1995
CATTLEMEN'S DAY

Report of Progress 727
Agricultural Experiment Station
Kansas State University, Manhattan
Marc A. Johnson, Director

CONTENTS

RANGE LIVESTOCK NUTRITION

GROWING AND FINISHING NUTRITION

MANAGEMENT

HARVESTED FORAGES

MEATS AND FOOD SAFETY

BREEDING AND GENETICS

REPRODUCTION

Cattlemen's Day 1995

EFFECTS OF GRAZING SYSTEM AND STOCKING RATE
ON COW-CALF PERFORMANCE IN THE FLINT HILLS

K. C. Olson, R. C. Cochran, D. C. Hartnett [1],
C. E. Owensby [2], and D. E. Johnson [3]

Summary

A 6-year study was designed to measure the influences of stocking rate and grazing system on performance of cow-calf pairs grazing tallgrass prairie. This paper summarizes the initial 3 years. Late-season rest-rotation was compared to continuous grazing over low, moderate, and high stocking rates. No differences (P>.10) were observed in body weight of cows or calves as a result of grazing system or stocking rate. However, calf weaning weight tended (P=.20) to be greater with continuous grazing than with late season rest-rotation. Cow body condition score was unaffected (P>.10) by stocking rate or grazing system. Conception rates were also similar between stocking rates and grazing systems. This preliminary information suggests that application of a late-season rest-rotation grazing system will support cow-calf performance comparable to that with a continuous system at a similar stocking rate.

(Key Words: Stocking Rate, Grazing Systems, Cow-Calf Performance.)

Introduction

Ideally, systems of grazing management should be designed to accommodate seasonal changes in plant physiology. During mid and late summer, warm-season grasses replace carbohydrate reserves spent on growth and seed production. By allowing areas of pasture to rest during this period, plant vigor may be improved. Thus, a system of late-season rest-rotation may be well suited for use in the tallgrass prairie region. However, when natural grazing activity is manipulated, cattle weight gains and reproductive performance often decrease.

By definition, specialized grazing systems involve application of special management practices (e.g., rotation, rest, etc.) for all or part of the grazing season. Such management practices may affect forage availability, which, in turn, may limit forage intake and animal performance. The likelihood that a change in forage availability will influence performance depends heavily on stocking rate. Thus, comparison of grazing systems at a single, static stocking rate may be misleading. Our objective for this research trial was to compare performance of cow-calf pairs under either a continuous grazing or a late-season rest-rotation system at high, moderate, and low stocking rates.

Experimental Procedures

Thirteen native tallgrass pastures, located at the Kansas State University Range Research Unit, were used to compare continuous (C) vs late-season rest-rotation (LSRR) grazing at low, moderate, and high stocking rates (approximately 9.6, 6.9, and 4.5 acres/cow-calf pair, respectively). Stocking rates were based on a 16 year study evaluating optimal stocking rates for young, growing steers. Cows with calves at side (145 pairs/year) were stratified by number of parities, body condition, and weight and assigned randomly to pastures each spring. Four pastures were assigned to be grazed at each stocking rate. A single pasture was left

---

[1]Division of Biology.
[2]Department of Agronomy.
[3]Department of Statistics.

ungrazed to monitor vegetation response. Three pastures, one at each stocking rate, were grazed continuously during the 1992 - 1994 growing seasons. Nine pastures were designated for the late-season rest-rotation (LSRR) treatment, three pastures per stocking rate. Cattle assigned to an LSRR treatment were allowed access to all three pastures within a given stocking rate from May 1 to July 15 each year and then restricted to two of the pastures from July 15 to October 1. Pastures allowed rest within each LSRR system were rotated, so that each paddock was rested once during the 3-year period. During the breeding season (May 15 to July 15), cattle were combined within stocking rate and rotated through treatment pastures on an equal time per unit area basis. Two complete rotation cycles were completed each year. This was done to reduce the number of bulls needed. Cows and calves were weighed at the beginning, middle, and end of the grazing season, and cow body condition scores were determined. Pregnancy was ascertained by rectal palpation each October. Data were analyzed for effects of grazing system and stocking rate using a least-squares multiple regression approach.

