in a matter of days. This transition possibly was aided by the limited number of employees operating the system on a regular basis. Even considering the range in feedlot capacity among yards using these systems, 75% indicated that fewer than five employees used the system regularly.

Paper-Based Record-Keeping Systems

From the general survey, 56 respondents indicated using a manual, paper-based system for keeping health records. A breakdown of the one-time feeding capacity of these yards is presented in Table 2. Of feedlots indicating their capacity, 36% were over 10,000 head, and 44% were less than 5,000 cattle.

All feedlots using a manual system indicated that monitoring animal and pharmaceutical inventories was easily handled by their system. A majority of feedlots satisfied with their present system also indicated that good communications existed between employees treating cattle and those responsible for monitoring withdrawal periods and customer billing. Ninety percent of feedlots using a manual system felt even though their pharmaceutical inventory included a variety of products, monitoring withdrawal times and pharmaceutical inventory presented no problems. Twenty-two percent of respondents using manual systems used a blood or urine test prior to shipment in order to confirm drug clearance in treated cattle.

Thirty-eight percent of feedlots responding indicated that inaccurate or incomplete treatment records were a concern. Interestingly, virtually the same proportion (36%) of yards was considering switching to a microcomputer system. However, 69% of these feedlots also viewed their manual record-keeping system as labor intensive.

Overall, all of the feedlots responding to our survey were confident in the functionality of their current record-keeping systems; however, residue prevention clearly was a high priority. The commercial cattle feeding business is a vital check in protecting the wholesomeness of beef. Consumer acceptance and confidence in beef is critical. Thus, beef safety is everybody's business.

Table 1. Number of Feedlots Responding to Health Record-keeping Surveys

		Number of Responses	
Survey Type	Number of Questionnaires Mailed	Microcomputer	Paper-Based
Microcomputer	55	42	NA
General	254	17	56
Total	309	59	56

Table 2. Capacity of Feedlots Using Microcomputer and Manual, Paper-Based, Record-keeping Systems

	Type of Record-Keeping System	
Feedlot Capacity[a]	Microcomputer	Paper-Based
Less than 5,000	6	20
5,000 to 9,999	7	9
10,000 to 14,999	11	7
15,000 to 19,999	12	5
20,000 or more	17	4
Total[b]	53	45

[a]One-time feeding capacity.
[b]Some yards responding to the survey did not indicate capacity.

PERFORMANCE OF RAT-TAIL CALVES[1]

R. R. Schalles, D. Powell [2], L. V. Cundiff [2], and J. B. Glaze [2]

Summary

The rat-tail syndrome occurs in a small percentage of calves produced by crossing Continental breeds of cattle with Angus or Holstein. These calves are characterized by short, curly, malformed, sometimes sparse body hair and an abnormal tail switch.

The performance of 43 rat-tail calves was compared to that of 570 normal calves of the same breeding and contemporary groups. All rat-tail calves were sired by Simmental bulls and were from cows with various percentages of Angus breeding. As the percentage of Angus increased, the frequency of rat-tail calves increased.

The rat-tail condition had no effect on birth weight, weaning weight, or gain from birth to weaning. However, the rat-tail calves had significantly lower rates of gain from weaning to yearling (during the winter months) than the normal calves, resulting in 43 lb lighter yearling weights. The gains of steers from yearling to slaughter were not significantly different, but the rat-tail steers were 78 lb lighter (P = .01) and 13 days older (P = .15) at slaughter than the normal steers.

(Key Words: Rat-tail, Cattle, Performance, Genetics.)

Introduction

After the introduction of the Continental breeds of cattle in the 1960s and 70s, a congenital condition commonly referred to as "rat-tail" was reported when those breeds were crossed with Angus or Holstein.

The condition is characterized by short, curly, malformed, sometimes sparse body hair and an abnormal tail switch. Their hair morphology was studied by Ayers, Leipold, Schalles and Cole (J. Vet. Med., 1989), who found enlarged, irregularly distributed, and clumped melanin granules in the hair shaft of affected animals. The hair shafts were asymmetrical, short, curled, and small. The scale surface was rough and pitted, with areas where scales failed to form.

The condition is very infrequent or nonexistent in pure breeds but occurs in crosses, indicating that at least two loci are involved in its inheritance. Breeders have reported various effects on performance, from none to severe. The condition affects calf appearance, and in some markets these animals are discriminated against, thus affecting their economic value. Our objective was to determine the effect of the rat-tail condition on calf performance.

Experimental Procedures

During the winter of 1991, 43 rat-tail calves were visually identified among 1169

[1]Sponsored by the American Simmental Association.

[2]Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, Nebraska.

crossbred calves at the Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, NE. Factors considered included the length, texture, curliness, and amount of hair, and the presence of a tail switch. White hair of rat-tail animals appears to be unaffected, so when the tail was white and normal but the animal had the other characteristics, it was classified as rat-tail. An attempt was made to evaluate these animals as a buyer might.

The basic color (red, black, yellow, grey, or white) of the calves was also recorded. All rat-tail calves were sired by Simmental bulls from cows with various percentages of Angus breeding. None of the other sire breeds that were evaluated (Charolais, Gelbvieh, Pinzgauer, Longhorn, Piedmontise, and Salers) produced rat-tail calves from Angus-cross cows.

Calves were born between March 8 and May 29, 1990. They nursed their dams until weaning in September or October at an average age of 169 days. All calves of a line (the same breeding) were weaned at the same time. Calves were then separated by sex, and fed a growing ration in dry lot until January. They were then weighed and re-grouped by weight and sex, and placed on a finishing ration.

Yearling weights were taken in late April and early May at an average age of 366 days. Females selected for breeding were removed at this time. Steers remained on a finishing ration and were slaughtered in groups when visually judged to have sufficient finish. Because selected heifers were removed from the study as yearlings, only steers were included in the post-yearling performance phase of the study.

Only lines that produced at least one rat-tail calf with complete data were used in the analysis of performance data. The rat-tail calves were compared to normal calves of the same line. The least squares model included the fixed effects of sex, rat-tail classification, line, and age of dam group (2, 3, 4, 5 to 10, and over 10 years) and age of the calf as a covariate. Rat-tail by line and rat-tail by sex interactions were nonsignificant and were removed from the final analysis.

Results and Discussion

All rat-tail calves were sired by Simmental bulls and were from dams that had some Angus breeding (Table 1). All rat-tail calves had the dominant gene for black, but the color was modified to gray or charcoal. Twenty-three percent of the rat-tail calves were gray. As the percentage Angus in the dam increased, the percentage of rat-tail calves increased. Dam color was not available; however, a higher frequency of the black gene would be expected with a higher percentage of Angus breeding.

There were no significant differences in birth or 205-day weights between rat-tail and normal calves (Table 2). However, rat-tail calves had lower ($P = .01$) average daily gains from weaning to yearling (during the winter months), resulting in 43 lb lighter average 365-day weights ($P = .03$). Perhaps the hair of rat-tail calves did not provide enough normal insulation to avoid excessive heat loss during cold weather. There was no significant difference in average daily gains of rat-tail and normal steers between yearling and slaughter. However, the rat-tail steers were 78 lb lighter ($P = .01$) and 13 days older ($P = .15$) at slaughter.

The mode of inheritance of the rat-tail condition is not known. Another project is currently under way to determine how the condition is inherited and to find appropriate procedures to reduce or avoid its occurrence.

Table 1. Number of Calves Produced by Dam Line[a]

Cow breed[b] composition	Total calves	No. rat-tail	Percent rat-tail
AN	104	14	
Total 100% AN cows			13.5
AN - HH	43	3	
HH - AN	41	5	
GV - AN	14	1	
PZ - AN	20	1	
CH - AN	11	0	
SH - AN	13	1	
GA - AN	15	0	
TL - AN	22	2	
NE - AN	23	2	
PI - AN	21	1	
SA - AN	21	0	
Total half AN cows	244	16	6.6
MARC 3	312	13	
Total quarter AN cows			4.2

[a]All calves were sired by Simmental bulls.
[b]AN = Angus, HH = Hereford, GV = Gelbvieh, PZ = Pinzgauer, CH = Charolais, SH = Shorthorn, GA = Galloway, TL = Longhorn, NE = Nellore, PI = Piedmontese, SA = Salers, MARC 3 = 1/4 each PZ, HH, AN, Red Poll.

Table 2. Performance of Normal and Rat-Tail Calves

Trait	No.	Normal	Rat-tail	P[a]
Birth wt, lb	610	93.6	95.6	.46
205d wt, lb	610	547	535	.33
365d wt, lb	610	982	939	.03
Slaughter wt[b], lb	301	1324	1246	.01
Slaughter age[b], days	301	467	480	.15
Daily gain:				
Birth - weaning, lb	610	2.21	2.14	.24
Weaning - yearling, lb	610	2.72	2.54	.01
Yearling - slaughter[b], lb	301	2.71	2.47	.12

[a]Probability of a rat-tail effect.
[b]Only steers were included.

HERITABILITIES AND GENETIC CORRELATIONS OF ULTRASOUND-MEASURED RIBEYE AREA WITH OTHER PERFORMANCE TRAITS IN BRANGUS CATTLE[1]

M. Z. Johnson, R. R. Schalles, M. E. Dikeman, and W. Olson

Summary

Heritabilities and genetic correlations for ultrasound-measured ribeye area and fat thickness, as well as growth traits and scrotal circumference, were determined using performance records of 1613 Brangus calves born from 1987 to 1990. Moderate heritabilities of .39 for weaning and .40 for yearling ultrasound-measured ribeye area indicate that selection to change these traits should be effective. The positive, and generally large, genetic correlations between ultrasound-measured ribeye areas and growth traits indicate that genetic change of these traits can be made in tandem. The low heritability (.14) of fat thickness, the small amount of fat, and the lack of variation would make it very difficult to change the genetic ability of animals to deposit fat.

(Key Words: Heritability, Genetic Correlation, Ultrasound-measured Traits, Growth, Scrotal Circumference, Brangus Cattle.)

Introduction

Ultrasound technology has been proposed as a means of evaluating ribeye area and fat thickness of young breeding stock. Determining the best age to obtain these measurements was our first step and was reported in the Cattlemen's Day Report in 1991. The second step in determining the usefulness of ultrasound measurements was to estimate the genetic parameters of these traits and their genetic relationships with other traits.

Experimental Procedures

Real-time ultrasound equipment was used to measure weaning and yearling ribeye area and yearling fat thickness from 2101 calves born at the Brinks Brangus Ranch, Eureka, KS from 1987 through 1990. Editing the data for completeness and restricting calf age to between 160 and 250 days at weaning and 320 to 410 days at yearling scan dates resulted in the number of observations shown in Table 1, which were used in these analyses. Calves were sired by 59 bulls, were out of 814 dams, and were from 121 weaning contemporary groups formed on the basis of sex, age (not more than 90 days difference in birth date), pre-weaning management (creep vs. no creep), and weaning scan date. Weaning contemporary groups were then subdivided according to post-weaning management and yearling scan date, resulting in 151 yearling contemporary groups.

Calves were born and birth weights taken in both the fall and spring of each year. Weaning data were collected at an average age of 204 days. After weaning, bulls were placed in an on-farm, 140-day performance test, whereas heifers were placed on a growing program. Yearling data were collected at an average age of 361 days.

Of the 1613 calves with weaning data, 378 were in full-sib groups (ranging from 2 to 11 per mating), largely as a result of embryo transfer (ET). All recipient cows were Brangus, and the ET calves were used in calculating the direct heritabilities and genetic

[1]Supported by Brinks Brangus Ranch, Eureka, KS and International Brangus Breeders Association.

correlations. In subsequent editing, the ET calves were deleted, thus eliminating ET recipient cows from the analysis to obtain the maternal heritabilities. A derivative-free, restricted-maximum-likelihood procedure was used with a full numerator relationship matrix in a mixed-linear-animal model. The model included contemporary group and age of dam (2, 3, 4, 5, 6-10, and > 10 yr) as fixed effects; measurement-age to regress all records to an equal age basis; and individual animal, maternal, and permanent maternal environment as random effects.

Results and Discussion

Heritabilities and genetic correlations of birth weight, weaning weight, post-weaning gain, yearling weight, frame score, and scrotal circumference (Table 2) are generally within the range of previous literature reports for within-herd analysis, except that birth weight heritability was .75, whereas other estimates average approximately .45. The heritabilities obtained for ultrasound-measured weaning and yearling ribeye areas were .39 and .40, respectively, with a genetic correlation of .66 between them. These estimates indicate a moderate amount of genetic influence on these traits and that most of the genes affecting weaning ribeye area also affect yearling ribeye area. The genetic correlations between ultrasound-measured ribeye areas and weight-growth traits were all positive and generally moderate to high, with the exception of weaning ribeye area and post-weaning gain (.06). The genetic correlations obtained between yearling frame score and ribeye area at weaning (.18) and for yearlings (.01) were positive and very low. Similar small, positive, genetic correlations were obtained between ultrasound-measured ribeye areas and scrotal circumference. Scrotal circumference had positive genetic correlations with all measures of growth and a moderate negative (-.33) correlation with fat thickness. The heritability (.14) of ultrasound-measured yearling fat thickness was very low, and cattle averaged only .17 in. with little variation (standard deviation of .07 in.), indicating that genetic differences in ability to deposit fat were probability not expressed at this age and level of nutrition. Genetic correlations between fat thickness and weaning and yearling ribeye areas, as well as frame score, were positive but small. The maternal heritability for both ultrasound-measured ribeye areas was .01, indicating no maternal influence on these traits. The maternal heritability of fat thickness (.10) was low, although nearly equal to the direct heritability, indicating that preweaning maternal environment and an individual animal's own fattening ability have almost equal effects on yearling fat thickness.

Table 1. Number of Observations, Means and Standard Deviations of Data Analyzed for Each Trait

Trait	n	Mean	SD
Birth wt, lb	1583	85	13
Weaning wt, lb	1613	548	85
Weaning Ribeye are, in^2	1613	6.9	1.2
Yearling wt, lb	1296	904	176
Post-weaning gain, lb	1296	346	151
Yearling frame score	325	7.4	.87
Scrotal circumference, cm	373	34.3	2.7
Yearling ribeye area, in^2	1296	10.0	2.1
Yearling fat thickness, in	1111	.17	.07

Table 2. Hertitabilities and Genetic Correlations[a] of Traits Analyzed for Brangus Cattle

Trait[b]	BW	WW	WRE	YW	PWG	FRA	SC	YRE	FAT
BW	.75								
WW	.52	.48							
FRE	.26	.68	.39						
YW	.54	.90	.42	.44					
PWG	.38	.50	.06	.88	.31				
FRA	.46	.47	.18	.67	.71	.42			
SC	.37	.07	.04	.23	.38	.20	.48		
YRE	.17	.29	.66	.38	.43	.01	.06	.40	
FAT	.52	-.17	.19	-.53	.44	.14	-.33	.12	.14

[a]Heritabilities are on the diagonal and genetic correlations are below the diagonal.
[b]BW = birth weight, WW = weaning scan weight, WRE = weaning ultrasound ribeye area, YW = yearling scan weight, PWG = post-weaning gain, FRA = yearling frame socre, SC = yearling scrotal circumference, YRE = yearling ultrasound ribeye area, FAT = yearling ultrasound twelfth-rib fat thickness.

COMPARISON OF FEEDLOT AND CARCASS CHARACTERISTICS OF ANGUS, HEREFORD, BRAHMAN, CHAROLAIS, AND GELBVIEH CROSSBRED STEERS

D. T. Hickok, R. R. Schalles, M. E. Dikeman, and D. E. Franke[1]

Summary

Feedlot performance of 207 steers with various percentages of Angus, Hereford, Charolais, Brahman, and Gelbvieh breeding were compared at a constant 1) days fed, 2) adjusted carcass backfat, and 3) slaughter weight. As the percentage of Angus, Hereford, or Brahman increased, growth rate decreased, whereas increasing the percentage of Charolais increased growth rate. Increasing the percentage of Gelbvieh increased weaning weight but had little effect on post-weaning gains. Increasing percentage of Charolais increased feed conversion efficiency, whereas the other breeds were similar, except that at a constant slaughter weight, greater percentage of Hereford improved feed conversion efficiency.

Increasing the percentage of Charolais increased carcass weight and ribeye area and decreased yield grade, but marbling was not different from that of Angus. An increase in percentage of Hereford caused a decrease in carcass weight, ribeye area, marbling, and quality grade. Increasing percentage of Angus decreased carcass weight and ribeye area but increased marbling and quality grade. Increasing percentage of Brahman caused the greatest reduction of marbling and quality grade of any breed. Increasing the percentage Gelbvieh breeding resulted in increased ribeye area and decreased marbling at constant days fed and slaughter weight.

(Key Words: Cattle, Breeds, Performance, Carcass.)

Introduction

Crossbreeding is well accepted in the beef industry. With over 60 breeds available to choose from, information is necessary to make sound selections. This study was designed to compare feedlot and carcass characteristics of steers produced from 2-, 3-, and 4-breed rotational and terminal crossbreeding systems involving British, Continental, and Zebu breeds of cattle.

Experimental Procedures

Crossbred steers were produced from 2-, 3-, and 4-breed rotational crossbreeding systems involving Angus (AN), Hereford (HH), Charolais (CH), Gelbvieh (GV), and Brahman (BR) breeds at Louisiana State University, Baton Rouge. Half of each cow breed group were bred to GV bulls as a terminal cross. The remaining cows were mated to the least related breed of bulls within the rotation. Calves were born between Jan. 31 and April 14 and weaned at an average age of 185 days. At weaning, steer calves were randomly assigned, within breed groups, to either a calf feeding or yearling feeding management group. After an approximate 3 wk conditioning period, 45 calves were shipped to KSU in 1989 and 64 in 1990 to constitute the calf management group. The 44 steers in 1989 and 54 in 1990 assigned to the yearling management group were grazed during the winter at Baton Rouge on rye grass pasture and shipped to KSU in early May. Steers in both management groups were group fed for 18 to 21 days, while the energy density of the ration was increased

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to 75% concentrate of the total dry matter. Steers were then sorted into pens of 5 or 6 head, and the ration was increased over the next 3 wk to 90% concentrate of total dry matter. Cattle remained on that ration until slaughter. The ration consisted of cracked corn, soybean meal, vitamin and mineral supplement, and sorghum silage. Half of each breed group in each management system was slaughtered when ultrasound-measured backfat was between .3 and .4 in., and the other half was slaughtered with backfat between .5 and .6 in. Carcass data were collected after 24 hr in the cooler.

Three alternative slaughter points within management systems were evaluated: 1) constant days on feed, 2) constant adjusted carcass backfat, and 3) constant slaughter weight. Data were analyzed using least squares analysis of variance. The model included the fixed effects of year and management group. In addition, the regressions of weaning age; the alternative slaughter point within management; and percentage of HH, BR, CH, and GV were included. This produced regression coefficients that express the amount of change in a trait, as a deviation from AN, for each percentage change of a breed in the crossbred steers.

Results and Discussion

At a constant adjusted backfat or days on feed (Table 1), slaughter weight increased the most with increasing percentage of CH, with GV and BR being intermediate; increasing percentage of HH decreased slaughter weight compared to AN. At all end points, an increase in CH increased total feedlot gain and feedlot ADG the most. At constant days on feed, increasing percentage of GV and HH decreased total gain the most. However, at a constant slaughter weight or backfat end point, BR and GV had the greatest depression on total gain. At a constant BF, increased percentage of HH had the greatest depression on gain. At a constant slaughter weight or backfat end point, age at slaughter was greatest for BR, CH, and GV and least for AN and HH. Increased percentage of BR, CH, or GV increased the number of days on feed to reach constant slaughter weight or backfat. At all three end points, increasing the percentage of GV and BR reduced feed conversion efficiency, whereas increasing percentage of CH improved feed conversion efficiency. At a constant backfat and days on feed, increasing percentage of CH and GV increased lifetime ADG. However, at a constant slaughter weight, increased percentage of AN and HH produced the greatest lifetime ADG.

At a constant backfat or days on feed, increasing percentage of HH decreased and increasing percentage of CH increased slaughter weight (Table 2.). At a constant backfat, GV was similar to CH in slaughter weight, but at a constant days on feed, GV was similar to AN and BR. Increasing percentage of HH decreased and increasing percentage of BR increased dressing percentage at all end points. As percentage of AN and HH increased, ribeye area decreased, whereas CH and GV increased it. At a constant backfat, BR decreased marbling and quality grade, with no differences among the other breeds. At constant days on feed or slaughter weight, an increase in percentage of BR and GV decreased marbling and quality grade. At constant days on feed or slaughter weight, increasing percentage of CH and GV decreased backfat thickness and improved yield grade.

Table 1. Regressions and Standard Error for Feedlot Traits by Breed[a]

Trait[e]	Angus	Hereford	Brahman	Charolais	Gelbvieh
ADJUSTED BACKFAT WITHIN MANAGEMENT GROUP[b] HELD CONSTANT					
Sl. wt,lb	0^{yz}	-.692^{z}	.730^{xy}	2.44^{w}	1.419^{x}
Gain, lb	0^{yz}	-.466^{z}	-.049^{yz}	2.000^{x}	.605^{y}
Age, d	0^{z}	-.022^{z}	.402^{y}	.533^{y}	.524^{y}
Fed, d	0^{z}	-.047^{z}	.229^{yz}	.488^{y}	.466y
ADG_f, lb/d	0^{yz}	-.002^{z}	-.003^{z}	.004^{y}	-.003^{z}
TDN, lb	0^{z}	-2.158^{z}	2.551^{yz}	7.716^{y}	6.992^{y}
F/G	0^{y}	-.000^{y}	.009^{y}	-.018^{z}	.004^{y}
ADG_l,lb/d	0^{z}	-.001^{z}	-.000^{z}	.002^{y}	.000^{y}
DAYS ON FEED WITHIN MANAGEMENT GROUP[c] HELD CONSTANT					
Sl. Wt., lb	0^{yz}	-.702^{z}	.813^{xy}	1.488^{x}	.444^{y}
Gain, lb	0^{z}	-.462^{z}	.113^{z}	.829^{y}	-.528^{z}
ADG_f, lb/d	0^{yz}	-.002^{z}	-.002^{z}	.004^{y}	-.003^{z}
TDN, lb	0^{z}	-1.787^{y}	-.012^{yz}	-.205^{yz}	-.230^{yz}
F/G	0^{y}	.001^{y}	.003^{y}	-.016^{z}	.006^{y}
ADG_l,lb/d	0^{yz}	-.003^{z}	-.001^{yz}	.002^{y}	.001^{yz}
SLAUGHTER WEIGHT WITHIN MANAGEMENT GROUP[d] HELD CONSTANT					
Gain, lb	0^{y}	-.113^{yz}	-.629^{z}	.223^{y}	-.554^{z}
Age, d	0^{z}	.025^{z}	.343^{y}	.310^{y}	.386^{y}
Fed, d	0^{z}	-.001^{z}	.172^{y}	.257^{y}	.320^{y}
ADG_f, lb/d	0^{y}	-.000^{y}	-.005^{z}	-.002^{y}	-.007^{z}
TDN, lb	0^{yz}	-1.036^{z}	1.019^{yz}	1.308^{yz}	3.108^{y}
F/G	0^{z}	-.004^{z}	.012^{y}	-.002^{z}	.015^{y}
ADG_l,lb/d	0^{y}	-.000^{y}	-.002^{z}	-.001^{yz}	-.002^{z}

[a]For each 1% change of a breed in a crossbreeding system, the trait is expected to change by the given amount, expressed as a deviation from Angus.
[b]Adjusted backfat means were 1.11 cm for the calf and 1.15 cm for the yearling management groups.
[c]Days fed means were 222 days for the calf and 131 days for the yearling management groups.
[d]Slaughter weight means were 489 kg for the calf and 570 kg for the yearling management groups.
[e]Feedlot performance traits; Sl. Wt. = live weight at slaughter; Gain = Total feedlot gain, Age = Days of age at slaughter, Fed = Days fed, ADG_f = Feedlot ADG, TDN = TDN fed during the finishing period, F/G = kg of TDN / kg of gain, ADG_l = Lifetime ADG.
[w,x,y,z] Means in the same row with different superscripts are different ($P < .05$).

Table 2. Regressions and Standard Error for Carcass Traits by Breed[a]

Trait[e]	Angus	Hereford	Brahman	Charolais	Gelbvieh
ADJUSTED BACKFAT WITHIN MANAGEMENT GROUP[b] HELD CONSTANT					
CARWT,lb	0[y]	-.556[z]	.634[xy]	1.591[x]	.893[x]
Dress, %	0[yz]	-.012[z]	.018[y]	.009[y]	.003[y]
REA, in^2	0[z]	-.006[z]	.008[yz]	.022[y]	.013[y]
Marb[f]	0[y]	-.349[y]	-1.317[z]	.019[y]	-.515[y]
ACTBF,in	0[z]	-.000[z]	-.001[y]	-.001[y]	.000[z]
Q. Grade[g]	0[y]	-.193[y]	-.698[z]	.102[y]	-.206[yz]
KPH, %	0[z]	-.005[z]	.002[yz]	.009[y]	.005[y]
Y. Grade	0[z]	-.001[z]	.000[z]	.001[z]	.000[z]
DAYS ON FEED WITHIN MANAGEMENT GROUP[c] HELD CONSTANT					
CARWT,lb	0[y]	-.547[z]	.681[xy]	.783[x]	.180[y]
Dress, %	0[yz]	-.011[z]	.017[y]	-.005[yz]	.010[yz]
REA, in^2	0[z]	-.005 [z]	.008[yz]	.022[y]	.012[y]
Marb[d]	0[z]	-.370[z]	-1.292[y]	-.608[yz]	-1.078[y]
ACTBF,in	0[z]	-.001[z]	-.001[z]	-.004[y]	-.003[y]
Q. Grade[e]	0[z]	-.216[yz]	-.662[y]	-.275[yz]	-.539[y]
ADJBF,in	0[z]	-.000[z]	.000[z]	-.004[y]	-.003[y]
KPH, %	0[yz]	-.004[z]	.006[y]	.001[yz]	-.001[yz]
Y. Grade	0[y]	-.002[y]	.002[y]	-.013[z]	-.012[z]
SLAUGHTER WEIGHT WITHIN MANAGEMENT GROUP[d] HELD CONSTANT					
CARWT,lb	0[yz]	-.133[z]	.169[y]	-.000[yz]	-.056[yz]
Dress, %	0[yz]	-.012[z]	.017[y]	.000[yz]	-.004[yz]
REA, in^2	0[z]	-.002[z]	.003[yz]	.017[y]	.011[y]
Marb[d]	0[z]	-.248[z]	-1.430[y]	-.787[yz]	-1.077[y]
ACTBF,in	0[z]	-.000[z]	.001[z]	-.004[y]	-.003[y]
Q. Grade[e]	0[z]	-.145[z]	-.764[y]	-.392[y]	-.565[y]
ADJBF,in	0[y]	-.000[y]	.000[y]	-.004[z]	-.003[z]
KPH, %	0[z]	-.004[z]	.001[z]	.000[z]	-.001[z]
Y. Grade	0[y]	-.001[y]	.000[y]	-.016[z]	-.012[z]

[a]For each 1% change of a breed in a crossbreeding system, the trait is expected to change by the given amount, expressed as a deviation from Angus.
[b]Adjusted backfat means were 1.11 cm for the calf and 1.15 cm for the yearling management groups.
[c]Days on fed means were 222 days for the calf and 131 days for the yearling management groups
[d]Slaughter weight means were 489 kg for the calf and 570 kg for the yearling management groups.
[e]Carcass traits; CARWT = Carcass weight; Dress = Dressing percent; REA = Ribeye area; ACTBF = Actual carcass backfat; ADJBF = Adjusted carcass backfat; KPH = Kidney, Pelvic and Heart fat; Y. Grade = yield grade.
[f]Marbling (Slight = 200, Small = 300, Modest = 400, etc.).
[g]Quality Grade (Select = 100, Choice = 200, and Prime = 300).
[x,y,z] Means in the same row with different superscripts are different ($P < .05$).

EVALUATION OF INOCULANT AND NPN SILAGE ADDITIVES: A SUMMARY OF 26 TRIALS AND 65 FARM-SCALE SILAGES

K. K. Bolsen, R. N. Sonon, B. Dalke, R. Pope, J. G. Riley, and A. Laytimi[1]

Summary

Results from 26 trials comparing fermentation, dry matter (DM) recovery, and effects on cattle performance of inoculated or non-protein nitrogen (NPN)-treated silages vs. controls were summarized using paired t-test analysis. Inoculants consistently improved fermentation efficiency, DM recovery, feed conversion, and gain per ton of crop ensiled in both corn and forage sorghum silages. The use of NPN, particularly urea or anhydrous ammonia, adversely affected fermentation efficiency, DM recovery, avg daily gain, and gain per ton of crop ensiled, particularly for the higher moisture forage sorghums.

(Key Words: Inoculant, Urea, Ammonia, Molasses, Silage.)

Introduction

Research with inoculant and non-protein nitrogen (NPN) silage additives using the farm-scale tower silos in Manhattan and at the Fort Hays and Southeast Branch Experiment Stations began over 17 years ago. Summarized here are results of the 26 trials and 65 farm-scale silages in which fermentation, dry matter (DM) recovery, and effects on cattle performance of inoculant and non-protein nitrogen (NPN) silages vs. untreated (control) silages were compared.

Experimental Procedures

In 23 of the 26 trials, silages were made by the alternate load method. In three of the sorghum trials (seven silages), control and treated silages were made on consecutive days. Upright, concrete stave silos were used in all but one trial, when both control and inoculated silages were made in polyethylene bags. Further details of all other procedures are given in KAES Reports of Progress 377, 394, 413, 427, 448, 470, 494, 514, 539, 567, and on page 103 of this report. Products from 11 companies were used in the corn silage trials and products from eight companies were used in the sorghum trials.

Statistical analysis of the data from the 14 corn silage trials and 12 forage sorghum trials was conducted using paired t-tests. Only overall mean comparisons were made between paired observations for the nine criteria measured.

Results and Discussion

A summary of treatment means for control and treated silages and significance levels is shown in Table 1.

The 19 inoculated corn silages had a 1.30 percentage unit higher ($P < .001$) DM recovery compared to untreated silages, and the inoculated silages supported a 1.8% more efficient ($P < .11$) gain and a 3.6 lb increase ($P < .001$) in gain per ton of crop ensiled.

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Adding anhydrous ammonia to corn silage increased pH and fermentation acids ($P < .01$), and there was a strong trend for both DM recovery and gain per ton of crop ensiled to be lower; 2.1 percentage units and 6.3 lb ($P < .07$), respectively.

Inoculating forage sorghum silages increased ($P < .01$) DM recovery, improved ($P < .04$) feed conversion, and produced 4.6 lb more ($P < .001$) gain per ton of crop ensiled. The forage sorghum silages treated with ammonia or urea had a 5.1 percentage unit lower ($P < .09$) DM recovery, and cattle fed treated silages gained .27 lb per day slower (not significant), required 1.06 lb more (not significant) DM per lb of gain, and gained 13.9 lb less ($P < .24$) per ton of crop ensiled compared to cattle fed untreated silage. The urea-molasses blend (LSA-100) had less of a negative influence on silage preservation and cattle performance.

Table 1. Summary of Treatment Means for Silage Fermentation, Dry Matter Recovery, and Effects on Cattle Performance from Inoculant and NPN Additions to Corn and Forage Sorghum Silages

Crop and silage treatment	No. of silages	DM recovery[1]	Avg daily gain, lb	Daily DM intake, lb	Feed/ gain, lb	Gain/ton of crop ensiled, lb	pH	Lactic acid	Acetic acid	Ethanol[2]
Corn:								- % of the silage DM -		
Control	15	90.2	2.41	17.05	7.10	99.1	3.82	5.31	2.49	.770
Inoculant	19	91.5	2.48	17.10	6.97	102.7	3.82	5.45	2.26	.614
Probability level	---	.001	NS	NS	.11	.001	NS	.12	.03	NS
Control	3	91.5	2.29	17.20	7.52	96.3	3.81	4.67	2.01	---
Anhydrous NH_3	3	89.4	2.22	17.55	7.84	90.0	4.19	6.13	2.47	---
Probability level	---	NS	.16	NS	NS	.07	.01	.01	NS	---
Forage sorghum:										
Control	10	83.1	1.65	13.14	8.32	70.6	3.94	5.15	2.58	1.36
Inoculant	10	85.2	1.68	12.89	7.98	75.2	3.93	5.23	2.10	1.20
Probability level	---	.01	NS	.20	.04	.001	NS	NS	.02	NS
Control	3	87.7	1.35	11.93	9.52	74.6	3.91	5.14	2.04	---
Anhydrous NH_3 or urea[3]	3	82.6	1.08	11.30	10.58	60.7	4.63	6.07	3.63	---
Probability level	---	.09	NS	NS	NS	.24	.10	NS	.08	---
Control	3	80.8	2.06	13.90	7.00	70.6	4.14	3.85	2.06	---
LSA-100	3	76.5	2.23	14.20	6.64	70.3	4.64	3.90	2.49	---
Probability level	---	.18	.06	NS	NS	NS	NS	NS	NS	---

[1]As a percent of the crop DM ensiled.
[2]Ethanol was not measured in trials conducted prior to 1984.
[3]One trial with anhydrous NH_3 and two trials with urea.

EVALUATION OF INOCULANT-TREATED CORN SILAGES[1,2,3]

K. K. Bolsen, D. G. Tiemann[4], R. N. Sonon, R. A. Hart, B. Dalke, J. T. Dickerson[5], and C. Lin[6]

Summary

Whole-plant corn silages treated with either Pioneer 1174® or Biotal® inoculants were preserved more efficiently than control silages. They had slightly higher dry matter (DM) recoveries; more lactic acid; higher lactic to acetic acid ratios; and less acetic acid, ethanol, and ammonia-nitrogen. Laboratory silo results showed that both inoculated silages produced lactic acid faster than control silages during the first 7 days and had more desirable fermentation profiles at the end of 90 days. Applying 5 or 10 times the recommended rate of Biotal inoculant had only a small and nonsignificant effect on rate and efficiency of fermentation.

Yearling steers fed the two inoculated corn silages gained numerically but not significantly faster and more efficiently than steers fed control silages, so inoculated silages produced about 6.1 lb more steer gain per ton of crop ensiled than controls.

(Key Words: Silage, Bacterial, Inoculants, Corn.)

Introduction

Research with bacterial inoculants and nonprotein nitrogen (NPN) silage additives using farm-scale, tower silos in Manhattan and at the Fort Hays and Southeast Kansas Agricultural Experiment Stations began over 17 years ago. Reported here are results from the last four of the 65 corn and forage sorghum silages in which fermentation characteristics, dry matter (DM) recovery, and cattle performance from inoculant and NPN silages were compared to untreated controls. A summary of the 26 trials is presented on page 101 of this report.

Experimental Procedures

Pioneer 3377 and 3379 corn hybrids were grown under irrigation in 1988, using agronomic practices similar to those on page 111 of KAES Report of Progress 592 (1990). Pioneer 3377 was harvested on August 11, and two 10 × 50 ft. concrete stave silos were filled by the alternate load method. One silo received no additive (control), and the other received the recommended rate of Pioneer 1174 Silage Inoculant, 1.9 liters per ton. The 1174 was applied at the blower and supplied 1.75×10^5 colony-forming units (cfu) of lactic acid bacteria (LAB) per gram of crop. Twelve thermocouple wires were evenly spaced in the center of each silo, and ensiling temperatures were monitored for the first 6 wks of storage.

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[1]Pioneer 1174 Silage Inoculant® is a product of Pioneer Hi-Bred International, Inc., Des Moines, Iowa.

[2]Biotal Silage Inoculant® is a product of Biotal, Inc., Eden Prairie, Minnesota.

[3]Pioneer and Biotal provided financial assistance.

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[5]Former graduate student. Current address: Biotal, Inc., Ft. Dodge, Iowa.

[6]Former graduate student. Current address: Agri-King, Inc., Fulton, Illinois.

During the harvest, fresh forage was removed from a randomly selected load and control and treated materials were each ensiled in 14 PVC laboratory silos. Duplicate silos were opened at 6, 12, and 24 hr and 2, 3, 4, and 90 days post-filling.

Pioneer 3379 was harvested on August 15 and treated in the same manner as 3377, except that the inoculant was Biotal, applied at 1.9 liters per ton to supply 1.70×10^5 cfu of LAB per gram of crop. Two additional PVC silo treatments were Biotal applied at five and 10 times the recommended rate.

The farm-scale silos were opened on December 14, 1988 and emptied at uniform rates during the following 12 weeks. Samples were taken twice weekly for DM recovery calculations and chemical analyses. Each silage was fed to 18 yearling steers (three pens of six steers per silage) in an 84-day growing trial, which began on December 16, 1988. Rations were full-fed and contained 87.6% silage and 12.4% supplement on a DM basis. Rations were formulated to provide 12.0% crude protein (DM basis); 200 mg of Rumensin® per animal daily; required amounts of calcium and phosphorus; and vitamins A, D, and E. Supplements were top-dressed and partially mixed with the silages in the bunk.

For 3 days before the start of the growing trial, all cattle were limit-fed a forage sorghum silage ration to provide a DM intake of 1.88% of body weight. Cattle were then weighed individually on 2 consecutive days after 16 hr without feed or water. For 2 days before the final weighing, the cattle were fed their respective silage rations at a restricted DM intake of 1.88% of body weight. Individual weights then were taken on 2 consecutive days after 16 hr without feed or water.

Results and Discussion

Ensiling temperatures (Table 1) were nearly identical for the four silages; the absolute temperatures were quite high (93.3 to 107.3 F) because of hot weather at harvest.

Dry matter recovery and chemical compositions are shown in Table 2. Both inoculants increased DM recovery; 1174 by 1.6 percentage units and Biotal by .8 units. Inoculated silages had more lactic acid; higher lactic to acetic acid ratios; and less acetic acid, ethanol, and ammonia nitrogen, indicating improved fermentation efficiencies. Laboratory silo results showed that both 1174- and Biotal-treated silages had faster rates of lactic acid production during the first 7 days (data not shown). At 7 and 90 days, 1174 silages had more ($P < .05$) lactic acid and less ($P < .05$) acetic acid, ethanol, and ammonia-nitrogen than control silages. Biotal silages had higher ($P < .05$) lactic acid and lower ($P < .05$) ethanol values than controls at 3, 7, and 90 days. Applying five or 10 times the recommended rate of Biotal inoculant had only a small and nonsignificant effect on rate and efficiency of fermentation.

Performance by cattle fed the four corn silage rations is presented in Table 3. Steers fed the two inoculated corn silages gained slightly but not significantly faster and more efficiently than steers fed control silages, producing an average of 6.1 lb more steer gain per ton of crop ensiled than control silages.

Table 1. Ensiling Temperatures as Change from Initial Temperature (Temp.) for the Control and Inoculated Corn Silages

Days	Pioneer 3377		Pioneer 3379	
post-filling	Control	1174	Control	Biotal
	----------Initial forage temp., F ----------			
	94.5	94.7	93.7	93.3
	---------- Change from initial temp., F ----------			
1	+ 9.1	+ 8.4	+ 8.7	+ 9.1
2	+ 11.5	+ 11.6	+ 11.9	+ 11.9
3	+ 12.5	+ 12.2	+ 12.6	+ 12.5
4	+ 12.2	+ 12.6	+ 12.5	+ 12.3
5	+ 12.3	+ 12.4	+ 12.5	+ 12.0
6	+ 12.4	+ 12.4	+ 12.8	+ 12.6
7	+ 11.9	+ 11.6	+ 12.7	+ 12.2
10	+ 10.5	+ 10.5	+ 11.2	+ 11.2
14	+ 7.6	+ 7.9	+ 10.4	+ 10.8
17	+ 6.6	+ 6.4	+ 7.6	+ 7.4
21	+ 2.4	+ 3.7	+ 7.2	+ 6.7
28	+ 1.4	+ 2.2	+ 3.7	+ 1.8

Table 2. Dry Matter Recovery and Chemical Composition[1] of the Four Corn Silages

	Pioneer 3377		Pioneer 3379	
Item	Control	1174	Control	Biotal
Dry matter, %	37.2	38.0	34.0	33.6
DM recovery[2]	91.2	92.8	88.6	89.4
pH	3.86	3.84	3.72	3.70
	---------- % of the silage DM ----------			
Lactic acid	5.8	6.4	6.8	7.1
Acetic acid	3.1	2.6	3.6	2.8
Lactic:acetic	1.9	2.4	1.8	2.5
Ethanol	.58	.46	.76	.54
NH_3-nitrogen	.145	.124	.162	.148
Crude protein	8.6	8.5	8.8	8.7
NDF[3]	51.8	51.6	53.8	53.6
ADF[3]	25.4	25.1	26.9	26.7

[1]Each value is the mean of 24 samples taken from the silos during the growing trial.
[2]Expressed as a percent of the crop DM ensiled.
[3]NDF = neutral detergent fiber and ADF = acid detergent fiber.

Table 3. Performance by Yearling Steers Fed the Four Corn Silage Rations

	Pioneer 3377		Pioneer 3379	
Item	Control	1174	Control	Biotal
No. of steers[1]	18	18	18	18
Initial wt, lb	655	658	654	654
Final wt, lb	855	863	865	872
Avg daily gain, lb	2.38[b]	2.44[ab]	2.51[a]	2.59[a]
Daily DM intake, lb[2]	17.5	17.2	17.8	17.5
Feed/lb of gain, lb[2]	7.36[b]	7.06[ab]	7.04[ab]	6.82[a]
Silage fed, lb/ton of crop ensiled[3]	1,824	1,856	1,772	1,788
Silage/lb of gain, lb[3]	18.38	17.60	17.74	16.88
Cattle gain/ton of crop ensiled, lb[3]	99.3	105.5	99.9	105.9

[1]Three pens of six steers per silage.
[2]100% DM basis.
[3]Adjusted to 35% dry matter.
[ab]Means in the same row with different superscripts differ ($P < .05$).