Results and Discussion

Although cow-calf pairs assigned to the LSRR system were restricted to two-thirds of the available forage base for the latter half of the grazing season, cow body weights or condition scores did not differ between grazing systems at any data collection time (Table 1). Alteration of nutrient intake as a result

of the LSRR treatment was apparently insufficient to cause a significant decrease in cow weight gain. However, calf body weight at the end of the grazing season tended (P=.20) to be greater under continuous grazing. Because most of the difference in calf gain occurred between July 15 and October 1, the effect on calf performance may have been the result of reduced forage availability and/or quality on LSRR pastures during the second half of the grazing season. These factors may have combined to reduce milk yield of dams or decrease calf forage intake and diet quality. Conception rates were not different between grazing systems (Table 1). However, bull exposure was confined to the first half of the grazing season when forage quality was highest. Furthermore, cattle were combined by stocking rate, across grazing systems, during the 60-day breeding season in order to reduce the number of bulls needed. Thus, the principle effects of grazing system on performance would be expected during the latter half of the grazing season. No differences were detected in weight of cows or calves or body condition score of cows as a result of stocking rate (Table 2). Conception rate was also not statistically different between stocking rates. These preliminary results suggest that a late-season rest-rotation grazing system will support cow-calf performance comparable to that with continuous grazing when managed at a similar stocking rate. However, the ultimate decision to use a particular grazing system or stocking rate must consider impacts on both livestock and rangeland. Concurrent measurements of range plant response are being collected and will become available to aid in the development of grazing management guidelines.

Table 1.   Influence of Grazing System on Performance of Cow-Calf Pairs

	Grazing System			
Item	Continuous	Late-Season Rest-Rotation	SEM	P-Value
Cow BW, lb				
May 1	873	875	12.8	.90
July 15	1023	1034	8.4	.51
Oct 1	1065	1060	15.7	.89
Calf BW, lb				
May 1	139	139	0.9	.27
July 15	340	335	4.4	.61
Oct 1	522	503	7.7	.20
Cow body condition score[a]				
May 1	4.41	4.39	0.04	.83
July 15	5.06	5.07	0.08	.93
Oct 1	5.30	5.19	0.10	.53
Conception rate	99%	94%	—	.54

[a]Body condition score scale 1 to 9 (1 = very thin, 9 = very fat).

Table 2.   Influence of Stocking Rate on Performance of Cow-Calf Pairs

	Stocking Rate				
Item	Low	Moderate	High	SEM	P-Value
Cow BW, lb					
May 1	877	872	873	10.6	.91
July 15	1033	1035	1018		.94
Oct 1	1077	1055	1056	13.2	.89
Calf BW, lb					
May 1	135	139	142	2.2	.28
July 15	339	338	333	6.4	.89
Oct 1	520	509	507	7.7	.85
Cow body condition score[a]					
May 1	4.40	4.40	4.40	0.07	.98
July 15	5.01	5.19	5.00	0.09	.91
Oct 1	5.29	5.24	5.22	0.11	.87
Conception rate	96%	97%	94%	—	.54

[a]Body condition score scale 1 to 9 (1 = very thin, 9 = very fat).

Cattlemen's Day 1995

INFLUENCE OF DEGRADABLE INTAKE PROTEIN ON SITE AND EXTENT OF DIGESTION IN BEEF COWS CONSUMING LOW-QUALITY, TALLGRASS-PRAIRIE FORAGE [1]

H. H. Köster, R. C. Cochran, E. C. Titgemeyer, E. S. Vanzant[2], and G. St Jean[3]

Summary

Five Angus × Hereford cows with ruminal and duodenal fistulas were used to evaluate the effect of providing increasing degradable intake protein (DIP) on the site and extent of digestion of dormant, tallgrass-prairie forage. The DIP was provided from sodium caseinate, divided in two equal portions and infused intraruminally twice daily. Levels of DIP were: 0, 180, 360, 540, and 720 g/day. Supplemental DIP generally improved utilization of low quality forage, with maximum effects on duodenal N flow and forage organic matter intake at 540 g DIP/day.

(Key Words: Beef Cows, Intake, Digestibility, Forage.)

Introduction

In many parts of the Western United States, beef cattle are maintained on low-quality forages. To optimize the utilization of these forages and maintain acceptable animal performance, it is frequently necessary to provide supplemental nutrients that will enhance intake and fiber digestion. Generally, protein is considered to be "first limiting" to the utilization of low-quality forage. However, for ruminal microorganisms to be able to use protein for their growth and, hence, degradation of forage fiber, protein must be in a form that will degrade in the rumen (i.e., degradable intake protein [DIP]). Our objective was to define the amount of DIP required to optimize the utilization of low-quality, tallgrass-prairie forage consumed by mature beef cows.