EVALUATION OF INTERSEEDED GRAIN SORGHUM AND SOYBEANS AS A SILAGE CROP

L. H. Harbers, K. K. Bolsen, and H. Hartadi[1]

Summary

Dry matter yield of grain sorghum alone averaged more than 1.0 ton per acre higher than that of intercropped grain sorghum-soybeans in both 1988 and 1989. All silage yields were lower in 1989 because of drought. Grain sorghum silage had less NDF and ADF, but intercropped silages had over 4 percentage units more crude protein. Digestibility coefficients for crude protein, NDF, and ADF tended to favor intercropped silages, but yearling steer performance favored grain sorghum silage. Studies over 4 years (1986 to 1989) suggest that intercropping might be more beneficial for dairy cattle producers than beef producers.

(Key Words: Grain Sorghum, Soybeans, Intercrop, Silage.)

Introduction

Grain sorghum interseeded with soybeans has been used as a silage crop by dairy and beef cattle producers for several years in many southeastern states. A series of experiments was begun in Manhattan in 1986 to evaluate various methods of combining these two crops for optimum silage yield and nutritive value. Presented here are the agronomic, chemical composition, digestibility, and growing cattle performance results from the last 2 years. Previous data are in KAES Reports of Progress 539, 567, and 640.

Experimental Procedures

Cultural practices for the nine silages in 1988 (Table 1) are detailed on pages 183 and 184 of KAES Report of Progress 539 (1988). Similar procedures were followed for the 11 silages in 1989, except drought resulted in very poor stands, even after reseeding, and only one plot was harvested per silage. In both years, the crops were ensiled in PVC laboratory silos. Four crops in 1988 and five in 1989 were ensiled in pilot-scale silos and used in voluntary intake and digestion trials.

DeKalb 42Y grain sorghum and DeKalb 42Y-Williams 82 soybean intercrop were grown under dryland conditions and harvested on August 25 and 26, 1988, when the sorghum kernels were in the late-dough stage. Approximately 60 tons of each silage was made in plastic bags using a Kelly Ryan bagging machine. The two silages were fed in a cattle growing trial.

In 1988, 36 crossbred wethers (avg wt, 86 lb, 9 per ration) were blocked by weight and randomly assigned to each silage ration. In 1989, 35 crossbred wethers (avg wt, 97 lb, 7 per ration) were assigned similarly. All rations were 90% silage and 10% supplement (DM basis). Other procedures were similar to those on page 111 of KAES Report of Progress 592 (1990).

The cattle growing trial was conducted concurrently with another trial described on page 103 of this report.

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Results and Discussion

Yield, plant ratio, and chemical composition of the silages are shown in Table 1. In 1988, the DM yield was lower ($P < .05$) for the intercrops than for grain sorghum alone. Grain sorghum in 6-in. rows outyielded ($P < .05$) its 15- and 30-in. row spacing counterparts, but the 6-in. rows gave the lowest ($P < .05$) yield for Williams 82 soybeans. Silage DM yields were drastically lower in 1989 than 1988. Because only one plot was harvested per crop, no statistical analysis was possible; these data are given for comparative purposes only. Grain sorghum yields appeared to be affected more by the drought than were the two soybean varieties, so the intercropped silages had higher proportions of soybeans in 1989 than in 1988. In both years, crude protein, NDF, and ADF values were consistent with those of previous studies. The soybean component increased the CP content of the intercrop silages by an average 4.0 percentage units compared to grain sorghum alone; however, NDF and ADF were each about 4.0 percentage units higher in the intercrop silages.

In general, intakes and nutrient digestibilities (Table 2) were similar for the nine silage rations. DM intakes ranged from 2.5 to 2.8% of body weight, quite acceptable for high-silage rations. Grain sorghum silage had the highest ($P < .05$) DM digestibility in 1988, but not in 1989. There was a trend for the six intercrop silages to have higher NDF and ADF digestibilities than either the grain sorghum or Pershing soybean silages.

Results for the two farm-scale silages and cattle growing trial are presented in Tables 3 and 4. Both silages were adequately preserved. The DM recoveries were acceptable and consistent with previous results for bagged silages. Steers fed grain sorghum silage outperformed those fed the intercrop silage, which agrees very closely with previous data (page 81, KAES Report of Progress 567 (1989)). When silage yields per acre and silage recoveries were combined with steer performance in the 1988 trials, cattle gain was 270 lb higher per acre of crop and 7.6 lb higher per ton of crop ensiled for the grain sorghum silage.

Table 1. Yield, Plant Ratio, and Chemical Composition of the Silages

Silage: hybrid or variety and	DM yield, tons/acre		GS:SB ratio[1]		Dry matter, %		CP		NDF		ADF	
row spacing	1988	1989	1988	1989	1988	1989	1988	1989	1988	1989	1988	1989
							-----% on a DM basis -----					
DeKalb 42Y												
1. 30-inch	4.77	3.31	---	---	34.7	35.6	11.5	11.7	41.8	45.7	25.3	29.0
2. 15-inch	4.95	2.94	---	---	33.2	30.0	11.5	11.4	43.0	46.0	26.0	29.6
3. 6-inch	5.24	3.48	---	---	32.0	29.9	11.0	11.5	44.0	46.2	26.4	29.8
Williams 82												
4. 30-inch	2.72	1.90	---	---	32.7	30.1	21.2	31.3	48.0	46.5	36.1	33.4
5. 15-inch	2.92	1.86	---	---	32.9	29.5	21.9	20.6	48.2	49.6	35.8	32.6
6. 6-inch	2.18	1.83	---	---	33.7	29.9	20.9	20.9	47.4	48.6	35.6	34.0
DeKalb 42Y and Williams 82												
7. 15-inch	3.99	2.16	1.8:1	1.0:1	35.4	30.4	15.4	18.1	46.9	45.9	32.4	30.5
8. 6-inch	3.58	2.06	1.6:1	1.3:1	33.8	29.2	16.6	16.0	45.7	49.6	32.0	31.8
DeKalb 42Y and Pershing												
9. 15-inch	4.21	2.88	1.8:1	1.1:1	35.4	28.4	15.2	17.0	44.9	51.0	29.6	34.1
Pershing												
10. 15-inch	---	2.60	---	---	---	28.2	---	20.6	---	45.5	---	32.4
11. 6-inch	---	2.01	---	---	---	28.7	---	20.8	---	47.0	---	34.1

[1]Grain sorghum (GS) to soybean (SB) whole-plant ratio (DM basis).

Table 2. Voluntary Intake and Digestibility of the Nine Silages

Silage: hybrid or variety and row spacing	DM intake, % of body wt		Digestibility, % DM		CP		NDF		ADF	
	1988	1989	1988	1989	1988	1989	1988	1989	1988	1989
DeKalb 42Y										
1. 30-inch	2.64	2.54^{ab}	63.2^{a}	58.8^{bc}	70.0^{b}	70.7^{b}	48.4	46.2^{b}	46.9^{b}	46.6^{b}
DeKalb 42Y and Williams 82										
7. 15-inch	2.58	2.71^{ab}	61.0^{b}	61.0^{ab}	70.7^{b}	75.3^{a}	49.6	49.5^{ab}	48.4^{b}	53.3^{a}
8. 6-inch	2.78	2.80^{a}	61.9^{b}	61.0^{a}	72.2^{a}	70.9^{b}	49.4	51.1^{a}	50.3^{a}	54.6^{a}
DeKalb 42Y and Pershing										
9. 15-inch	2.66	2.50^{b}	61.5^{b}	57.7^{c}	70.3^{b}	71.8^{b}	48.7	50.2^{ab}	47.3^{b}	53.1^{a}
Pershing										
10. 15-inch	---	2.77^{ab}	---	59.9^{ab}	---	71.5^{b}	---	46.1^{b}	---	44.6^{b}

^{a,b,c}Means in the same column with different superscripts differ (P < .05).

Table 3. Dry Matter Recovery and Chemical Composition[1] of the Two Silages Fed in the Steer Growing Trial in 1988

Item	DeKalb 42Y	DeKalb 42Y + Williams 82
Dry matter, %	34.4	39.1
DM recovery[2]	88.8	89.8
pH	3.88	4.14
	- % of the silage DM -	
Lactic acid	7.2	6.4
Acetic acid	2.7	2.4
Lactic:acetic	2.7	2.6
Ethanol	.48	.56
NH_3-nitrogen	.134	.174
Crude protein	9.8	13.9
NDF[3]	49.7	46.9
ADF[3]	28.9	32.4

[1]Each value is the mean of 24 samples taken from the silos during the growing trial.
[2]Expressed as a percent of the crop DM ensiled.
[3]NDF = neutral detergent fiber and ADF = acid detergent fiber.

Table 4. Performance by Yearling Steers Fed the Two Silage Rations in 1988

Item	DeKalb 42Y	DeKalb 42Y + Williams 82
No. of steers[1]	18	18
Initial wt, lb	651	650
Final wt, lb	835	807
Avg daily gain, lb	2.19^{a}	1.86^{b}
Daily DM intake, lb[2]	18.8^{a}	17.7^{b}
Feed/lb of gain, lb[2]	8.48^{a}	9.54^{b}
Silage DM recovery, % of the DM ensiled	88.8	89.2
Silage fed, lb/ton ensiled	1,776	1,784
Silage/lb of gain, lb[3]	21.54	23.82
Cattle gain/ton of crop ensiled, lb[3]	82.5	74.9
Cattle gain/acre of crop, lb	1,124	854

[1]Three pens of six steers per silage.
[2]100% DM basis.
[3]Adjusted to 35% dry matter.
^{a,b}Means in the same row with different superscripts differ (P < .05).

EVALUATION OF 20 CORN HYBRIDS FOR SILAGE AGRONOMIC CHARACTERISTICS

R. N. Sonon, B. S. Dalke, R. Suazo, L. Pfaff, and K. K. Bolsen

Summary

Twenty corn hybrids were grown under irrigation and harvested at 90 % of the kernel milk line. Hybrid had a significant effect on plant height, whole-plant dry matter (DM) and DM yield, grain yield, stover yield, and plant part proportions. The highest whole-plant DM (45.9%) was for Cargill 7997, whereas the lowest was for Cargill 4327 (30.1%). Cargill 8427 and Pioneer 3245 had the highest whole-plant DM and grain yields, whereas Cargill 4327 was lowest. Grain yield and the percentage of grain in the whole-plant DM increased as the plant height increased.

(Key Words: Corn, Hybrid, Silage, Yield.)

Introduction

Typically, corn hybrids grown for silage have been selected for their high grain-yield potential and not necessarily for silage traits. Therefore, our objective was to measure the agronomic characteristics important to silage-making, from 20 corn hybrids grown under irrigation in 1991.

Experimental Procedures

Twenty, high grain-yielding corn hybrids, representing a range of season lengths and wide genetic diversity, were grown under irrigation in 1991 near the Kansas State University campus. The experiment was a randomized complete block design, with each hybrid assigned to a plot and replicated three times. The hybrids were planted on May 9, in plots 33 ft. long that contained six, 30-inch rows. Two weeks after seedling emergence, plots were thinned to about 23,400 plants per acre. All hybrids were harvested just before the black layer stage of maturity (approximately 90% of the milk line of kernel development). Agronomic data included days to mid-silk, plant height, whole-plant DM percent and yield, grain and stover yields, and plant part proportions. Shortly prior to harvest, each plot was trimmed to remove border effects. Whole-plant DM yield was determined from two inside rows, and grain and stover yields and plant part proportions were obtained from the other two inside rows.

Results and Discussion

Agronomic characteristics for the 20 corn hybrids are presented in Table 1. Days to reach the mid-silk stage ranged from 58 to 62 (data not shown). The tallest hybrid was Cargill 9027 (103 inches); the shortest, Cargill 4327 and Pioneer 3417 (87 inches).

Hybrid had a significant effect on the other five agronomic measurements. The highest whole-plant DM (45.9%) was for Cargill 7997, whereas Cargill 4327 had the lowest (30.1%). The average DM was 38.8%, and 10 of the 20 hybrids had 40% DM or more. Hot, dry weather from August 10 to 30 likely contributed to these high DM values. Cargill 8427 and Pioneer 3245 had the highest whole-plant DM and grain yields, whereas the lowest yields were obtained for the two shortest and earliest-maturing hybrids, Cargill 4327 and Pioneer 3417. Whole-plant DM yield was positively correlated with plant height and grain yield, confirming our 1988 studies (KAES Report of Progress 592, page 110). Grain yield was positively correlated with grain percentage but negatively correlated with stover percentage.

Table 1. Harvest Date; Plant Height; Dry Matter (DM) Content; Whole-plant DM, Grain, and Stover Yields; and Plant Part Proportions of the 20 Corn Hybrids

Hybrid	Harvest date	Plant height,	Whole-plant DM and DM yield,		Grain yield,	Stover DM yield,	Plant part proportions		
		inches	%	T/A[1]	Bu/A[2]	T/A	grain	stover	cob
	August						-% of the whole-plant DM-		
Cargill									
4327	8	87	30.1	5.66	104.3	3.63	37.6	54.7	7.7
6227	18	98	36.2	8.23	160.5	4.17	44.8	48.7	6.5
7697	26	97	43.6	7.87	128.2	4.20	38.6	52.9	8.5
7877	18	94	35.8	8.27	135.1	4.27	39.6	52.6	7.8
7997	26	94	45.9	7.17	118.4	3.63	39.8	51.1	9.2
8427	29	94	40.0	8.93	195.0	4.47	46.1	43.9	10.0
8527	26	100	38.5	7.93	137.3	3.90	41.7	49.4	8.9
9027	27	103	43.1	8.07	143.4	4.53	40.2	53.1	6.7
DeKalb									
649	19	96	34.3	8.33	148.3	4.80	38.8	52.5	8.7
656	19	97	35.8	8.37	155.6	4.83	40.7	53.0	6.3
671	23	91	38.5	7.13	113.9	4.70	33.4	57.7	8.9
711	29	94	39.2	8.07	160.7	4.10	44.3	47.6	8.1
Pioneer									
3124	28	91	42.2	8.07	153.3	4.13	43.3	48.7	8.0
3162	29	90	41.7	8.03	160.3	4.13	44.5	47.9	7.6
3245	27	98	40.5	8.87	173.7	3.93	47.4	45.1	7.5
3377	18	94	37.5	7.57	151.1	4.03	43.3	48.1	8.6
3379	26	92	41.1	7.30	122.9	4.27	38.4	55.7	5.9
3389	19	100	36.5	8.50	149.4	4.60	40.4	52.3	7.3
3394	27	92	42.5	8.37	162.7	4.13	44.9	47.5	7.6
3417	8	87	33.2	6.67	110.7	3.50	39.1	51.5	9.4
Mean	22.5	94.5	38.8	7.87	144.2	4.20	41.3	50.7	8.0
LSD (P < .05)[3]	---	4.5	2.1	1.08	25.7	.45	4.1	4.1	1.3

[1]Tons per acre.

[2]Bushels per acre; adjusted to 14.5% moisture.

[3]The LSD (least significant difference) is valid only within a column.

EPIPHYTIC LACTIC ACID BACTERIA SUCCESSION DURING THE PRE-ENSILING AND ENSILING PERIODS OF ALFALFA AND CORN[1]

Chunjian Lin*[2]*, B. E. Brent, K. K. Bolsen, and Daniel Y.C. Fung

Summary

Twenty three species and 306 strains of epiphytic lactic acid bacteria (LAB) were found for two cuttings of alfalfa, each harvested at three stages of maturity, and three whole-plant corn hybrids. Epiphytic LAB counts were low and variable on the standing crops, particularly on alfalfa. Wilting increased LAB numbers slightly for alfalfa, but the chopping process increased counts dramatically for both crops. *Lactobacillus plantarum*, *Pediococcus pentosaceus*, *Enterococcus faecium*, and *E. faecalis* were predominant on both standing crops. The changes in LAB caused by wilting or chopping were mainly proportional changes in the four dominant species. Once the crops were ensiled, total LAB counts increased rapidly, reached a maximum within 1 day, and then declined after 7 days of fermentation. *Enterococcus* species decreased sharply or disappeared during the early fermentation. The species most prominent through day 7 were *L. plantarum* and *P. pentosaceus*. After 7 days, more species, i.e., *L. homohiochii*, *L. brevis*, and *L. gasseri*, joined the succession and became prevalent, depending on the crop.

Only two of the six alfalfa silages were adequately preserved, whereas all three corn hybrids fermented normally. No relationship was found between epiphytic LAB numbers or species and adequacy of fermentation. Neither were pH changes during the fermentation explained by the epiphytic LAB count or population succession. Rather, the well-fermented alfalfa silages were those ensiled at a high dry matter (DM) content (> 36%) and low buffering capacity (< 450 meq/kg of DM). Only a few of the LAB strains were consistently present, thus indicating that populations changed during fermentation to fit an ecological niche.

(Key Words: Epiphytic Lactic Acid Bacteria, Alfalfa, Corn, Silage.)

Introduction

Epiphytic LAB (i.e., lactobacilli, lactococci, enterococci, pediococci, streptococci, and leuconostocs) play a major role in silage fermentation. Their absolute and relative numbers might be important in predicting fermentation adequacy and in deciding whether or not to apply a silage bacterial inoculant. Epiphytic LAB counts are usually low and variable on silage crops, and LAB counts usually increase coincident to the chopping process.

Only limited information is available on epiphytic LAB succession during the ensiling of alfalfa and corn, the two major silage crops in the United States. Our objective was to investigate the epiphytic LAB succession during the pre-ensiling and ensiling periods for

[1]Financial assistance was provided by Chr. Hansen's Bio Systems, Milwaukee, Wisconsin; Kemin Industries, Inc., Des Moines, Iowa; and Pioneer Hi-Bred International, Inc., North American Seed Division, Johnston, Iowa.

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alfalfa and whole-plant corn.

Experimental Procedures

A second-year stand of Cody alfalfa was harvested at the 2nd and 4th cuttings and at the late-bud, 10% bloom, and 50% bloom stages of maturity within each cutting in the 1989 growing season. Following mowing, the alfalfa was wilted in the windrow for 5 to 6 hr prior to chopping. Three corn hybrids (Pioneer 3377, 3379, and 3389) were grown under irrigation in 1989 and directly chopped at the 2/3 milk line stage of kernel maturity. Samples were aseptically taken from standing crops, windrowed alfalfa prior to chopping, and chopped forages. The forages were ensiled in laboratory silos, stored, and sampled as described for the alfalfa and corn silages on pages 118 and 124, respectively, of this report.

Isolation of lactic acid bacteria. Each sample was homogenized with phosphate buffer (0.7 mM, pH 7.0) and serially diluted in the same buffer. Lactobacilli, pediococci, and leuconostocs were counted on Rogosa SL medium (Difco #480). Plates were overlaid with the same medium and incubated at 35 C for 2 days. Streptococci were counted on Slanetz & Bartley medium (Oxoid CM 377) following incubation at 35 C for 2 days.

Approximately 30 colonies from Rogosa SL medium and 20 from the Slanetz & Bartley medium were picked at random. Each colony was purified twice on Lactobacilli MRS medium (Difco #881) containing 1.5% agar (Difco #140). The pure cultures were grown in Lactobacilli MRS broth at 35 C for 20 hr, mixed with sterile glycerol in a ratio of 2:3, and stored as stock cultures at -22 C for further examination.

Morphology, soluble proteins, and biochemical tests. The cultures were examined for Gram reaction, morphology, and catalase production. Gram-positive, catalase-negative rods and cocci were studied further. For the isolates from Slanetz & Bartley medium, only Gram-positive, catalase-negative cocci were tested further.

Soluble cellular proteins from the pure cultures were analyzed by polyacrylamide gel electrophoresis, using a commercial *Pediococcus* strain as a control.

Cultures with different soluble protein patterns underwent final tests for lactic acid configuration, growth at 15 and 45 C in Lactobacilli MRS broth, gas production from glucose, fermentation of 32 carbohydrates, hydrolysis of esculin, and deamination of arginine.

Identification and counts of lactic acid bacteria. The identity of each isolate was determined by a dBASE III computer program that compared the tested characteristics of the LAB to respective phenotypic information in Bergey's Manual of Systematic Bacteriology. The percentage of each species or strain was calculated from the total LAB counts for each sample. Total LAB count was defined as count from Rogosa SL medium plus streptococci count from the Slanetz & Bartley medium.