Experimental Procedures

Five Angus × Hereford cows (1296 lb) with ruminal and duodenal fistulas were housed in individual tie stalls and had unlimited access to dormant tallgrass-prairie forage (1.9% crude protein [CP]; 77% neutral detergent fiber [NDF]). Sodium caseinate (casein; 90% CP) was used to provide DIP because it is high-quality protein that is almost entirely degraded in the rumen. The casein was solubilized in water (7 liters/day), divided in two equal portions, and infused intraruminally at 6:30 AM and 6:30 PM immediately before feeding forage. DIP levels were 0, 180, 360, 540, and 720 g/day. Acid insoluble ash was used as an indigestible marker for calculating digestion values. Cows were allowed to adapt to diets for 14 days during each of the five experimental periods. Adaptation was followed by a 4-day sampling period for intake and digesta. On days 16 through 18, duodenal and fecal grab samples were collected every 6 hours (collection time advanced 2 hours each day). Fluid dilution rate was determined by pulse dosing (just before the morning feeding) and collecting ruminal fluid samples at 3, 6, 9, 12, and 24 hours after dosing.

Results and Discussion

Forage organic matter (OM), digestible OM, and total N intake increased in response to increasing DIP levels, although the rate of increase was less with greater amounts of DIP supplementation (quadratic effect, P<.01; Table 1). The magnitude of this response underlines the importance of providing adequate degradable protein for beef cattle to make the best use of low-quality forages. The increased forage intake in response to supplementation with DIP was related at least partially to concomitant increases in rate of passage (increased fluid dilution rate; linear, P=.02) and forage digestibility. Apparent digestibility of ruminal OM and NDF, as well as total tract digestibility of OM and NDF, tended to increase with the addition of 180 to 360 g DIP/day, but in some cases declined when greater amounts of DIP were infused. The

initial digestibility increase probably was due to additional supplemental protein stimulating growth of fiber-digesting microbes. At the same time, the increases in both intake and passage rate with the higher DIP infusion levels resulted in a shorter retention time of forage in the rumen, leaving less time for the microbes to digest fiber. Although maximum fiber digestibility was observed at 180 to 360 g DIP/day, total duodenal N flow (which represents the protein arriving at the small intestine) peaked at 540 g DIP/day, but declined slightly at 720 g DIP/day (quadratic effect, P<.01). Because the amount of protein flowing into the small intestine and forage intake were not increased when the supplemental DIP exceeded 540 g/day, and because digestible OM intake changed little between 540 and 720 g/day, 540 g of DIP/day is probably adequate to optimize use of low-quality, tallgrass prairie by mature beef cows.

Table 1.   Effect of Increasing Amount of Degradable Intake Protein (DIP) on Intake, Flow, and Digestibility in Beef Cows Fed Dormant Tallgrass-Prairie Forage

Item	DIP Level (g/day)					SEM	Contrasts [a]		
	0	180	360	540	720		L	Q	C
OM intake	---------------- g/kg BW $^{.75}$ --------------------								
Forage	29.3	48.1	57.3	64.7	61.6	2.72	<.01	<.01	.91
Casein	–	1.62	3.24	4.86	6.48	–			
Total	29.30	49.72	60.54	68.56	68.08	2.73	<.01	<.01	.91
Digestible OM intake	12.9	26.8	33.1	35.5	37.4	1.77	<.01	<.01	.26
Total N intake, g/d	13.4	48.5	80.5	110.9	137.8	1.23	<.01	<.01	.94
Ruminal digestibility	---------------- % of intake --------------------								
Apparent OM	43.3	47.3	47.4	45.3	47.4	1.36	.22	.28	.12
True OM	46.1	52.4	54.4	53.1	58.1	1.29	<.016	.30	.03
NDF	47.2	55.6	56.7	53.2	54.6	1.15	.01	<.01	.01
Apparent N	-139.5	-34.9	-15.0	2.0	23.2	16.20	<.01	.03	.14
Duodenal flow	------------------- g/day ----------------------								
Total N	30.7	65.6	92.4	111.7	109.3	5.83	<.01	<.01	.51
Microbial N	19.3	46.3	67.0	80.0	90.4	6.06	<.01	.12	.86
Ammonia N	.31	.77	1.94	4.20	4.77	.35	<.01	.36	.07
Nonmicrobial- nonammonia N	11.1	18.5	23.5	27.5	14.1	2.87	.17	<.01	.16
ADIN	6.9	9.8	12.3	11.4	12.0	.91	<.01	.05	.57
Microbial efficiency, g N /kg OM truly digested	12.2	15.2	17.0	19.1	20.0	1.21	<.010	.43	.98
Total tract digestibility	---------------------- % ------------------------								
OM	44.6	54.3	54.2	51.3	53.8	2.27	.09	.09	.08
NDF	50.3	58.7	57.9	54.6	55.6	1.85	.34	.04	.06
N	-39.8	39.0	51.1	60.5	70.4	6.96	<.01	<.01	.02
Fluid dilution rate %/hour	4.74	5.47	6.29	7.07	6.39	.48	.02	.16	.37