Results and Discussion

LAB species succession during the preensiling and ensiling periods. Twenty three species and 306 strains of LAB were identified out of 3,400 colonies isolated from the crops and their silages (Table 1). Of the total LAB colonies isolated, more than 90% were homofermentative (produce only lactic acid). *Lactobacillus plantarum* was the predominant species, followed by *Pediococcus pentosaceus*. *Enterococcus faecium*, *E. faecalis*, *L. brevis*, and *L. homohiochii* contributed about 33% of the isolates. Remaining species were each 1% or less of the total. More LAB species were recovered from alfalfa than corn, although two of the species on corn (*L. casei* and *Streptococcus bovis*) were absent on alfalfa. Heterofermentive LAB were more numerous on alfalfa than corn, whereas the proportion of homofermentative *L. plantarum* was higher on corn. Only a few strains of *L. plantarum* and

P. pentosaceus were the same between the crops.

The LAB species or strains and their percentages of the total isolates at each period varied considerably among silage and showed profound changes as fermentation progressed (Tables 2 and 3). The second cutting, 10% bloom, standing alfalfa was inhabited only by heterofermentative *L. brevis* and *Leuconostoc mesenteroides* subsp. *mesenteroides*. The second cutting, 50% bloom and all the fourth cutting, standing alfalfas were dominated by homofermentative LAB species, *L. plantarum*, *P. pentosaceus*, and *E. faecalis*. Homofermentative LAB species predominated on all three standing corn hybrids. *P. pentosaceus* comprised 89 and 60% of the total isolates on 3389 and 3377, respectively, and *E. faecalis* comprising 96% of the isolates on 3379.

Table 1. Epiphytic LAB Species Isolated from the Six Alfalfa and Three Corn Hybrids during the Pre-ensiling and Ensiling Periods

	Total isolates		Alfalfa isolates		Corn isolates	
Species[1,2]	No. of strains	Percent-age	No. of strains	Percent-age	No. of strains	Percent-age
Lactobacillus plantarum	135	41.86	74	39.99	61	44.88
L. acidophilus	2	.02	2	.03	--	--
L. curvatus	2	.04	2	.07	--	--
L. gasseri	3	1.06	3	1.72	--	--
L. helveticus	3	.37	1	.26	2	.53
L. homohiochii	20	4.65	18	6.16	2	2.22
L. brevis	29	6.74	24	7.00	5	6.32
L. buchneri	3	.27	3	.44	--	--
L. viridescens	4	1.15	4	1.86	--	--
Leuconostoc mesenteroides subsp. *mesenteroides*	4	.45	3	.57	1	.26
Pediococcus pentosaceus	49	20.25	34	19.88	15	20.84
P. acidilactici	2	.10	2	.17	--	--
Enterococcus faecium	24	11.28	12	9.87	12	13.57
E. faecalis	12	9.63	10	10.18	2	8.74
Lactococcus lactis	5	.99	4	.57	1	.26

[1]Species having only one strain isolated from alfalfa were: *L. coryniformis* (subsp. *coryniformis*), *L. maltaromicus*, *L. confusus*, *L. collinoides*, *L. hilgardii*, and P. *inopinaius*.
[2]Species having only one strain isolated from corn were: *L. casei* (subsp. *casei*), *L. confusus*, and *Streptococcus bovis*.

Table 2. Epiphytic LAB Sucession during the Pre-ensiling and Ensiling Periods of the Second and Fourth Cutting Alfalfas

Species[1,2]	Cutting and stage of maturity	No. of strains	Pre-ensiling			Ensiling, days				
			ST[2]	WR[4]	CH[5]	1	3	7	42	90
			---------- percent of the total isolates ----------							
	Second									
L. plantarum	Late-bud	17	--	--	43	46	92	84	80	100
	10% bloom	12	--	--	5	48	66	72	89	100
	50% bloom	9	8	--	--	8	22	29	63	28
P. pentosaceus	Late-bud	5	--	--	14	23	--	16	--	--
	10% bloom	5	--	--	10	34	31	6	--	--
	50% bloom	3	23	--	11	76	75	61	15	--
Leu. mesenteroides subsp. *mesenteroides*	Late-bud	1	--	--	43	--	--	--	--	--
	10% bloom	2	33	--	5	--	--	--	--	--
L. brevis	10% bloom	3	67	--	10	--	3	--	5	--
	50% bloom	3	--	--	18	--	--	10	11	4
L. viridescens	10% bloom	2	--	--	65	18	--	--	--	--
L. homohiochii	Late-bud	4	--	--	--	--	--	--	20	--
	10% bloom	4	--	--	5	--	--	22	6	--
E. faecalis	50% bloom	3	69	--	71	--	--	--	--	--
L. gasseri	50% bloom	3	--	--	--	--	--	--	11	68
	Fourth									
L. plantarum	Late-bud	9	4	3	29	46	6	11	--	--
	10% bloom	14	1	--	53	29	76	91	20	47
	50% bloom	12	100	19	96	96	93	45	24	41
P. pentosaceus	Late-bud	9	62	--	37	54	76	63	4	--
	10% bloom	6	2	1	18	57	--	9	41	7
	50% bloom	7	--	--	4	4	--	50	32	19
E. faecium	Late-bud	7	21	86	26	--	--	18	2	3
	10% bloom	3	64	70	16	--	--	--	--	--
E. faecalis	10% bloom	3	32	29	--	--	--	--	--	--
	50% bloom	3	--	76	--	--	--	--	--	--
L. brevis	Late-bud	4	8	--	--	--	11	4	42	52
	50% bloom	7	--	1	--	--	--	5	16	29
L. homohiochii	Late-bud	5	--	--	8	--	5	4	50	41
	10% bloom	4	--	--	--	--	24	--	30	33

[1]Species contributing less than 14 percent of the total isolates at various stages of maturity and times during the pre-ensiling and ensiling periods of the second cutting alfalfa were: *L. confusus* (late-bud); *L. brevis* (late-bud); *L viridescens* (late-bud and 50% bloom); *E. faecium* (50% bloom); and *P. acidilactici* (50% bloom).

[2]Species contributing less than 14 percent of the total isolates at various stages of maturity and times during the pre-ensiling and ensiling periods of the fourth cutting alfalfa were: *L. lactis* (late-bud); *L. brevis* (10% bloom); *L. homohiochii* (50% bloom); *L. coryniformis*, subsp. *coryniformis* (late-bud); *P. inopinatus* (10% bloom); *L. acidophilus* (10% bloom); *L. collinoides* (10% bloom); *L. curvatus* (10% bloom); *L. hilgardii* (50% bloom); *L. maltaromicus* (50% bloom); *L. helveticus* (50% bloom); *L. buchneri* (50% bloom); and *P. acidilactici* (50% bloom).

[3]Standing alfalfa. [4]Windrow alfalfa. [5]Chopped alfalfa.

Wilting in the windrow caused a dramatic increase in *E. faecalis* and *E. faecium* counts on the fourth cutting alfalfa at all three stages of maturity. The chopping process changed the distribution of the main species (*L. plantarum*, *P. pentosaceus*, *E. faecalis*, *E. faecium*, and *L. brevis*) and caused recovery of a few more species (*L. homohiochii*, *L. viridescens*, and *P. inopinatus*). *E. faecalis* disappeared from the fourth cutting alfalfas and all three corn hybrids. *L. plantarum* numbers increased on all chopped alfalfa and corn. The proportions of *L. brevis* and *Leu. mesenteroides* subsp. *mesenteroides* on the second cutting, 10% bloom, standing alfalfa were greatly decreased by the chopping process, and *L. viridescens* became predominant. Also, some homofermentative species (i.e., *L. plantarum*, *P. pentosaceus* and *L. homohoichii*) were more numerous after chopping.

Dramatic changes in epiphytic LAB occurred during the ensiling period. *E. faecalis* disappeared within 1 day. *E. faecium* decreased and vanished within 3 days, except for the fourth cutting, late-bud alfalfa. *L. plantarum* predominated throughout the ensiling period of the second cutting, 10 and 50% bloom alfalfa silages and, with *P. pentosaceus*, dominated the other silages through day 7. After 7 days of fermentation, *L. brevis* and *L. homohiochii* increased and, along with *L. plantarum* and *P. pentosaceus*, became prevalent in several silages at 42 days. At the end of the ensiling period, two of the silages had *L. brevis* and one had *L. gasseri* as predominant LAB species. The other six were dominated by *L. plantarum*. *P. pentosaceus* disappeared from seven of the nine silages and was minor in the other two. None of the LAB strains remained predominant throughout the ensiling period in either alfalfa or corn.

Fermentation changes during the ensiling period (data not shown). For the second cutting alfalfa ensiled at 10 and 50% bloom, pH declined rapidly to 4.9 on the second day and dropped an additional .2 to .4 pH units by the end of the ensiling period. For the other four alfalfas, pH decreased to about 5.0 at 1 day but did not decline further. For the corn silages, the minimum pH was reached on day 3 of fermentation for hybrids 3377 and 3389; however, 3379 silage did not reach its lowest pH until day 7.

Lactic acid levels varied with both fermentation time and crop. For the second cutting, 10 and 50% bloom alfalfas, lactic acid increased rapidly during the first 3 days of fermentation and remained high (5.5 to 7.5% of the silage DM). For the other four alfalfa silages, lactic acid increased initially, then declined to only 2 to 3% of the silage DM at the end of the ensiling period. Lactic acid content in the second cutting, late-bud alfalfa silage remained almost constant during the final 87 days of fermentation, but in the fourth cutting, 50% bloom silage, lactic acid decreased from 8.5% of the silage DM on day 42 to only 2.5% on day 90. In all three corn silages, lactic acid concentration continued to increase throughout the ensiling period.

Ammonia-nitrogen increased throughout the ensiling period for all six alfalfa silages. However, only second cutting alfalfa ensiled at either 10 or 50% bloom had low enough ammonia-nitrogen values at the end of the fermentation to be acceptable (less than 12% of the total silage nitrogen). Before ensiling, these two alfalfas had the highest DM contents and lowest buffering capacities (Table 4). For all three corn hybrids, ammonia-nitrogen was produced slowly during fermentation and was less than 12% of the total nitrogen at 120 days.

Conclusions. These results indicate that the numbers and species of epiphytic LAB varied between alfalfa and corn and during the pre-ensiling and ensiling periods. Because knowing the numbers and species of LAB did not predict the outcome of the fermentations, further characterization of the epiphytic LAB strains and chemical composition of the ensiled crops, particularly their water soluble carbohydrate profiles and buffering capacity, is necessary.

Table 3. Epiphytic LAB Succession during the Pre-ensiling and Ensiling Periods of the Three Corn Hybrids

Species[1]	Hybrid	No. of strains	Pre-ensiling		Ensiling, days						
			ST[2]	CH[3]	.25	.5	1	3	7	42	120
			---------- percent of the total isolates ----------								
L. plantarum	3377	23	12	48	61	79	65	89	76	3	100
	3379	23	1	28	12	8	100	16	90	27	83
	3389	19	11	13	30	63	45	83	80	71	15
P. pentosaceus	3377	7	60	3	35	21	35	11	24	10	--
	3379	6	--	--	3	37	--	84	10	73	--
	3389	4	89	15	10	17	55	6	10	22	--
E. faecium	3377	2	24	49	--	--	--	--	--	--	--
	3379	7	3	72	49	43	--	--	--	--	--
	3389	2	--	31	--	--	--	7	--	--	--
E. faecalis	3379	1	96	--	36	12	--	--	--	--	--
L. homohiochii	3377	1	--	--	--	--	--	--	--	56	--
L. brevis	3377	2	--	--	--	--	--	--	--	17	--
	3389	3	--	--	50	20	--	4	7	7	85
L. confusus	3379	1	--	--	--	--	--	--	--	--	17
L. lactis	3389	1	--	36	--	--	--	--	--	--	--

[1]Species contributing less than 14 percent of the total isolates of the three hybrids at various times during the pre-ensiling and ensiling periods were: *E. faecalis* (3377); *L. casei*, subsp. *casei* (3377); *L. homohiochii* (3389); *L. helveticus* (3377); *lue. mesenteroides*, subsp. *mesenteroides* (3389); and *S. bovis* (3389).
[2]Standing corn. [3]Chopped corn.

Table 4. Dry Matter Content and Buffering Capacity of the Six Alfalfas

Cutting and item	Late-bud	10% bloom	50% bloom
Second			
Dry matter, %	31.2	36.7	44.4
Buffering capacity, meq/kg of DM	557	447	393
Fourth			
Dry matter, %	25.3	27.6	25.5
Buffering capacity, meq/kg of DM	559	492	468

EFFECTS OF BIOMATE® INOCULANT AND DEXTROSE ON THE FERMENTATION OF ALFALFA SILAGES[1]

C. Lin[2], K. K. Bolsen, J. E. Bradford, B. E. Brent, A. M. Feyerherm[3], and W. R. Aimutis[4]

Summary

This study documented once again that ensiling alfalfa is difficult and unpredictable. Adding 2% dextrose or Biomate® inoculant alone or in combination had little influence on the ensiling process but did improve fermentation efficiency somewhat. The pre-ensiling characteristics (i.e., dry matter (DM) and water soluble carbohydrate (WSC) values, buffering capacity, and epiphytic microflora) at the different cuttings and stages of maturity undoubtedly influenced the effectiveness of the two additives. Apparently, alfalfa often has too little WSC and too much buffering capacity to produce adequately preserved silage, especially when ensiled at a low DM content (less than 30 to 34%).

(Key Words: Silage, Alfalfa, Bacterial, Inoculant, Dextrose.)

Introduction

The goal of silage fermentation is to produce enough lactic acid and to inhibit plant catabolic enzymes and growth of undesirable epiphytic microorganisms. The most numerous undesirable microflora are the Enterobacteriaceae and yeasts and molds; they compete with the lactic acid bacteria (LAB) for fermentable sugars. Clostridial spores (obligate anaerobes) can also multiply rapidly as soon as oxygen is depleted and can lead to extensive deterioration.

Alfalfa is generally recognized as difficult to ensile, because of its high buffering capacity, wide range in moisture contents, and low level of water soluble carbohydrates (WSC). Typically, multiple cuttings are ensiled at numerous stages of maturity throughout the growing season, which further contributes to the variability seen in alfalfa silage. Stimulating fermentation by adding bacterial cultures has become common. These products are safe to handle and help establish a homolactic fermentation (fermentations producing only lactic acid). Our objective was to determine the effects of a commercial bacterial inoculant and WSC additions on the ensiling process of two alfalfa cuttings, each harvested at three maturity stages. The effect of these additives on microbial succession was presented last year (KAES Report of Progress 623).

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[1]Financial assistance was provided by Chr. Hansen's Bio Systems, Milwaukee, Wisconsin; Kemin Industries, Inc., Des Moines, Iowa; and Pioneer Hi-Bred International, Inc., North American Seed Division, Johnston, Iowa.

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Experimental Procedures

In 1989, a second-year stand of Cody alfalfa was mowed and swathed at the 2nd and 4th cuttings each at late-bud, 10% bloom, and 50% bloom and wilted in the windrow for 5 to 6 h prior to chopping. The chopped alfalfa received no additive (control), dextrose at 2% of the forage DM, Biomate inoculant (*Lactobacillus plantarum* and *Pediococcus cerevisiae*; from Chr. Hansen's Bio Systems, Milwaukee, Wisconsin) to provide 1.5×10^5 colony-forming units (cfu)/g of fresh forage, or a combination of dextrose and Biomate. All material was ensiled in 4 × 14 in. PVC laboratory silos and packed to the same density using a hydraulic press. Each silo was equipped with a Bunsen valve at one end, which excluded air but enabled gases to escape. Silos were stored at 80 ± 5 F. Three silos per treatment were opened at various times during the 90-day ensiling period. Silage samples were taken aseptically for microbiological and chemical analyses at each opening.

Each alfalfa cutting was analyzed separately as a split-plot design, in which the whole-plot was a randomized complete block and opening times were the sub-plots. The general linear models procedure of SAS® was used to analyze the data, and a probability of $P < .05$ was used to denote significance, unless otherwise indicated.

Results and Discussion

Presented in Table 1 are the chemical compositions and epiphytic microflora count of the chopped, pre-ensiled alfalfas. Even though wilting times were the same, the DM in the chopped material averaged 37.4% at the second cutting vs. 26.1% at the fourth. Temperature was higher and relative humidity was lower when the second cutting was wilted. The 10 and 50% bloom, second cutting alfalfas had the lowest buffering capacities, and the late-bud, second cutting had the lowest WSC content. Both buffering capacity and WSC content were relatively high for the fourth cutting alfalfas. All five categories of epiphytic microorganisms were found on the pre-ensiled material and Enterobacteriaceae were predominant (10^6 cfu/g). The lactobacilli, pediococci, and leuconostoc group of LAB was only a small and variable proportion of the total population; 10^2 to 10^6 cfu/g.

Fermentation results are presented in Table 2. pH decreased ($P < .05$) as stage of maturity advanced. It was lowered ($P < .05$) by dextrose and the combination treatments in the fourth cutting silages, but only by the combination in the second cutting silages. Lactic acid increased ($P < .05$) and acetic acid, ethanol, and ammonia-nitrogen decreased ($P < .05$) as maturity advanced for the second cutting silages, but not in the fourth cutting silages. The combination-treated silages had the best fermentation profiles; more lactic acid and less acetic acid, ethanol, and ammonia-nitrogen. Adding dextrose improved the fermentation of the fourth cutting silages compared to the controls. Lactic acid content in the second cutting silages increased ($P < .05$) from day 1 to 3 but did not change ($P > .05$) during the remainder of the ensiling period. For the fourth cutting silages, lactic acid contents were similar ($P > .05$) during the first 7 days, but decreased sharply ($P < .05$) thereafter. Acetic acid, ethanol, and ammonia-nitrogen increased in both second and fourth cutting silages throughout the 90-day ensiling period.

Shown in Tables 3 and 4 are the changes that occurred in the fermentation characteristics during the ensiling period. Silages treated with Biomate alone had lower ($P < .05$) pH values only at 12 h compared to the control silages, but the combination-treated silages had lower pHs all the way to day 90. In general, adding dextrose alone to the fourth cutting silages had the same effect on the rate of pH decline as combining dextrose with inoculant. At the end of the 90-day ensiling period, all silages had similar pH values ($P > .05$), regardless of treatment.

Although lactic acid was slightly higher in the second cutting, late-bud alfalfa silages than in either the 10 or 50% bloom silages at days 1 and 3, it was lower ($P < .05$) in the late-bud silages thereafter. In the fourth cutting silages, lactic acid was higher in the 50% bloom than in either the late-bud or 10% bloom silages at each time period. In contrast to the second cutting silages, stage of maturity did not consistently influence acetic acid levels; silages from each maturity stage had the highest value at some time during the ensiling period. Ammonia-nitrogen content was highest ($P < .05$) in the late-bud silages from days 3 to 90, but ethanol levels were not affected by stage of maturity.

In second cutting silages, those treated with Biomate alone had the highest lactic acid at day 1 of fermentation. After day 1, the combination-treated silages had higher ($P < .05$) lactic acid levels than the control and Biomate-treated silages. The combination and dextrose-treated silages had similar ($P > .05$) lactic acid values after day 3. In the fourth cutting alfalfa, dextrose-treated silages had higher ($P < .05$) lactic acid during the first 7 days than controls, but only the combination silages maintained these higher levels at the end of 90 days. Biomate inoculant alone did not affect lactic acid content at any time during the ensiling period.

At 90 days, all treated silages had lower acetic acid levels than control silages, but only Biomate-treated and combination silages produced lower ($P < .05$) levels of ethanol. Ammonia-nitrogen content was not affected ($P > .05$) by the additive treatments. Butyric acid was detected in only two of the 24 silages; .15 and .87% in second cutting, late-bud control and Biomate-treated silages, respectively. Propionic acid was present in a few of the silages, but always less than .2% of the dry matter.

The difficulties encountered in successfully ensiling alfalfa were similar to those in several previous studies (KAES Report of Progress 567). Among the six control alfalfa silages, only two (second cutting, 10 and 50% bloom) were well preserved, as evidenced by a low and stable pH; relatively high lactic acid; and low acetic acid, ethanol, and ammonia-nitrogen. Those two alfalfas also had higher pre-ensiled DM and lower buffering capacities than the other four alfalfas. The addition of Biomate inoculant to the alfalfa silages improved the fermentation profile at the end of the 90-day ensiling period compared to the controls, but did not increase the number of well preserved silages. We have previously observed that inoculants improved the fermentation characteristics in numerous crops even when control silages were also satisfactorily preserved, but inoculants have not consistently improved silages that might not be capable of adequate fermentation.

All alfalfa silages benefitted from dextrose addition alone, especially in the first few days of fermentation, as evidenced by higher lactic acid and lower pH. However, by the end of 90 days, the only improvement from adding dextrose alone was a modest reduction in acetic acid in the second cutting silages. The increased acetic acid and decreased lactic acid in the latter stages of fermentation in all alfalfa silages, especially the fourth cutting, probably demonstrates WSC depletion and subsequent fermentation of lactic acid to acetic acid by lactic acid bacteria.

Table 1. Chemical Composition and Epiphytic Microflora Count of the Chopped, Pre-ensiled Alfalfas

	2nd cutting			4th cutting		
Item	Late-bud	10% bloom	50% bloom	Late-bud	10% bloom	50% bloom
Dry matter, %	31.2	36.7	44.4	25.3	27.6	25.5
Buffering capacity, meq/100 g of DM	55.7	44.5	39.3	55.4	49.2	46.3
Water soluble carbohydrates, % of the DM	6.8	8.9	9.7	10.2	10.4	10.8
pH	5.8	5.7	5.7	5.9	5.9	5.8
	))))))) $\log_{10}$ cfu/g of fresh forage ((((((					
Lactobacilli, pediococci, and leuconostocs	1.78	5.78	4.09	4.72	5.03	5.81
Enterobacteriaceae	6.76	6.45	5.83	6.80	6.63	6.49
Yeasts and molds	5.34	5.37	5.85	5.30	5.57	5.66
Lactate-assimilating yeasts	2.00	4.41	4.84	3.78	4.63	5.04
Lactate-fermenting clostridial spores	0	0	0	2.17	0	1.60

Table 2. Effects of Stage of Maturity, Additive Treatment, and Time during the Ensiling Period on the Fermentation of Second and Fourth Cutting Alfalfa Silages

	Maturity[1]			Additive[2]				Time, days				Statistical significance for comparison[1]			
Item	LB	10	50	C	D	B	D + B	1	3	7	90	M	A	T	A × T
	)))))))))))))))) Second cutting (((((((((((((((((((														
pH	5.38^{a}	4.80^{b}	4.72^{b}	5.19^{a}	4.99^{a}	4.98^{a}	4.72^{b}	5.03^{a}	4.82^{b}	5.01^{a}	4.78^{b}	**	*	**	NS
	)))))))))) % of the silage DM ((((((((((														
Lactic acid	4.33^{b}	5.38^{ab}	5.92^{a}	3.98^{b}	5.20^{ab}	5.00^{b}	6.65^{a}	2.25^{b}	5.42^{a}	5.79^{a}	6.07^{a}	†	*	**	NS
Acetic acid	4.90^{a}	3.07^{b}	1.87^{c}	3.52^{a}	3.32^{ab}	3.34^{ab}	2.93^{b}	1.61^{d}	2.42^{c}	3.18^{b}	5.02^{a}	**	†	**	NS
Ethanol	.43^{a}	.44^{a}	.23^{b}	.38^{a}	.42^{a}	.34^{b}	.33^{b}	.36	.42	.39	.42	**	**	*	NS
NH_4-N	.65^{a}	.29^{b}	.14^{c}	.41	.33	.42	.29	.07^{c}	.17^{bc}	.33^{b}	.64^{a}	**	NS	**	NS
	)))))))))))))))) Fourth cutting (((((((((((((((((((														
pH	5.34^{a}	5.08^{b}	4.99^{b}	5.35^{a}	4.97^{b}	5.31^{a}	4.91^{b}	4.91^{c}	5.27^{a}	5.23^{a}	5.09^{b}	**	**	**	**
	)))))))))) % of the silage DM ((((((((((														
Lactic acid	3.88^{b}	3.72^{b}	5.57^{a}	3.53^{b}	4.89^{a}	3.63^{b}	5.52^{a}	4.61^{a}	5.32^{a}	5.31^{a}	2.46^{b}	**	†	**	NS
Acetic acid	2.46^{c}	4.34^{a}	3.46^{b}	3.61^{a}	3.38^{ab}	3.50^{ab}	3.20^{b}	1.87^{b}	1.93^{b}	2.17^{b}	5.38^{a}	**	NS	**	NS
Ethanol	.20^{c}	.41^{a}	.28^{b}	.30	.27	.32	.30	.20^{b}	.11^{b}	.14^{b}	.48^{a}	**	*	**	NS
NH_3-N	.66^{a}	.43^{c}	.54^{b}	.60^{a}	.51^{bc}	.58^{ab}	.48^{c}	.22^{d}	.48^{c}	.58^{b}	.74^{a}	**	*	**	NS

[1]LB = late-bud; 10 = 10% bloom; and 50 = 50% bloom.
[2]C = control; D = dextrose; and B = Biomate.
[3]M = stage of maturity; A = additive treatment; T = time in the ensiling period; and A × T = interaction between additive and time.
[a,b,c,d,e]Means in the same row within maturity, additive, and time with different superscripts differ (P < .05).
†P < .10. *P < .05. **P < .01.

Table 3. Effects of Stage of Maturity and Additive Treatment on the Fermentation Characteristics at Different Times during the Ensiling Period of Second Cutting Silages

Time in the ensiling period, days	Item[1]	Maturity (M)			Additive (A)				Statistical significance for comparison	
		LB[2]	10	50	C[3]	D	B	D + B	M	A
.5	pH	5.58^{a}	5.18^{b}	5.50^{a}	5.59^{a}	5.48^{ab}	5.26^{b}	5.33^{b}	*	†
1	pH	5.24	4.89	4.95	5.32^{a}	5.26^{a}	4.93^{ab}	4.61^{b}	NS	*
3	pH	5.20^{a}	4.70^{b}	4.57^{b}	5.12^{a}	4.81^{ab}	4.85^{a}	4.50^{b}	**	*
7	pH	5.64^{a}	4.86^{b}	4.54^{b}	5.28^{a}	4.97^{ab}	5.13^{a}	4.68^{b}	**	*
90	pH	5.37^{a}	4.62^{b}	4.35^{c}	4.89^{ab}	4.68^{ab}	4.91^{a}	4.64^{b}	**	†
		))))))))) % of the silage DM)))))))								
1	LA	3.51	1.76	1.47	1.14^{b}	1.11^{b}	3.07^{a}	3.67^{a}	NS	*
	AC	2.37^{a}	1.72^{b}	.74^{c}	1.62	1.66	1.67	1.49	**	NS
	ETOH	.43^{a}	.45^{a}	.20^{b}	.38	.38	.33	.34	*	NS
	NH_3-N	.10^{a}	.06^{b}	.04^{b}	.05	.07	.08	.08	**	NS
3	LA	5.76	5.17	5.33	4.05^{b}	4.98^{b}	5.19^{b}	7.46^{a}	NS	*
	AC	3.29^{a}	2.58^{b}	1.38^{c}	2.27	2.47	2.68	2.24	**	NS
	ETOH	.43^{b}	.62^{a}	.22^{c}	.41^{b}	.47^{a}	.43^{ab}	.38^{b}	**	*
	NH_3-N	.26^{a}	.14^{b}	.10^{b}	.20	.16	.17	.13	**	NS
7	LA	4.45^{b}	5.85^{a}	7.05^{a}	4.46^{b}	6.07^{ab}	5.07^{b}	7.54^{a}	*	*
	AC	4.61^{a}	3.01^{b}	1.92^{c}	3.46	3.31	3.27	2.68	**	NS
	ETOH	.39^{b}	.55^{a}	.22^{c}	.40^{ab}	.46^{a}	.34^{b}	.34^{b}	**	*
	NH_3-N	.56^{a}	.31^{b}	.13^{c}	.38	.33	.37	.24	**	NS
90	LA	3.32^{b}	6.87^{a}	8.01^{a}	4.77^{b}	6.64^{ab}	5.72^{b}	7.13^{a}	**	†
	AC	7.72^{a}	4.56^{b}	2.76^{c}	5.71^{a}	4.95^{b}	4.98^{b}	4.42^{c}	**	**
	ETOH	.46^{b}	.56^{a}	.26^{c}	.46^{a}	.48^{a}	.37^{b}	.38^{b}	**	*
	NH_3-N	1.28^{a}	.43^{b}	.21^{b}	.76	.54	.76	.50	**	NS

[1]LA = lactic acid; AC = acetic acid; NH_3-N = ammonia-nitrogen; and ETOH = ethanol.
[2]LB = late-bud; 10 = 10% bloom; and 50 = 50% bloom.
[3]C = control; D = dextrose; and B = Biomate.
[a,b,c]Means in the same row within maturity and additive with different superscripts differ (P < .05).
†P < .10.
*P < .05.
**P < .01.

Table 4. Effects of Stage of Maturity and Additive Treatment on the Fermentation Characteristics at Different Times during the Ensiling Period of Fourth Cutting Silages

Time in the ensiling period, days		Maturity (M)			Additive (A)				Statistical significance for comparison	
	Item[1]	LB[2]	10	50	C[3]	D	B	D + B	M	A
0.5	pH	5.20^{a}	5.21^{a}	4.95^{b}	5.28^{a}	5.12^{b}	5.15^{b}	4.93^{c}	**	**
1	pH	5.10^{a}	4.84^{b}	4.77^{b}	5.13^{a}	4.75^{b}	5.08^{a}	4.66^{c}	**	**
3	pH	5.53^{a}	5.18^{b}	5.10^{b}	5.54^{a}	4.99^{b}	5.56^{a}	4.99^{b}	**	**
7	pH	5.47^{a}	5.12^{b}	5.10^{b}	5.46^{a}	5.00^{b}	5.46^{a}	4.98^{b}	**	**
90	pH	5.34^{a}	4.95^{b}	4.97^{b}	5.21	5.02	5.14	4.98	**	NS
		))))))) % of the silage DM)))))))								
1	LA	5.23^{a}	3.12^{b}	5.49^{a}	3.41^{c}	4.71^{b}	4.27^{bc}	6.06^{a}	**	**
	AC	1.18^{b}	3.33^{a}	1.09^{b}	1.95	1.75	1.94	1.82	**	NS
	ETOH	0^{b}	.43^{a}	.18^{b}	.21	.12	.27	.21	**	NS
	NH_3-N	.27^{a}	.11^{b}	.28^{a}	.21	.23	.22	.21	**	NS
3	LA	4.81^{b}	4.20^{c}	6.96^{a}	3.85^{b}	6.60^{a}	4.16^{b}	6.69^{a}	**	**
	AC	1.06^{b}	3.46^{a}	1.27^{b}	2.14	1.81	2.10	1.68	**	NS
	ETOH	0^{b}	.35^{a}	0^{b}	.14	.11	.12	.10	**	NS
	NH_3-N	.62^{a}	.34^{c}	.48^{b}	.54^{a}	.44^{b}	.53^{a}	.41^{b}	**	**
7	LA	4.28^{b}	4.92^{b}	6.74^{a}	4.10^{b}	6.32^{a}	4.43^{b}	6.40^{a}	**	**
	AC	1.53^{b}	3.59^{a}	1.38^{b}	2.31	2.05	2.30	2.00	**	NS
	ETOH	0^{b}	.41^{a}	0^{b}	.13	.14	.13	.14	**	NS
	NH_3-N	.72^{a}	.45^{c}	.58^{b}	.66^{a}	.51^{b}	.66^{a}	.51^{b}	**	**
90	LA	1.81	2.63	2.90	1.74^{b}	2.64^{ab}	1.99^{ab}	3.42^{a}	NS	†
	AC	2.26^{c}	6.28^{b}	7.61^{a}	5.63	5.58	5.44	4.90	**	NS
	ETOH	.51^{a}	.37^{b}	.55^{a}	.50	.43	.50	.48	**	NS
	NH_3-N	.88^{a}	.63^{b}	.72^{b}	.83^{a}	.71^{ab}	.77^{ab}	.66^{b}	*	*

[1]LA = lactic acid; AC = acetic acid; NH_3-N = ammonia-nitrogen; and ETOH = ethanol.
[2]LB = late-bud; 10 = 10% bloom; and 50 = 50% bloom.
[3]C = control; D = dextrose; and B = Biomate.
[a,b,c]Means in the same row within maturity and additive with different superscripts differ ($P < .05$).
†$P < .10$.
*$P < .05$.
**$P < .01$.

EFFECT OF 1174® SILAGE INOCULANT ON THE FERMENTATION OF CORN SILAGES[1]

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Summary

The effect of 1174® Silage Inoculant on the ensiling process was studied using three Pioneer corn hybrids. All hybrids fermented rapidly, and 1174 did not significantly influence any of the fermentation characteristics during the 120 days. The epiphytic lactic acid bacteria (LAB) counts on the chopped corn plants were high; 14 times greater than the numbers of LAB provided by the inoculant. Although during fermentation, statistically significant differences occurred among the hybrids for fermentation end-products, no observed trends suggested that hybrid effects were real.

(Key Words: Silage, Corn, Bacterial, Inoculant.)

Introduction

About 75 to 80 million tons of corn silage are produced annually in the U.S., including about 1.5 million tons in Kansas. Whole-plant corn is recognized as the "near perfect" silage crop.

The epiphytic microflora (microorganisms naturally present on forages) are responsible for silage fermentation. Of greatest importance are the homofermentative lactic acid bacteria (LAB) (those producing only lactic acid). Normally, epiphytic LAB counts on silage crops are low and include primarily heterofermentative species. Adding homolactic bacteria at ensiling is one way to increase the numbers of desirable microbes. Although adding commercial bacterial inoculants has become common practice, their effects have been quite variable, particularly with corn and sorghum.

Our objective was to determine the effect of a commercial bacterial inoculant on the fermentation of three whole-plant corn hybrids. The effect of the inoculant on the microbial succession in this study was presented last year (KAES Report of Progress 623).

Experimental Procedures

Three corn hybrids (3377, 3379, and 3389; Pioneer Hi-Bred International, Inc., Johnston, Iowa) were grown under irrigation in 1989 and harvested at the 2/3 milk line of kernel maturity. They were chopped and ensiled with no additive (control) or 1174 Silage Inoculant (*Lactobacillus plantarum* and *Enterococcus faecium*; Pioneer Hi-Bred International, Inc.) to provide 1.5×10^5 colony-forming units (cfu)/g of fresh crop. All silages were treated as described for the alfalfa silages on page 118 of this report.

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[1]Financial assistance was provided by Chr. Hansen's Bio Systems, Milwaukee, Wisconsin; Kemin Industries, Inc., Des Moines, Iowa; Pioneer Hi-Bred International, Inc., North American Seed Division, Johnston, Iowa; and Alltech, Inc., Nicholasville, Kentucky.

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Results and Discussion

Presented in Table 1 are the chemical compositions and epiphytic microflora counts of the chopped, pre-ensiled hybrids. Although all were ensiled at identical kernel maturities, 3379 was harvested 5 days later and had a 5.5 percentage unit higher DM content than the other two, due mainly to hot weather between the two harvest dates. All five categories of epiphytic microorganisms were found on the pre-ensiled material; Enterobacteriaceae and yeasts and molds predominated. The lactobacilli, pediococci, and leuconostocs (LPL) group was only a small part of the total population on all three hybrids (about 10^6 cfu/g).

As expected, fermentation characteristics were affected ($P < .01$) by time during the ensiling period (Table 2). pH decreased sharply during the first 3 days, reaching an average of 3.77. Lactic and acetic acids, ethanol, and ammonia-nitrogen increased throughout the 120 days. Propionic and butyric acids were not detected at any time. No significant interactions occurred between additive treatment and fermentation time, and adding 1174 did not affect ($P > .05$) any of the fermentation characteristics during the 120 days.

Also presented in Table 2 is the effect of hybrid on the fermentation characteristics at different times during the ensiling period. pH values were highest ($P < .05$) in 3379 silages and lowest ($P < .05$) in 3377 silages during the first 24 h. Both 3377 and 3379 had similar pH values after day 3, which were higher ($P < .05$) than pH of the 3389 silages. Lactic acid contents were highest in 3377 silages during the first 3 days, were similar in 3377 and 3379 after day 3, and were lowest ($P < .05$) in 3389 silages from day 7 to 120. Although statistically significant differences occurred among the hybrids for fermentation end-products at various times during the ensiling period, no observed trends suggested that hybrid effects were biologically significant.

Table 1. Chemical Composition and Epiphytic Microflora Count of the Chopped, Pre-ensiled Corn Hybrids

	Hybrid		
Item	3377	3379	3389
Dry matter, %	32.4	38.0	32.6
Buffering capacity, meq/kg of DM	214	252	169
Water soluble carbohydrates, % of the DM	14.8	13.2	13.1
pH	5.8	5.8	5.8
	---Count-[1]--		
Lactobacilli, pediococci, and leuconostocs	6.43	5.95	6.41
Enterobacteriaceae	7.18	7.69	7.47
Yeasts and molds	7.20	7.08	7.06
Lactate-assimilating yeasts	6.57	6.87	6.34
Lactate-fermenting clostridial spores	2.63	2.97	2.97

[1]Expressed as $\log_{10}$ cfu/g of fresh forage.

The fact that 1174 did not influence the counts of the LPL group (KAES Report of Progress 623) could be attributed to the relatively high initial epiphytic LPL count (Table 1), 14 times greater than the numbers provided by the 1174 inoculant.

Distinct differences occurred in the epiphytic microflora and fermentation characteristics of the three hybrids. As we reported last year (KAES Report of Progress 623), 3389 silage had no undesirable microorganisms (Enterobacteriaceae, yeasts and molds, lactate-assimilating yeasts, or lactate-fermenting clostridial spores) at the end of the 120-day ensiling period. 3389 had significantly less ammonia-nitrogen and lactic acid than silages from the other two hybrids. However, 3389 silages had the lowest pH values, perhaps due to a lower buffering capacity and antibiosis of

the epiphytic LAB. Silages from 3389 also had much greater aerobic stability than 3377 and 3379 silages (data not shown).

We have observed in numerous previous studies that whole-plant corn ferments rapidly, and bacterial inoculants have only a limited effect on the rate and efficiency of fermentation. That might be because of corn's high epiphytic LAB counts and good ensiling characteristics (i.e., high DM and WSC values and low buffering capacity). Furthermore, the epiphytic LAB on these three hybrids were almost totally homofermentative (page 113 of this report).

Table 2. Effects of 1174® Inoculant and Hybrid on the Fermentation Characteristics at

	Treatment[1]	Time in the ensiling period, days						
Characteristic	or hybrid	.25	.5	1	3	7	42	120
pH	Control	5.24	4.76	4.44	3.77	3.69	3.65	3.59
	1174	5.24	4.75	4.44	3.77	3.70	3.65	3.60
		-------- % of the silage DM --------						
Lactic acid	Control	.31	.74	1.35	3.19	3.59	4.51	5.44
	1174	.34	.69	1.54	3.12	4.22	4.54	5.35
Acetic acid	Control	.15	.55	.67	1.05	1.17	1.04	1.53
	1174	.16	.51	.67	1.12	1.13	1.17	1.45
Ethanol	Control	.07	.02	.08	.08	.07	.25	.43
	1174	.13	.02	.14	.13	.19	.38	.49
Ammonia-	Control	.07	.07	.07	.10	.10	.12	.13
nitrogen	1174	.08	.07	.07	.10	.10	.12	.12
pH	3377	4.90^{c}	4.30^{c}	3.86^{c}	3.65^{b}	3.70^{a}	3.66^{a}	3.67^{a}
	3379	5.57^{a}	5.48^{a}	5.51^{a}	4.01^{a}	3.71^{a}	3.67^{a}	3.67^{a}
	3389	5.26^{b}	4.50^{b}	3.94^{b}	3.64^{b}	3.66^{b}	3.61^{b}	3.43^{b}
		-------- % of the silage DM --------						
Lactic acid	3377	$.41^{a}$	1.14^{a}	2.26^{a}	4.63^{a}	4.47^{a}	4.98^{a}	6.28^{a}
	3379	$.46^{a}$	$.52^{b}$	$.62^{c}$	2.53^{b}	4.81^{a}	6.05^{a}	6.75^{a}
	3389	$.11^{b}$	$.48^{b}$	1.45^{b}	2.30^{b}	2.42^{b}	2.53^{b}	3.15^{b}
Acetic acid	3377	.13	$.52^{a,b}$	$.58^{b}$	$.73^{b}$	.79	1.17	2.02
	3379	.20	$.67^{a}$	$.87^{a}$	1.25^{a}	1.26	1.03	1.13
	3389	.15	$.40^{b}$	$.55^{b}$	1.28^{a}	1.40	1.12	1.32
Ethanol	3377	.19	0^{b}	.18	.06	.10	.57	.67
	3379	0	0^{b}	0	0	.23	.14	.31
	3389	.11	$.06^{a}$	.15	.26	.07	.25	.40
Ammonia-	3377	$.04^{b}$	.08	$.09^{a}$	$.09^{b}$	.09	$.11^{b}$	$.16^{a}$
nitrogen	3379	$.08^{a}$	.06	$.06^{b}$	$.09^{b}$	.10	$.11^{b}$	$.12^{b}$
	3389	$.09^{a}$	.08	$.08^{a}$	$.11^{a}$	.10	$.13^{a}$	$.09^{c}$

[1]Inoculant effect was not significant ($P > .05$).

[a,b,c]Means in the same column within each fermentation characteristic with different superscripts differ ($P < .05$).

LOSSES FROM TOP SPOILAGE IN HORIZONTAL SILOS IN WESTERN KANSAS[1,2]

J. T. Dickerson[3], G. Ashbell[4], K. K. Bolsen, B. E. Brent, L. Pfaff, and Y. Niwa[5]

Summary

The top 3 ft. of silage from each of 30 horizontal silos in western Kansas was sampled at three locations across the width of the silo for 2 consecutive years (1990 and 1991). Ninety-five percent of the silages were either corn or forage sorghum, and only 22 percent of the silos were sealed with polyethylene sheeting. Losses of organic matter (OM) from spoilage were estimated by using ash content as an internal marker. Sealing silos dramatically reduced the estimated spoilage losses in the top 3 ft.