[a]Probability of a greater F value. L = linear change with increasing DIP, Q = quadratic change with increasing DIP, C = cubic change with increasing DIP.

Cattlemen's Day 1995

INFLUENCE OF INCREASING PROPORTION OF SUPPLEMENTAL NITROGEN FROM UREA ON INTAKE AND FERMENTATION CHARACTERISTICS IN BEEF STEERS CONSUMING LOW-QUALITY, TALLGRASS-PRAIRIE FORAGE [1]

H. H. Köster, R. C. Cochran, E. C. Titgemeyer,
E. S. Vanzant [2], T. G. Nagaraja,
K. K. Kreikemeier [3], and G. St Jean [4]

Summary

Five ruminally and duodenally fistulated Angus × Hereford steers were used to determine intake and fermentation responses associated with increasing the proportion of supplemental degradable intake protein (DIP) provided by urea. Steers had free access to a dormant, tallgrass-prairie forage. The supplemental DIP was provided by sodium caseinate and (or) urea, at a level that was determined previously to optimize use of a similar forage. Supplemental DIP was balanced with corn starch to provide a final supplement of 40% crude protein. Percentages of DIP from urea were: 0, 25, 50, 75, and 100%. Supplements were given intraruminally. Increasing the percentage of urea as supplemental DIP from urea did not significantly affect forage DM intake; however, fermentation characteristics changed.

(Key Words: Beef Cows, Intake, Rumen Fermentation, Forage.)

Introduction

Previous research has demonstrated limited utilization of low-quality forages when concentrations of ruminal ammonia and other microbial nutrients are low. Providing protein sources with a high concentration of degradable intake protein (DIP) like soybean meal addressed such limitations, but these natural protein sources are expensive. To minimize supplement costs, previous research has evaluated the efficacy of non-protein nitrogen (NPN, for example urea) for replacing natural proteins as a supplemental DIP source. Generally, response to NPN as a source of supplemental DIP has been poorer than response to natural protein when fed in supplements for livestock on low-quality forages. However, the NPN level in many previous studies was arbitrarily chosen and often represented a high percentage of the total crude protein. It may be possible to include low levels of urea in range supplements without significant loss of animal performance. This experiment represents the first in a series designed to identify optimal level of urea inclusion in "protein" supplements fed to beef cattle eating low-quality, tallgrass-prairie forage.

Experimental Procedures

Five ruminally and duodenally fistulated Angus × Hereford steers (904 lb) were penned in individual tie stalls with unlimited access to low-quality, tallgrass-prairie forage. Steers were supplemented with an amount of DIP previously determined to maximize utilization of a similar forage (.92 g/kg BW). The DIP (380 g/day) was comprised of sodium caseinate (casein; 90% CP) and (or) urea (287% CP) and was balanced with corn starch (0% CP) to provide a final supplement of 40% CP. Percentages of DIP from urea were: 0, 25, 50, 75, and 100%. The N:S ratio was maintained at 10:1. The total daily supplement was divided into two equal portions, and administered intraruminally at 6:30 AM and 6:30 PM, immediately

before feeding forage. Supplements were given intraruminally because they were powdery and infeasible to pellet. Steers were adapted to diets for 14 days, followed by 4 days of voluntary intake measurement and digesta sampling. Ruminal fluid and DM contents were determined by manually evacuating the rumen just before (0 hour) and 4 hours after feeding and infusing supplements. Fluid dilution rate, pH, ammonia N (NH_3 N), and volatile fatty acid (VFA) concentrations were determined on ruminal fluid samples collected at feeding (0 hour) and 3, 6, 9, 12, and 24 hours after feeding.