All silages had greater estimated spoilage losses in the top 18 in. in 1991 than 1990; sealing reduced spoilage losses of OM at that depth by 16 and 37 percentage units in 1990 and 1991, respectively. Sealing reduced losses in the second 18 in. by 4 percentage units in 1990 and 13 units in 1991.

The dry matter (DM) contents were lower in forage sorghum silages than in corn silages, and DM contents of sealed silages were lower than those of unsealed silages in both years. Silage in the top 18 in. had higher pH values than that in the second 18 in.; however, corn silages in the top 18 in. had the highest pH values in 1990, whereas forage sorghum silages had the highest values in 1991.

(Key Words: Survey, Top Spoilage, Silage, Bunker, Trench.)

Introduction

Kansas produces about 3.0 million tons of silage annually from corn and sorghum. During the past three decades, large horizontal silos (i.e., bunkers, trenches, and stacks) have become the most common means of storage. However, in these structures, a high percentage of the silage is exposed to the environment and weather.

The conventional method of protecting the top layer of silage in horizontal silos has been polyethylene sheeting weighted with tires. However, that protection is variable, depending on sealing techniques and the physical properties of the sheeting. Also the labor required to apply and remove the sealing materials has discouraged most producers from sealing silos.

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[1]Financial assistance was provided by Kemin Industries, Inc., Des Moines, Iowa.

[2]Appreciation is expressed to Mr. Russell Smith, Dodge City; Mr. Terry Hays, Clay Center; Mr. Les Chyba and Mr. Dan Weides, Scott Pro, Inc., Scott City; and Mr. Al Maddux, Scott City for help in collecting the data presented in this report.

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horizontal silos and to compare the losses in unsealed and sealed, corn and forage sorghum silages. Preliminary results from 1990 were presented last year (KAES Report of Progress 623).

Experimental Procedures

In mid-January of 1990 and mid-March of 1991, the top 3 ft. of silage from each of 30 horizontal silos (bunkers, trenches and stacks) in the Colby, Dodge City, Leoti, and Scott City areas of western Kansas were sampled at three locations across the width of the silo. Sampling depths were: 0 to 18 in. from the top (depth 1) and 18 to 36 in. from the top (depth 2). Reference samples were taken at least 6 or 7 ft. from the top at the feedout surface (depth 3 or face). All samples were taken with a coring device, then frozen and transported to Manhattan for analyses of pH, DM, and ash.

The relationship between ash content in a silage sample and estimated additional spoilage loss of OM (in excess of that lost in the presumably well preserved face sample) can be expressed as:

$$1 - [(AF \times OMS)/(AS \times OMF)] \times 100$$

Where:

AF	=	percent ash in the face sample.
OMF	=	percent OM in the face sample.
AS	=	percent ash in the top sample.
OMS	=	percent OM in the top sample.

The relationship, illustrated in Figure 1, is based on the assumption that as spoilage occurs, OM disappears but the absolute amount of ash remains constant. In theory, regardless of the percent ash in the face sample, a small increase in ash content in the deteriorated silage sample would represent a large percentage unit increase in loss of organic matter. For example, assume that 100 g of well preserved, face silage contains 5% ash and 95% organic matter. The same silage after spoilage contains 10% ash; however, because the absolute amount of ash is still 5 g, the silage weight has been reduced by one-half to 50 grams. The original sample contained 95 g of OM, and the spoiled sample now contains only 45 g of organic matter. Therefore, 45/95 = 47.4% of the OM remains and 52.6% was lost.

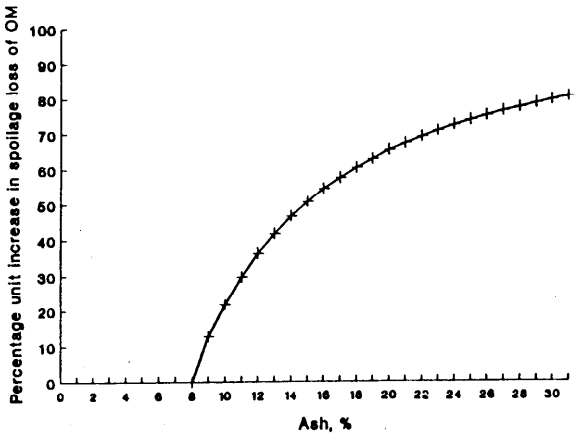

Figure 1. The Relationship Between Ash Content of a Silage and the Estimated Additional Spoilage Loss of Organic Matter.

Results and Discussion

The effects of crop and sealing treatment on ash contents and estimated additional spoilage losses of OM at the top two depths in horizontal silos are shown in Table 1. In the top 18 in., OM loss averaged 39% in 1990 and 51% in 1991. As expected, losses were higher in both corn and sorghum silages that were left unsealed. Applying a seal reduced OM loss by 16 percentage units in 1990 and 37 units in 1991, respectively, compared to silages that had no seal. Similarly, sealing reduced spoilage losses at depth 2 by 4 percentage units in 1990 and 13 percentage units in 1991.

All silages had greater spoilage losses of OM in 1991 than 1990, regardless of depth. The OM losses were 11 and 14 percentage units (depth 1) and 10 and 9 percentage units

centage units in 1990 and 13 percentage units in 1991.

All silages had greater spoilage losses of OM in 1991 than 1990, regardless of depth. The OM losses were 11 and 14 percentage units (depth 1) and 10 and 9 percentage units (depth 2) higher in 1991 than in 1990 for the corn and forage sorghum silages, respectively. Sealing corn silage reduced spoilage losses of OM by an additional 18 and 38 percentage units at depth 1 and 8 and 15 percentage units at depth 2 in 1990 and 1991, respectively. Similar trends were observed in sealed and unsealed forage sorghum silages.

The effects of crop and sealing treatment on DM and pH at the three sampling locations are shown in Table 2. The DM contents were lower in forage sorghum silages than in corn silages at all depths. The two crops were affected similarly by sealing treatment; the DM contents of the sealed silages were lower than those of the unsealed silages.

As expected, pH was higher near the surface than in the second 18 inches. A year × crop interaction occurred for pH near the surface; the corn silages had the highest values in 1990, whereas the forage sorghum silages had the highest values in 1991. In the second 18 in., silage pH was lower in 1991 than 1990. Near the surface, pH values of the unsealed silages were very high compared to deeper silage. Sealing forage sorghums reduced silage pH more (3.16 and 1.98 units) than sealing corn silages (2.24 and 1.24 units) for 1990 and 1991, respectively.

The DM contents of the face silage samples in the 60 silos surveyed ranged from 22 to 48 percent. As crop DM content increases, higher silage densities are required to prevent the damaging effects of air during the storing and feeding phases. However, the relatively low pH values of the face silages (3.5 to 4.5) indicate that satisfactory preservation had occurred. The high pH values near the surface of the unsealed silages were typical of severely deteriorated silage. Of the 30 silages having a pH value above 7.0, 28 were from unsealed silos.

The sampling date was approximately 60 days later in 1991 than in 1990, and the longer storage time undoubtedly contributed to the higher estimated additional spoilage losses in the unsealed silages in the second year.

Table 1. Effects of Crop and Sealing Treatment on Ash Contents and Estimated Additional Spoilage Losses of OM at the Top Two Depths in Horizontal Silos in 1990 and 1991

	Depth 1[2]		Depth 2		Depth 1		Depth 2	
Crop and Treatment [1]	1990	1991	1990	1991	1990	1991	1990	1991
	% Ash				Estimated OM loss[3]			
All crops (30, 30)[4]	13.6	15.5	8.1	8.7	39	51	6	13
Corn (14, 11)	11.8	12.3	7.0	7.1	38	49	7	17
Sorghum (13, 19)	13.6	17.4	8.9	9.6	38	52	3	12
Treatment								
unsealed (25, 22)	14.1	17.3	8.1	8.8	43	61	6	17
sealed (5, 8)	10.2	10.7	8.3	8.4	27	24	2	4
Corn								
unsealed (12, 8)	12.0	13.8	6.8	7.3	49	60	9	19
sealed (2, 3)	11.2	8.3	8.2	6.8	31	22	1	5
Sorghum								
unsealed (10, 4)	14.5	19.2	9.0	9.7	42	61	3	16
sealed (3, 5)	9.5	12.2	8.4	9.4	23	26	2	4

[1]Number of silos per crop or treatment in parentheses for 1990 and 1991, respectively. Sealed silos were covered with a single sheet of .4 or .6 mm, black polyethylene and weighted with either tires or soil.
[2]Depth 1 = 0 to 18 inches and depth 2 = 18 to 36 inches from the surface.
[3]Expressed as percentage unit increase in spoilage loss of OM and calculated from the equation on page 128.
[4]Includes data from unsealed alfalfa, wheat, and oat silages in 1990.

Table 2. Effects of Crop and Sealing Treatment on Silage DM and pH at the Three Sampling Locations in Horizontal Silos in 1990 and 1991

Crop and Treatment	Depth 1[2]		Depth 2		Face		Depth 1		Depth 2		Face	
	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991
	% DM						pH					
All crops (30, 30)[1,3]	39.8	42.1	36.4	37.4	33.9	35.4	6.58	7.01	4.04	3.78	3.78	3.83
Corn (14, 11)	43.1	43.2	37.9	37.9	36.4	38.9	6.27	5.91	4.12	3.71	3.71	3.76
Sorghum (13, 19)	34.5	41.4	33.9	37.1	31.0	33.3	6.92	7.69	3.94	3.75	3.75	3.81
Treatment												
unsealed (25, 22)	41.8	45.7	36.5	38.7	34.7	35.7	7.07	7.52	4.08	3.75	3.75	3.78
sealed (5, 8)	26.5	31.9	33.2	33.2	29.7	34.2	4.43	5.79	3.84	3.63	3.64	3.82
Corn												
unsealed (12, 8)	45.6	46.0	38.5	38.3	37.6	39.1	6.59	6.46	4.15	3.73	3.73	3.72
sealed (2, 3)	28.2	35.7	34.0	36.7	29.3	38.3	4.35	5.22	3.92	3.59	3.59	3.86
Sorghum												
unsealed (10, 14)	37.3	45.6	34.2	38.9	31.3	33.8	7.65	8.12	3.99	3.77	3.77	3.82
sealed (3, 5)	25.3	29.6	32.7	32.0	29.9	31.8	4.49	6.14	3.79	3.67	3.67	3.80

[1]Number of silos per crop or treatment in parentheses for 1990 and 1991, respectively. Sealed silos were covered with a single sheet of .4 or .6 mm, black polyethylene and weighted with either tires or soil.
[2]Depth 1 = 0 to 18 inches; depth 2 = 18 to 36 inches; and face = at least 6 to 7 ft. from the surface.
[3]Includes data from unsealed alfalfa, wheat, and oat silages in 1990.

LOSSES FROM TOP SPOILAGE IN CORN AND FORAGE SORGHUM SILAGES IN HORIZONTAL SILOS[1]

J. T. Dickerson[2], K. K. Bolsen, B. E. Brent, and C. Lin[3]

Summary

Corn and forage sorghum silages were stored in small (simulated), farm-scale, bunker silos for 180 days, and dry matter (DM) and organic matter (OM) losses; fermentation characteristics; and temperatures were measured at 10, 20, and 30 inches from the original silage surface. Sealing the exposed surface significantly increased DM and OM recoveries in both crops, regardless of depth. Immediate sealing preserved more DM and OM than delayed sealing, particularly at the 10-in. depth.

The unsealed silages from both crops maintained dramatically higher temperatures within the top 3 ft. than sealed silages. As expected, the unsealed silages deteriorated completely at 10- and 20-in. depths, and the delayed-seal, forage sorghum silage showed considerable deterioration at the 10-in. depth. The immediately sealed corn silages had better fermentation profiles than their forage sorghum counterparts. A mold inhibitor, Top Savor®, increased OM recovery by about 2 percent in the forage sorghum silage, but had no effect on corn silage.

These results indicate that sealing (covering) silos immediately after filling greatly improves storage efficiency and silage quality in the top 3 ft.

(Key Words: Silage, Top Spoilage, Corn, Sorghum.)

Introduction

Bunkers, trenches, or stacks appear to be economical for storing large amounts of ensiled feeds, but their design allows large percentages of the ensiled material to be exposed to the weather. In addition, silage in horizontal silos is affected by other influences such as crop DM, permeability of the silo walls, surface area exposure during filling, length of storage, and rate of removal, all of which result in a wide range of preservation losses throughout the silage mass.

Results presented last year (KAES Report of Progress 623) showed that over 50% of the DM was lost in the top 2 ft. of unsealed alfalfa silage after 12 wks of storage. To date, controlled experiments under farm-scale conditions have not adequately characterized DM losses in the top layer for corn and sorghum silages. Such data are necessary to assess the economic feasibility of sealing (covering) silage in horizontal silos.

Our objectives were to determine the extent of losses in the top 3 ft. of horizontal silos and to develop research techniques that simulate farm-scale conditions.

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[1]Financial assistance was provided by Kemin Industries Inc., Des Moines, Iowa and Mr. Richard Porter, Porter Farms, Reading, Kansas.

[2]Former graduate student. Current address: Biotal, Inc., Ft. Dodge, Iowa.

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Experimental Procedures

Experiment 1: whole-plant corn. On August 28 and 29, 1990, whole-plant corn (2/3 milk line maturity and 35.4% DM) was chopped and packed into four, 16 ft. long × 13.5 ft. wide × 4 ft. deep, bunker silos. During filling, nylon net bags, each containing 4.5 lb of fresh material, were placed 10, 20, and 30 inches from the top of the original ensiled mass (3 bags/depth/silo). Thermocouples were placed at each bag location, and temperatures were recorded for the first 42 days. The silos contained similar amounts of fresh material and were packed with tractors to densities that were similar to farm-scale conditions. Treatments were 1) left unsealed; 2) sealed with .4 mm polyethylene sheeting; 3) sealed with .4 mm polyethylene sheeting after a topical application of a commercial mold inhibitor, Top Savor®, at 1.0 lb/10 sq. ft. (provided by Kemin Industries, Inc., Des Moines, Iowa); and 4) left unsealed for 7 days post-filling, then sealed as described for treatment 3. The sheeting was weighted with tires. Bunkers were emptied at 180 days after filling. The nylon net bags were recovered, and the silage was weighed, mixed, sampled, and frozen for future analyses.

Experiment 2: forage sorghum. On September 27 and 28, 1990, whole-plant, Pioneer 947 forage sorghum (late-dough maturity and 30.8% DM) was chopped and packed into four bunker silos and treated the same as in Experiment 1 (above).

Chemical analysis of the samples. The DM content of pre-ensiled material and silages was determined by drying for 72 h at 55 C in a forced-draft oven, with no correction for volatile losses. The dried samples were then ground in a Wiley mill (1-mm screen), and analyzed for total ash content by combustion. Parallel samples were analyzed fresh for pH, lactic acid, volatile fatty acids, ethanol (ETOH), and ammonia-nitrogen.

Results and Discussion

Experiment 1: whole-plant corn. Results are presented in Table 1. The DM content was lower at the 10- and 30-in. depths and higher at the 20-in. depth in the unsealed silage than in sealed silages. The unsealed silage retained less DM and OM at each depth than the sealed silages, and fermentation characteristics at the 10- and 20-in. depths were significantly improved by all three sealing treatments. Silages that were sealed immediately (TRT 2 and 3) had higher DM and OM recoveries at the 10-in. depth than the delayed-seal silage (TRT 4).

Few fermentation differences were observed among the sealed silages, although the delayed-seal silage had a numerically lower lactic:acetic acid ratio at the 30-in. depth. Unsealed silage had the highest maximum temperatures at the 10- and 20-in. depths. Both silages that were sealed immediately (TRT 2 and 3) had similar temperature profiles. As expected, the unsealed and delayed-seal silages had similar temperatures at all three depths until day 7 post-filling, when the TRT 4 silage was sealed.

Experiment 2: forage sorghum. Results are presented in Table 2. The unsealed silage had lower DM at the 10-in. depth and higher DM content at the 20-in. depth compared to silages that were sealed immediately. Similar to the corn silages, unsealed forage sorghum silage had dramatically lower DM and OM recoveries at the 10- and 20-in. depths and numerically lower values at 30 in. compared to the sealed silages. The delayed-seal silage (TRT 4) tended to have lower DM and OM recoveries, regardless of depth, compared to the silages that were sealed immediately (TRT 2 and 3). At 10 in., silage sealed immediately with Top-Savor (TRT 3) had higher DM and OM recoveries than silage without Top-Savor (TRT 2). Estimated OM recovery values were generally higher than actual values, regardless of sealing treatment or storage depth.

The unsealed silage had deteriorated completely at the 10- and 20-in. depths, as evidenced by high pH values and lack of sufficient fermentation end-products. The delayed-seal forage sorghum silage at the 10-in. depth underwent more deterioration than its delayed-seal corn silage counterpart. Silages that were sealed immediately (TRT 2 and 3) had higher pH values and less fermentation acids at 10 in. than at the 20- and 30-in. depths. Similar to the corn silages, unsealed forage sorghum silage reached and maintained the highest temperatures, regardless of depth, and the maximum temperature at 20 in. was higher in the delayed-seal silage than in silages that were sealed immediately. The maximum temperature of the unsealed silage was reached on day 20 post-filling at all three depths. In contrast, temperatures in the delayed-seal silage reached their highest values at the 10-, 20-, and 30-in. depths by 6, 8, and 5 days post-filling, respectively. The two silages that were sealed immediately (TRT 2 and 3) both reached their maximum values at the 10-,20-, and 30-in. depths by 5, 7, and 5 days post-filling, respectively.

Conclusions. These results indicate that the mechanisms of silage losses from top spoilage are complex and probably not determined by a single factor. Actual spoilage loss appears to be due to an interaction of various chemical, physical, and microbiological processes. The partial verification of a rapid and accurate method to estimate these losses using silage ash content (see page 128 of this report), along with the small, farm-scale, research silos used in these experiments, should facilitate future studies on mechanisms of top spoilage loss and lead to the development of new, effective, protection methods.

Table 1. Effects of Sealing Treatment and Depth from the Original Surface (Depth) on the DM Content, DM and OM Recoveries (Rec.), Fermentation Characteristics, and Temperature (Temp.) of Corn Silages from Buried Bags Stored in the Farm-scale Silos in Experiment 1

Sealing treatment[1]	Depth, inches	DM, %	Actual DM rec.[2]	Actual OM rec.[2]	Est. OM rec.[3]	pH	Lactic acid	Acetic acid	ETOH	NH_3-N	Lactic: acetic	Temp.[4], °F
							----- % of the silage DM -----					
TRT 1	10	23.0	19.6	15.5	25.2	6.69	.15	.42	.20	.03	.36	131 (135)
	20	34.4	70.6	70.1	74.5	5.10	.52	1.00	.27	.02	.52	129 (131)
	30	30.3	80.8	78.0	90.8	3.78	3.51	3.43	1.64	.14	1.02	99 (100)
TRT 2	10	29.5	77.5	77.1	82.1	4.46	1.31	2.19	.37	.11	.60	84 (108)
	20	32.9	90.9	90.2	86.5	3.84	3.38	1.74	1.51	.11	1.94	93 (106)
	30	31.9	87.7	87.2	88.1	3.86	3.26	1.62	1.52	.10	2.01	91 (100)
TRT 3	10	29.3	75.3	74.0	74.2	5.54	.33	.57	.38	.10	.58	86 (109)
	20	32.3	85.3	84.7	83.6	3.89	1.41	1.34	1.89	.17	1.05	95 (109)
	30	32.1	85.3	84.3	81.5	3.81	3.01	1.65	1.16	.13	1.82	91 (97)
TRT 4	10	30.3	67.6	66.9	86.0	4.71	.83	1.23	1.09	.09	.67	90 (120)
	20	32.3	84.5	84.4	99.0	3.93	1.88	1.20	1.29	.07	1.57	91 (113)
	30	32.0	87.6	87.0	92.0	3.81	3.03	2.03	1.63	.10	1.49	91 (93)

[1]Treatment (TRT) 1 = unsealed; TRT 2 = sealed immediately; TRT 3 = sealed immediately plus Top Savor®; and TRT 4 = sealed 7 days post-filling plus Top Savor®.

[2]Expressed as a % of the DM or OM ensiled.

[3]Estimated (est.) OM recovery calculated from equation on page 128 of this report.

[4]Temperature at 30 days post-filling (maximum temperature from 0 to 42 days post-filling in parentheses).

Table 2. Effects of Sealing Treatment and Depth from the Original Surface (Depth) on the DM Content, DM and OM Recoveries (Rec.), Fermentation Characteristics, and Temperature (Temp.) of Forage Sorghum Silages from Buried Bags Stored in the Farm-scale Silos in Experiment 2

Sealing treat-ment[1]	Depth, inches	DM, %	Actual DM rec.[2]	Actual OM rec.[2]	Est. OM rec.[3]	pH	Lactic acid	Acetic acid	ETOH	NH_3-N	Lactic: acetic	Temp.[4], °F
							----- % of the silage DM ------					
TRT 1	10	27.7	23.0	19.1	23.9	8.77	ND[5]	.23	ND	.03	---	137 (137)
	20	36.9	46.8	44.0	51.9	9.12	.09	.10	ND	.04	.90	117 (117)
	30	27.7	79.8	75.8	74.5	3.90	5.75	6.61	1.04	.09	.87	97 (97)
TRT 2	10	31.5	78.7	75.2	79.1	4.43	.35	2.67	1.33	.09	.52	75 (108)
	20	29.4	93.3	90.0	101.7	3.81	5.18	2.77	.87	.07	1.87	81 (104)
	30	27.6	93.3	91.5	98.1	3.70	6.17	2.30	.70	.07	2.68	84 (91)
TRT 3	10	31.2	82.0	79.9	88.0	4.00	.45	1.42	.93	.04	.32	68 (109)
	20	29.7	93.4	91.3	95.3	3.80	3.82	2.46	.90	.08	1.55	82 (102)
	30	27.2	93.0	90.6	94.3	3.75	7.31	3.14	.76	.08	2.33	81 (95)
TRT 4	10	26.1	72.8	69.3	72.1	7.36	.17	.19	.62	.05	.89	77 (113)
	20	30.0	90.0	88.3	93.2	3.80	6.93	2.90	.83	.08	2.39	88 (109)
	30	28.2	87.1	84.2	91.6	3.82	7.33	4.23	1.16	.08	1.73	84 (95)

[1]Treatment (TRT) 1 = unsealed; TRT 2 = sealed immediately; TRT 3 = sealed immediately plus Top Savor®; and TRT 4 = sealed 7 days post-filling plus Top Savor®.

[2]Expressed as a % of the DM or OM ensiled.

[3]Estimated (est.) OM recovery calculated from equation on page 128 of this report.

[4]Temperature at 30 days post-filling (maximum temperature from 0 to 42 days post-filling in parentheses).

[5]ND = not detected.

RATE AND EXTENT OF LOSSES FROM TOP SPOILAGE IN PILOT-SCALE, HORIZONTAL SILOS[1]

J. T. Dickerson[2], K. K. Bolsen, B. E. Brent, C. Lin[3], and J. E. Boyer, Jr.[4]

Summary

Corn and forage sorghum silages were stored in pilot-scale silos for 180 days, and dry matter (DM) and organic matter (OM) recoveries and estimated OM recovery were measured at three depths within the top 3 ft. of silage. The unsealed silages deteriorated badly in the top 12 in. Actual DM and OM losses in the top 24 in. were higher in unsealed than sealed silages at each successive storage period (7 to 180 days).

The unsealed silages began to deteriorate immediately in the top 12 in. in both crops, and deterioration progressed to the second 12 in. by 90 days post-filling. Sealing immediately after filling preserved more DM and OM after 180 days in the top 12 in. than delayed sealing. Silages from both crops, when sealed immediately and treated with a mold inhibitor, Top Savor®, had the highest DM and OM recoveries in the 0- to 12-in. depth at 7 days post-filling.

Organic matter recoveries estimated by an equation using silage ash content were highly correlated ($r > .93$) to actual OM recoveries in all unsealed silages. Estimated and actual OM recoveries were not highly correlated in sealed silages, particularly below the top 12 in., where OM losses were quite low in both crops.

(Key Words: Silage, Top Spoilage, Pilot-scale, Ash.)

Introduction

Large horizontal silos (i.e., bunkers, trenches, and stacks) are economical for storing large volumes of ensiled feeds, but much of the silage is exposed to the environment. In shallow structures, 20 to 25% of the original ensiled volume can be within the top 3 ft. Past research with alfalfa and corn has shown DM losses of 30 to 60% in the top 2 ft. of silage. Controlled experiments have not adequately characterized the losses occurring in this top layer.

Therefore, our objectives were to determine the rate and extent of losses in the top 3 ft. in pilot-scale, horizontal silos and to verify a method designed to estimate these losses using silage ash content.

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[1]Financial assistance was provided by Kemin Industries Inc., Des Moines, Iowa and Mr. Richard Porter, Porter Farms, Reading, Kansas.

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[3]Former graduate student. Current address: Agri-King, Inc., Fulton, Illinois.

[4]Department of Statistics.

Experimental Procedures

Experiment 1: whole-plant corn. On August 28 and 29, 1990, 45 polyethylene-lined, 55-gallon capacity drums were packed to equal densities with whole-plant corn similar to that used to fill the farm-scale, bunker silos described on page 132 of this report. Each drum was divided horizontally with plastic netting into thirds to partition the fresh material at 12 and 24 in. below the original surface. A perforated 1.0 in. PVC pipe at the bottom of each drum drained off percolated water. Treatments were 1) left unsealed; 2) sealed with .4 mm polyethylene sheeting; 3) sealed with .4 mm polyethylene sheeting after a topical application of a commercial mold inhibitor, Top Savor®, at 1.0 lb/10 sq. ft. (provided by Kemin Industries, Inc., Des Moines, Iowa); and 4) left unsealed for 7 days post-filling, then sealed as described for treatment 3. Drums were stored outside and opened at 7, 21, 90, and 180 days post-filling (3 drums/treatment/opening time). The silage was weighed, mixed, and sampled at each location and processed as described for the farm-scale silages.

Experiment 2: forage sorghum. On September 27 and 28, 1990, 45 drums were packed to equal densities with whole-plant forage sorghum similar to that used to fill the farm-scale, bunker silos described on page 132 of this report. Procedures were the same as in Experiment 1.

Chemical analysis of the samples and statistical analysis of the data. All samples were analyzed as described on page 132 of this report. Data were treated by analysis of variance. Correlation coefficients and estimates of linear regression parameters were determined from actual and estimated OM recovery values from the pilot-scale silos.

Results and Discussion

The effects of sealing treatment, depth from the original surface, and day post-filling on the DM content and DM and OM recoveries of the corn and forage sorghum silages are presented in Table 1.

Experiment 1: whole-plant corn. Unsealed corn silage in the top 12 in. continued to loose DM and OM as storage time advanced ($P < .05$). Estimated OM recoveries were lower ($P < .05$) at both 90 and 180 days post-filling than at 7 and 21 days. The estimated corn silage OM recoveries tended to be higher than the actual OM recoveries in unsealed silage less than 24 in. deep. After 180 days, DM and OM recoveries of the unsealed corn silage at 12- to 24-in. depth were lower ($P < .05$) than the three previous storage times. However, at the 24-to 36-in. depth, DM and OM recoveries remained constant as storage time advanced.

Both corn silages sealed immediately (TRT 2 and 3) had similar DM and OM recoveries as storage time advanced. Delayed-seal silage (TRT 4) had similar ($P > .05$) DM and OM recoveries above 12 in. after 90 and 180 days. In addition, the DM and OM recoveries of the delayed-seal corn silage below 12 in. were not affected by storage time and had values that were similar to those of the two corn silages that were sealed immediately.

Experiment 2: forage sorghum. As was observed for the corn silages, unsealed forage sorghum silage in the top 12 in. continued to loose DM and OM as storage time increased ($P < .05$). In the second 12 in., DM and OM recoveries were lower at 90 and 180 days post-filling than at 7 and 21 days ($P < .05$), but the loss was much less pronounced. The DM recoveries for the silages sealed immediately (TRT 2 and 3) were higher ($P < .05$) in the top 12 in. at 7 and 21 days post-filling than at 90 and 180 days. The DM and estimated OM recoveries were similar ($P > .05$) for the delayed-seal silage stored above 12 in. by 21 days post-filling, and storage time did not affect DM or OM recoveries below 12 in.

Estimating OM recovery from silage ash content. When OM losses were large (top 24 in. in unsealed silage), OM recoveries esti-

mated from ash were highly correlated (r > .93) to actual OM recoveries. As expected, the relationship was much poorer when losses were low (sealed silage and silage deeper than 24 in.). We conclude that in situations where serious silage OM loss is occurring, those losses can be estimated from changes in silage ash content.

Table 1. Effects of Sealing Treatment, Depth from the Original Surface (Depth) and Day Post-filling on the DM Content and DM and OM Recoveries (Rec.) of the Corn and Forage Sorghum Silages in Experiments 1 and 2

Sealing treatment[1]	Depth, inches	Day post-filling	DM, %	Actual DM rec.[2]	Actual OM rec.[2]	Est. OM rec.[3]	DM, %	Actual DM rec.[2]	Actual OM rec.[2]	Est. OM rec.[3]
				------ Corn silages------				--- Forage sorghum silages ---		
TRT 1	0 to 12	7	33.6	86.1^{a}	78.6^{a}	83.0^{a}	30.2	85.9^{a}	85.2^{a}	90.0^{a}
		90	28.7	45.6^{c}	40.8^{c}	41.4^{b}	25.3	46.9^{c}	44.1^{c}	50.4^{c}
		180	36.0	35.7^{d}	31.5^{d}	36.9^{b}	22.1	37.7^{d}	36.6^{d}	42.3^{c}
	12 to 24	7	31.4	87.0^{a}	82.6^{a}	91.2^{a}	29.4	92.6^{a}	92.3^{a}	95.9^{a}
		90	26.9	81.5^{a}	76.8^{a}	81.1^{a}	21.6	67.9^{b}	62.3^{b}	69.7^{b}
		180	23.3	62.1^{b}	57.7^{b}	64.5^{b}	23.0	65.8^{b}	64.0^{b}	69.5^{b}
	24 to 36	7	32.2	88.8^{a,b}	84.2^{a,b}	89.7^{a}	29.1	93.1^{a}	92.6^{a}	92.6
		90	29.0	91.1^{a}	86.1^{a}	85.4^{a}	25.3	88.3^{b}	85.9^{b}	90.9
		180	27.7	83.4^{b}	78.9^{b}	84.2^{a}	25.5	92.6^{a,b}	91.8^{a,b}	87.5
TRT 2	0 to 12	7	32.8	92.7^{a}	88.1^{a}	94.0^{a}	29.4	91.4^{a}	88.7^{a,b}	88.7
		90	31.9	86.4^{b}	81.6^{b}	85.1^{b}	28.1	87.5^{a,b}	86.6^{a,b}	88.5
		180	33.2	85.2^{b}	80.6^{b}	86.2^{b}	29.4	86.5^{b}	85.8^{b}	89.5
	12 to 24	7	33.8	94.1^{a}	89.6^{a}	97.7^{a}	29.9	95.6^{a,b}	92.9	89.1
		90	31.9	87.2^{b}	82.6^{b}	88.5^{b}	29.0	93.6^{a,b}	93.0	91.8
		180	32.3	87.0^{b}	82.5^{b}	90.5^{b}	28.9	92.1^{b}	91.5	90.7
	24 to 36	7	33.6	93.9^{a}	89.3^{a}	96.4^{a}	29.9	96.2	93.7	93.7
		90	32.5	92.2^{a,b}	86.3^{a,b}	84.9^{b}	28.7	95.5	95.3	93.1
		180	31.0	86.1^{b}	81.3^{b}	83.7^{b}	29.3	94.6	94.0	90.9
TRT 3	0 to 12	7	31.8	96.9^{a}	92.3^{a}	97.0^{a}	29.6	93.4^{a}	92.9^{a}	93.4^{a}
		90	32.7	88.0^{b}	83.1^{b}	83.7^{b}	28.6	89.3^{b}	85.4^{b}	86.5^{b}
		180	32.9	87.7^{b}	83.0^{b}	87.4^{b}	29.4	90.0^{b}	89.6^{a,b}	94.5^{a}
	12 to 24	7	34.4	95.5^{a}	90.9^{a}	96.6^{a}	29.3	96.4	95.8^{a}	92.6^{a,b}
		90	32.3	89.6^{b}	84.7^{b}	84.7^{b}	28.7	91.4	88.7^{b}	89.1^{b}
		180	32.1	87.5^{b}	82.7^{b}	85.2^{b}	29.1	90.8	90.4^{a,b}	93.2^{a,b}
	24 to 36	7	33.5	93.8	89.0	91.8	29.8	96.9^{a}	96.4^{a}	92.7^{a,b}
		90	31.2	88.1	83.3	85.9	28.0	92.7^{b}	90.1^{b}	90.5^{b}
		180	30.9	86.3	81.5	83.9	29.3	96.4^{a}	95.8^{a}	92.0^{a,b}
TRT 4	0 to 12	7	33.6	86.1^{a}	78.6^{a,b}	83.0^{a}	30.2	85.9^{a}	85.2^{a}	90.0^{a}
		90	32.8	77.0^{b}	72.4^{b}	75.9^{b}	26.3	80.5^{b}	82.7^{a}	85.6^{b}
		180	33.9	77.1^{b}	72.6^{b}	76.3^{b}	30.5	78.1^{b}	73.0^{b}	79.9^{b}
	12 to 24	7	31.4	87.0^{a,b}	82.6^{a,b}	91.2^{a}	29.4	92.6	92.3	95.9
		90	31.1	85.1^{b}	80.1^{b}	78.4^{b}	27.9	89.3	88.5	87.8
		180	32.4	87.8^{a,b}	83.2^{a,b}	87.1^{a}	29.9	91.9	91.2	89.6
	24 to 36	7	32.2	88.8	84.2	89.7^{a}	29.1	93.1	92.6	92.6
		90	30.7	86.6	81.6	80.2^{b}	28.9	92.7	90.2	91.9
		180	30.2	88.1	83.1	81.6^{b}	28.5	95.6	95.0	91.4

[1]Treatment (TRT) 1 = unsealed; TRT 2 = sealed immediately; TRT 3 = sealed immediately plus Top Savor®; and TRT 4 = sealed 7 days post-filling plus Top Savor®.
[2]Expressed as a % of the DM or OM ensiled.
[3]Estimated (est.) OM recovery calculated from the equation on page 128 of this report.
[a,b,c,d]Means within day post-filling at each depth and sealing treatment in the same column with different superscripts differ (P < .05).

A COMPARISON OF BEEF FLAVOR INTENSITY AMONG MAJOR MUSCLES

C. F. Carmack, C. L. Kastner, M. E. Dikeman, and J.R. Schwenke[1]

Summary

Twelve muscles from eight Select/Choice grade steers were evaluated for beef flavor intensity, tenderness, and juiciness. Sample steaks were cut, and evaluation was performed by a five-member professional panel. The biceps femoris ranked highest in beef flavor intensity but was not different (P > .05) from the psoas major, gluteus medius, semimembranosus, and triceps brachii (scores of 7.8, 7.5, 7.4, 7.4, and 7.3, respectively). The rectus femoris, longissimus lumborum, serratus ventralis, infraspinatus, semitendinosus, deep pectoral, and supraspinatus were less intense in beef flavor (7.1, 7.1, 7.0, 6.8, 6.8, 6.7, and 6.6, respectively).

The psoas major was most tender (P < .05) of all muscles, followed by the infraspinatus, longissimus lumborum, rectus femoris, and serratus ventralis, which were all similar (P > .05). Muscles from the chuck and loin were generally juicier than those from the round.

This information may be useful in assisting processors in raw material selection for restructured, value-added processing and in assisting purveyors and consumers in selecting steaks and roasts for specific characteristics such as beef flavor intensity.

(Key Words: Beef Muscles, Flavor, Tenderness, Juiciness.)

Introduction

Beef flavor intensity is an important component of meat palatability. In fact, it is probably second only to tenderness among factors that influence consumers' perception of palatability. Unfortunately, evaluating meat palatability, particularly beef flavor, is not an easy task. Research has focused on characteristics of flavor desirability, off flavors, etc.; however, no work has focused on relative beef flavor intensity among major muscles.

This study was conducted to determine if there are differences in beef flavor intensity among muscles that are usually consumed in the form of intact steaks or roasts or may be restructured into steak- or roast-like products.

Experimental Procedures

Eight Select/Choice grade carcasses were fabricated 7 days after slaughter. The semimembranosus, semitendinosus, biceps femoris, rectus femoris, gluteus medius, longissimus lumborum, psoas major, supraspinatus, infraspinatus, triceps brachii, serratus ventralis, and deep pectoral muscles were utilized. Steaks (1 in.) were cut immediately, trimmed of all subcutaneous and intermuscular fat, vacuum packaged, and frozen (-4°F) until evaluation.

Panel Training. Three open discussion sessions were held to train the five-member professional panel. Training samples were selected from veal, Choice/Select, and grain-fed D/E maturity cattle to represent differences in beef flavor intensity, tenderness, and juici-

[1]KSU Department of Statistics.

ness. Additional differences in flavor intensity were created by soaking samples in water prior to cooking to leach out flavor components. Different degrees of doneness were also used to create a variety of tenderness and juiciness differences.

Evaluations. Steaks were thawed for 24 hr at 40°F and cooked on open-top electric grills to an internal temperature of 158 F, measured by thermocouples placed in the approximate center of each steak. After steaks reached 158 F, they were held in double boilers (147 F) until samples were cut. All dried edges were removed from the steaks, which were then cut into cubes (.5 × 0.5 × 1.0 in.). All muscles from an animal were evaluated in each of eight sessions. A reference sample of D/E maturity longissimus lumborum muscle was served first and between each group of four samples to keep panelists oriented. Samples were served in random order, and responses were marked on a line with 10 divisions (1 = least intense beef flavor, tender, juicy; 10 = most intense beef flavor, tender, juicy).

Results and Discussion

Means for sensory attributes are presented in Table 1. The biceps femoris ranked highest in beef flavor intensity. However, it was not different ($P > .05$) from the psoas major, gluteus medius, semimembranosus, semitendinosus, and triceps brachii. The rectus femoris, longissimus lumborum, serratus ventralis, infraspinatus, semitendinosus, deep pectoral, and supraspinatus were lower in beef flavor intensity ($P < .05$) than the biceps femoris, with the supraspinatus ranking the lowest. The psoas major and gluteus medius ranked higher ($P < .05$) in beef flavor intensity than the infraspinatus, semitendinosus, deep pectoral, and supraspinatus.

The psoas major was the most tender ($P < .05$) of all muscles. The infraspinatus, longissimus lumborum, rectus femoris, and serratus ventralis were all similar ($P > .05$) and more tender ($P < .05$) than the supraspinatus, semitendinosus, biceps femoris, semimembranosus, and deep pectoral muscles. The deep pectoral was ranked least tender, although it was not different ($P > .05$) from the semimembranosus.

The serratus ventralis was ranked juiciest but was not significantly different ($P > .05$) from the infraspinatus. The semimembranosus and semitendinosus scored lowest, but were not different ($P > .05$) from the triceps brachii, rectus femoris, gluteus medius, and biceps femoris. Generally, muscles of the chuck and loin, with the exception of the gluteus medius, were juicier than those from the round.

Overall, the psoas major consistently ranked high, whereas the semitendinosus ranked low. Our results indicate that the infraspinatus muscle could be used as a high quality steak because it ranked high in tenderness and juiciness and average for beef flavor intensity. These results suggest that by utilizing selected muscles in restructured or intact products, beef flavor, tenderness, and/or juiciness could be optimized depending on the processing goals and target markets.

Table 1. Rank and Means of Muscles by Sensory Evaluation

Rank	Beef flavor intensity[g]	Tenderness[h]	Juiciness[i]
1	Biceps femoris[a]	Psoas major[a]	Serratus ventralis[a]
	7.8	8.5	6.8
2	Psoas major[ab]	Infraspinatus[b]	Infraspinatus[ab]
	7.5	7.2	6.6
3	Gluteus medius[ab]	Longissimus lumborum[b]	Psoas major[bc]
	7.4	6.9	5.9
4	Semimembranosus[abc]	Rectus femoris[b]	Longissimus lumborum[cd]
	7.4	6.9	5.2
5	Triceps brachii[abcd]	Serratus ventralis[bc]	Deep pectoral[cd]
	7.3	6.5	5.1
6	Rectus femoris[bcde]	Gluteus medius[cd]	Supraspinatus[cd]
	7.1	5.8	5.1
7	Longissimus lumborum[bcde]	Triceps brachii[cd]	Triceps brachii[de]
	7.1	5.8	4.9
8	Serratus ventralis[bcde]	Supraspinatus[d]	Rectus femoris[de]
	6.9	5.1	4.8
9	Infraspinatus[cde]	Semitendinosus[de]	Gluteus medius[de]
	6.8	5.0	4.7
10	Semitendinosus[cde]	Biceps femoris[de]	Biceps femoris[de]
	6.8	4.9	4.7
11	Deep pectoral[de]	Semimembranosus[ef]	Semitendinosus[e]
	6.7	4.0	4.2
12	Supraspinatus[e]	Deep pectoral[f]	Semimembranosus[e]
	6.6	3.8	4.1

[a-f]Means within a column with same superscript are not significantly different ($P > 0.05$).
[g]The brown, roasted, aromatic flavor generally associated with beef cooked by dry heat; measured at its peak point during initial 10 chews.
[h]Ease with which a sample is masticated until it would be swallowed.
[i]Moisture in sample perceived at its peak during initial 10 chews.