Results and Discussion

Forage DM intake did not change ($P \geq .40$) with increasing urea levels, indicating that the replacement of natural protein with urea, per se, will not restrict nutrient intake from forages. However, because supplements were given intraruminally, effects on supplement palatability were

not evaluated. Other research where high (> 40-50% of the CP equivalent) concentrations of urea have been used in grain-based supplements has reported occasional supplement refusal. If supplement consumption was compromised, forage intake likely would be reduced. The lack of change in forage intake in our study agrees with the lack of treatment effect on ruminal DM and fluid contents ($P \geq .20$) as well as the lack of response for fluid dilution rate ($P \geq .38$). Increasing urea proportions did not affect ($P \geq .12$) pH or total VFA concentration. However, linear increases ($P \leq .02$) in ruminal NH_3 N and molar percent acetate were observed with increasing percentage of urea in supplement. In contrast, all other VFA's decreased ($P \leq .05$) as urea increased, except for propionate, which did not change ($P \geq .18$). In conclusion, although increasing percentage of supplemental DIP from urea did not affect forage DM intake, changes occurred in fermentation characteristics. More information regarding effects of level of urea inclusion on digestion, supplement palatability, and livestock performance is needed.

Table 1. Effect of Increasing Amount of Degradable Intake Protein (DIP) on Intake, Ruminal Contents, Dilution Rate, and Fermentation Characteristics in Beef Steers Fed Dormant Tallgrass-Prairie Forage

	Casein CP:Urea CP (%)						Contrasts [a]		
Item	100:0	75:25	50:50	25:75	0:100	SEM	L	Q	C
Forage DM intake, g/kg BW $^{.75}$	64.2	64.4	61.8	61.9	61.2	2.98	.40	.94	.84
Ruminal DM contents, g/kg BW	20.6	21.0	20.8	21.0	21.9	.62	.20	.56	.56
Ruminal fluid contents, g/kg BW	132.0	126.0	132.0	129.0	135.0	4.64	.51	.38	.68
Fluid dilution rate %/hour	5.34	5.31	5.38	4.73	5.62	.61	.99	.64	.50
pH	6.50	6.43	6.42	6.52	6.52	.06	.48	.32	.41
Ammonia N, mM	3.32	3.24	3.28	4.29	5.48	.70	.02	.24	.19
Total VFA, mM	80.4	88.5	80.3	79.1	83.8	4.17	.85	.99	.12
————mol/100mol————									
Acetate	73.4	75.0	76.2	75.6	76.5	.62	<.01	.19	.37
Propionate	15.0	15.1	14.8	15.5	15.7	.43	.18	.47	.98
Butyrate	7.03	6.54	6.19	6.54	6.20	.20	.01	.19	.23
Isobutyrate	1.50	1.16	.99	.84	.61	.07	<.01	.36	.26
Valerate	1.40	1.04	.89	.78	.58	.05	<.01	.05	.08
Isovalerate	1.66	1.16	.95	.77	.42	.09	<.01	.31	.12
Acetate:propionate	4.91	4.96	5.19	4.89	4.93	.18	.97	.42	.80

[a]Probability of a greater F value. L = linear change with increasing DIP, Q = quadratic change with increasing DIP, C = cubic change with increasing DIP.

7

Cattlemen's Day 1995

RESPONSE OF PREGNANT BEEF COWS TO UNDEGRADABLE INTAKE PROTEIN FED IN EXCESS OF THE DEGRADABLE INTAKE PROTEIN REQUIREMENT [1]