BEEF EMPIRE CARCASS MERIT DAYS INDEX SYSTEM

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Summary

Kansas State University, in cooperation with the Beef Empire Days committee, developed a new beef carcass index system for 1991, incorporating yield and quality traits as indicators of carcass merit. Development of the system considered current industry and consumer demands in a critical evaluation of final carcass ranking. The index starts from 100 points and applies positive and negative adjustments for hot carcass weight; ribeye area; adjusted 12th rib fat thickness; percent kidney, pelvic, and heart fat; and quality grade. The index was first used in 1991.

(Key Words: Beef, Carcass, Index, Quality, Cutability.)

Introduction

The annual Beef Empire Days carcass show provides an opportunity to educate both producers and packers. The show's former carcass ranking system had been criticized for its complexity. Kansas State researchers were asked to develop a ranking method that would accurately reflect the needs of the meat packing industry, while also being meaningful to the producers.

Description of Index System

The index starts with 100 points. Positive and negative adjustments are made based on hot carcass weight; adjusted backfat; ribeye area; internal fat (kidney, pelvic and heart fat); and quality grade. The system is easily adapted to a computer spreadsheet. Following is a description of the adjustment procedures.

Hot Carcass Weight

We defined the optimum hot carcass weight ranges as 700 to 750 lb for steers and 650 to 700 lb for heifers. Outside of those ranges the carcass indices are adjusted downward as follows:

Heifer Adjustment = –146.186 + (0.433725 × HCW) – (0.000321276 × HCW^2)

or

Steer Adjustment = –168.673 + (0.465860 × HCW) – (0.000321283 × HCW^2), where HCW = hot carcass weight in lbs.

These adjustments are illustrated in Figure 1.

Adjusted Twelfth Rib Fat Thickness

The optimum 12th rib fat thickness is defined as .30 in., which corresponds to a preliminary yield grade of 2.75 for both heifers and steers. Indices are adjusted according to the scale in Table 1. The adjustment is illustrated in Figure 2.

Ribeye Area

For each carcass, a ribeye requirement is calculated based on hot carcass weight. The requirement is calculated for both steers and heifers by the formula:

[1]Beef Empire Days Committee, Garden City, KS.

Ribeye req. = 4.8 + (0.012 × HCW).

Sample values are given in Table 2. Figure 3 illustrates the relationship between hot carcass weight and required ribeye area.

For every sq. in. that an entry's actual ribeye area deviates from the required value, a 5-point adjustment is made to the index. For example, the adjustment for a 600-lb carcass with a 14.0 sq. in. ribeye would be calculated as follows:

14.0 sq in (actual ribeye area)
–12.0 sq in (requirement for a 600-lb carcass)
2.0 sq in
× 5 points per sq in
+10 point adjustment to the index

For a 750-lb carcass with an 11.0 sq. in. ribeye, the adjustment would be:

11.0 sq in (actual ribeye area)
–13.8 sq in (requirement for a 750-lb carcass)
–2.8 sq in
× 5 points per sq in
–14 point adjustment to the index

We established ribeye areas of 16.0 and 15.4 sq. in. for steers and heifers, respectively, as the maximum allowed for full credit. Carcasses with ribeye areas greater than those are discounted 5 points for each sq. in. the ribeye area exceeds the maximum. For example, an 800-lb heifer carcass would have a required ribeye area of 14.4 sq. in. If that carcass actually had a 16.0-sq. in. ribeye, it would be adjusted as follows:

1. Adjustment for maximum ribeye area.

15.4 sq in (maximum for heifers)
–14.4 sq in (requirement for an 800-lb carcass)
1.0 sq in
× 5 points per sq in
+5 points

2. Discount for amount over the maximum ribeye area.

16.0 sq in (actual ribeye area)
–15.4 sq in (maximum for heifers)
0.6 sq in
× 5 points per sq in
– 3 points

5 – 3 = 2 points final adjustment for ribeye area

Kidney, Pelvic, and Heart Fat Adjustments

Internal fat adjustments are given in Table 1 and illustrated in Figure 4. The "base" percent kidney, pelvic, heart fat is 2.5% of the HCW, with small positive adjustments for smaller values and large penalties for larger values.

Quality Grade

To be competitive in the carcass show, a carcass must grade at least LOW CHOICE. In the index system, severe penalties are assessed to carcasses that grade below low Choice; small bonuses are given to carcasses that grade above low Choice (Table 1 and Figure 5).

The numerical (positive or negative) sum of all adjustments is added to 100 to obtain the final index for a carcass. Then carcasses are ranked (highest to lowest) according to their indexes. Three examples of all adjustments are found in Table 3.

Table 2. Ribeye Area Requirements for Specific Hot Carcass Weights

Hot Carcass Weight (lbs)	Requirement (sq in.)
500	10.8
550	11.4
600	12.0
650	12.6
700	13.2
750	13.8
800	14.4
850	15.0
900	15.6
950	16.2
1000	16.8

Table 1. Index Adjustments for Fat Depth, % KPH Fat, and Quality Grade

12th Rib Fat (in.)	Adj.	% KPH Fat	Adj.	Quality Grade	Adj.
0.00 - 0.03	-27	0.5	3.0	Standard	-72
0.04 - 0.07	-22	1.0	2.5	Low Select	-36
0.08 - 0.11	-17	1.5	2.0	High Select	-21
0.12 - 0.15	-12	2.0	1.0	Low Choice	0
0.16 - 0.19	-8	2.5	0.0	Ave. Choice	4
0.20 - 0.23	-4	3.0	-2.0	High Choice	6
0.24 - 0.27	-2	3.5	-4.0	Prime	8
0.28 - 0.31	0	4.0	-6.0		
0.32 - 0.35	-1	4.5	-8.0		
0.36 - 0.39	-2	>4.5	-10.0		
0.40 - 0.43	-5				
0.44 - 0.47	-9				
0.48 - 0.51	-14				
0.52 - 0.55	-19				
0.56 - 0.59	-24				
0.60 - 0.63	-29				
0.64 - 0.67	-35				
0.68 - 0.71	-41				
0.72 - 0.75	-47				
0.76 - 0.79	-53				
> 0.79	-60				

Table 3. Index Adjustments for Three Steer Carcasses

Hot Carcass Weight (lb)	Adj.	12th Rib Fat (in.)	Adj.	Ribeye Area (sq in.)	Adj.	KPH (%)	Adj.	Quality Grade	Adj.	Final Index Value
655	-1.4	.27	-2.0	13.8	+5.7	3.0	-2.0	Ch-	0.0	100.3
855	-5.2	.30	0.0	16.0	+4.7	2.0	+1.0	Ch+	+6.0	106.5
750	0.0	.45	-9.0	11.0	-14.0	3.5	-4.0	Se+	-21.0	52.0

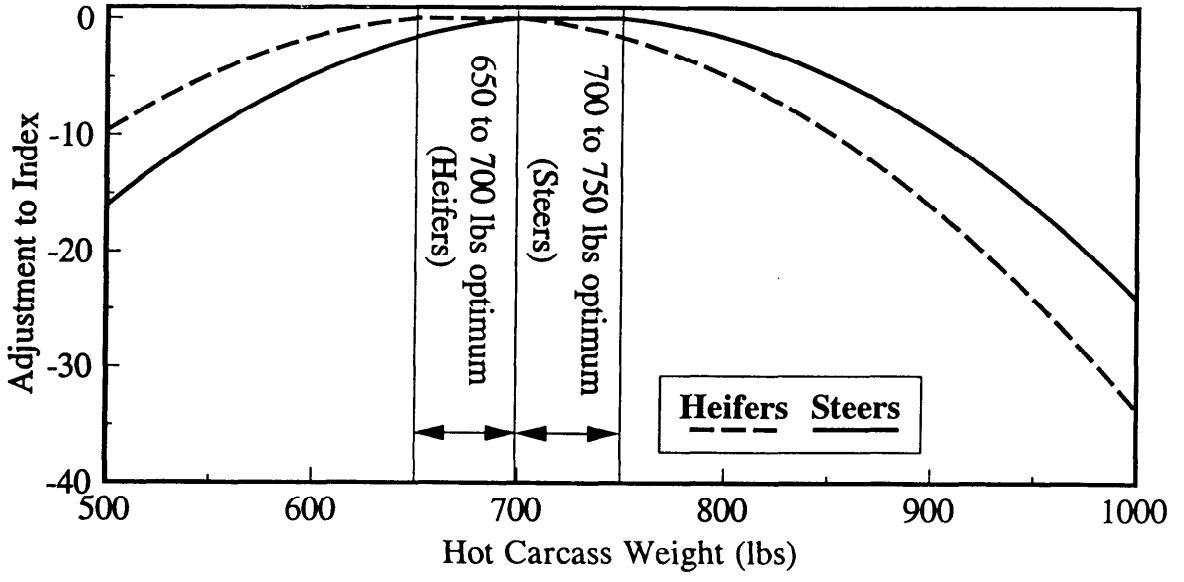


Figure 1. Adjustment for Hot Carcass Weight.

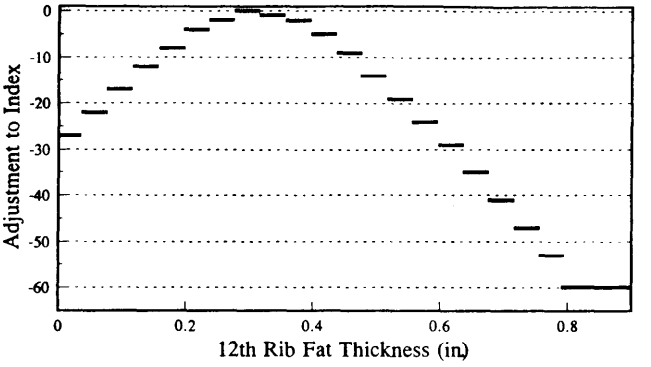


Figure 2. Adjustments for Fat Thickness.

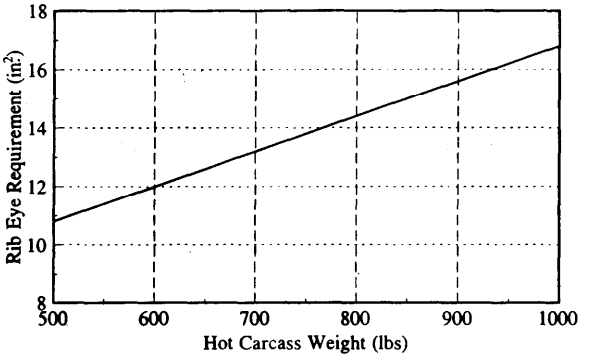


Figure 3. Ribeye Area Requirements.

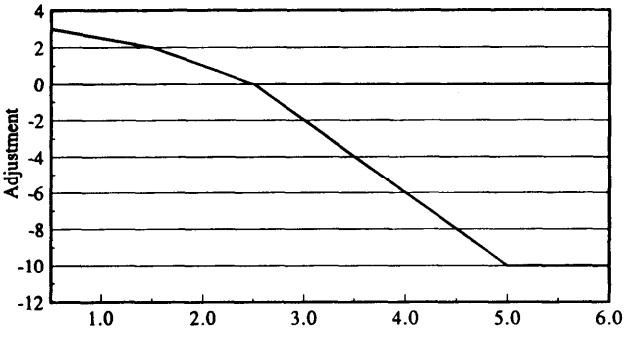


Figure 4. Adjustments for Kidney, Pelvic and Heart Fat.

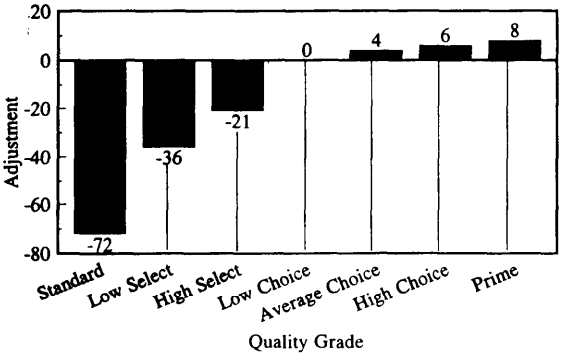


Figure 5. Adjustments for Quality Grade.

BIOLOGICAL VARIABILITY AND STATISTICAL EVALUATION OF DATA

The variability among individual animals in an experiment leads to problems in interpreting the results. Animals on treatment X may have a higher average daily gain than those on treatment Y, but variability within the groups may indicate that the difference between X and Y is not the result of the treatment alone. You can never be totally sure that the difference you observe is due to the treatment, but statistical analysis lets researchers calculate the probability that such differences are from chance rather than from the treatment.

In some articles, you will see the notation "$P < .05$." That means the probability that the observed difference was due to chance is less than 5%. If two averages are said to be "significantly different," the probability is less than 5% that the difference is due to chance — the probability exceeds 95% that the difference is true and was caused by the treatment.

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

You may see an average given as $2.5 \pm .1$. The 2.5 is the average; .1 is the "standard error." That means there is a 68% probability that the "true" mean (based on an unlimited number of animals) will be between 2.4 and 2.6. "Standard deviation" is a measure of variability in a set of data. One standard deviation on each side of the mean is expected to contain 68% of the observations.

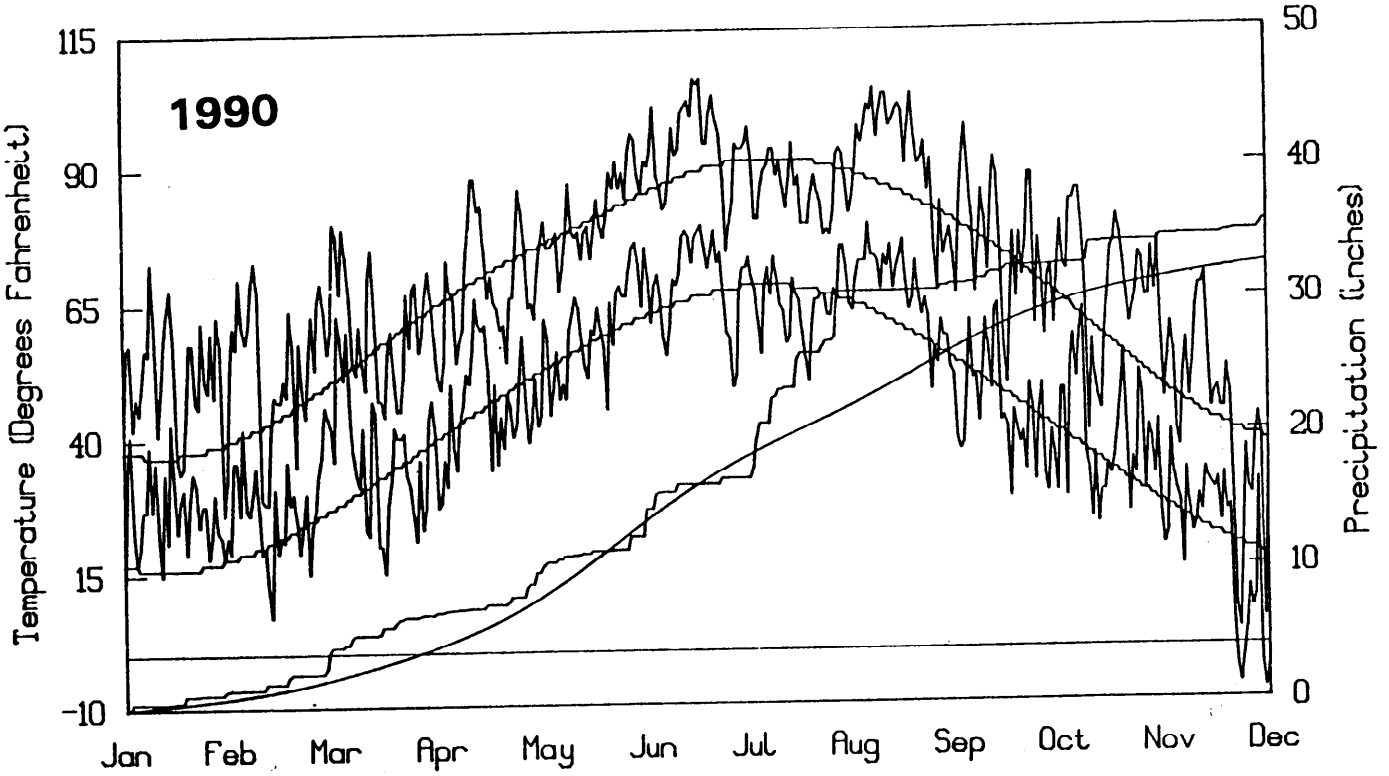
Many animals per treatment, replicating treatments several times, and using uniform animals all increase the probability of finding real differences when they actually exist. Statistical analysis allows more valid interpretation of the results, regardless of the number of animals in an experiment. In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

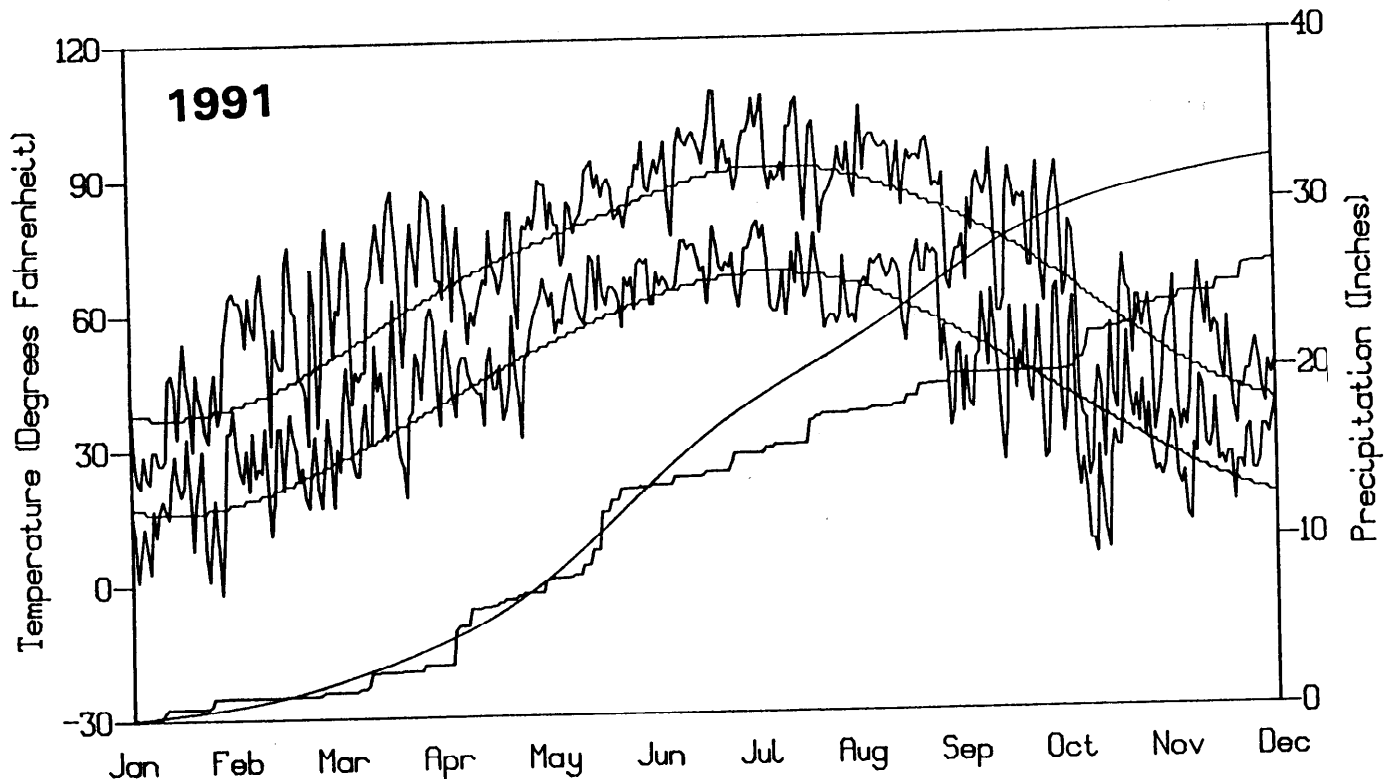
In most experiments, the statistical analysis is too complex to present in the space available. Contact the authors if you need further statistical information.

WEATHER DATA, 1990-1991

On the following page are graphs of the 1990 and 1991 Manhattan weather. They were produced by the Kansas Agricultural Experiment Station Weather Data Library. The smooth line that starts in the lower left corner of each graph is the normal accumulated precipitation since January 1. The rough line starting in the lower left corner represents actual accumulated precipitation. A long horizontal section of that line represents time during which no precipitation fell. A vertical section represents precipitation. The other two smooth lines represent average daily high and low temperatures, and the rough lines represent actual highs and lows.

These graphs are included because much of the data in this publication, especially data on animal maintenance requirements and forage yields, can be influenced by weather. Weather graphs have been included in Cattlemen's Day publications for the past seven years.





Graphical Weather Summary for Manhattan, Kansas

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