T. J. Jones, R. C. Cochran, K. C. Olson,
H. H. Köster, E. S. Vanzant, and E. C. Titgemeyer

Summary

Two concurrent experiments were conducted to evaluate the effect on performance and forage intake of increasing the supply of undegradable intake protein (UIP) to pregnant beef cows already receiving sufficient degradable intake protein (DIP) to maximize forage intake. Three supplements were fed at .34% BW/day, providing .092% BW/day of DIP (level determined in previous study to maximize forage intake) and .042, .059, and .077% BW/day of UIP (low, moderate, and high UIP, respectively). In study 1, ad libitum tallgrass-prairie forage intake was measured daily from 12/1/93 to 2/10/94 using 18 pregnant Angus × Hereford cows. Forage intake steadily increased throughout the study, but did not vary between supplements for the first 6 weeks. However, forage intake was less during the last 4 weeks for cows offered the moderate and high UIP supplements. In study 2, 117 pregnant Angus × Hereford cows grazing dormant bluestem range were used to determine the impact of the supplements on body weight and body condition changes. Level of UIP in the supplement exerted only minimal effects on cumulative or 28-day interval changes in body weight or condition.

(Key Words: Beef Cows, Intake, Protein Supplementation.)

Introduction

Feeding supplements with a high concentration of degradable intake protein (DIP) to pregnant beef cows grazing dormant rangeland increases forage intake and enhances performance. In addition, some previous research at KSU noted that performance of pregnant cows grazing winter range improved when they were fed supplements that contained more undegradable intake protein (UIP; for example, dehydrated alfalfa) than would generally exist in grain/oilseed meal mixtures. This could indicate that, even in situations where the DIP requirement (to maximize forage intake) is met, the metabolizable protein reaching the small intestine may not fully meet the needs of a pregnant cow. Recent studies at Kansas State have attempted to identify the amount of DIP required to optimize the use of low-quality, tallgrass-prairie forage. The present study was designed to evaluate whether providing UIP in addition to the DIP requirement would improve forage intake and (or) performance.

Experimental Procedures

Angus × Hereford cows from the same herd and in the final 3 to 5 months of pregnancy were used in both studies. Three different supplements that varied in the amount of UIP were provided. The proportion of DIP was the same in all supplements (27% of supplement DM) and provided an amount of DIP (.092 %BW) that was previously determined to maximize forage intake in nonpregnant cows fed a similar forage. Supplements were formulated with soybean meal, sorghum grain, molasses, blood meal, and corn gluten meal and were designated: 1) low UIP (UIP fed at .042 %BW), 2) moderate UIP (UIP fed at .059 %BW), and 3) high UIP (UIP fed at .077 %BW). Daily supplement was fed at .34 %BW (DM basis).

In study 1, 18 cows (940 lb) were blocked by weight and assigned to treatments. Six steers (650 lb) also were blocked by weight as environmental controls (steers were fed the low UIP supplement). Cattle were individually fed dormant tallgrass-prairie forage ad libitum. Daily forage intake was measured (12/l/93 to 2/10/94) and summarized as means for five 2-week periods. In study 2, 117 cows (1160 lb) grazing in three tallgrass prairie pastures were assigned randomly to supplement treatments. All supplement treatments were present within each pasture. Body weight and body condition were measured at 28-day intervals from 11/22/93 through 2/10/94, at calving (day 103), 2 weeks before the beginning of the breeding season (day 154), and at weaning (day 194).

Results and Discussion

In study 1, a sex × time interaction (P=.07) occurred for forage intake (Figure 1). Forage intake increased and was similar between the cows and steers for the first three periods, suggesting that increased

intake was largely due to the environmental conditions. However, forage intake differed between the sexes for periods 4 (P=.07) and 5 (P<.0l), with cow intake increasing with increased gestational length and steer intake plateauing. In addition, a level of UIP level × time interaction (P<.05) occurred for dry matter intake (Figure 2) . No differences (P>.10) occurred in the forage intake among supplemented groups in the first three 2-week periods. However, in periods 4 and 5, forage intake tended (P< .10) to be lower for cows fed higher levels of UIP in the supplements. This may imply that amount or composition of nitrogenous constituents arriving at the small intestine has a role in the peripheral control of forage intake. In study 2, amount of UIP in the supplement (Table 1) exhibited only a few sporadic effects on cow body weight or condition scores. Similarly, supplement type did not affect (P>.10) calf birth weight or ADG. Results from this study suggest that for cows in late gestation and fed low-quality, tallgrass prairie forage, the combination of microbial protein and UIP (from supplement and forage) flowing into the small intestine with the low UIP treatment was adequate to meet the metabolizable protein requirement.

Sex x Time (P=.07) [a] Difference between sexes, (P<.05)
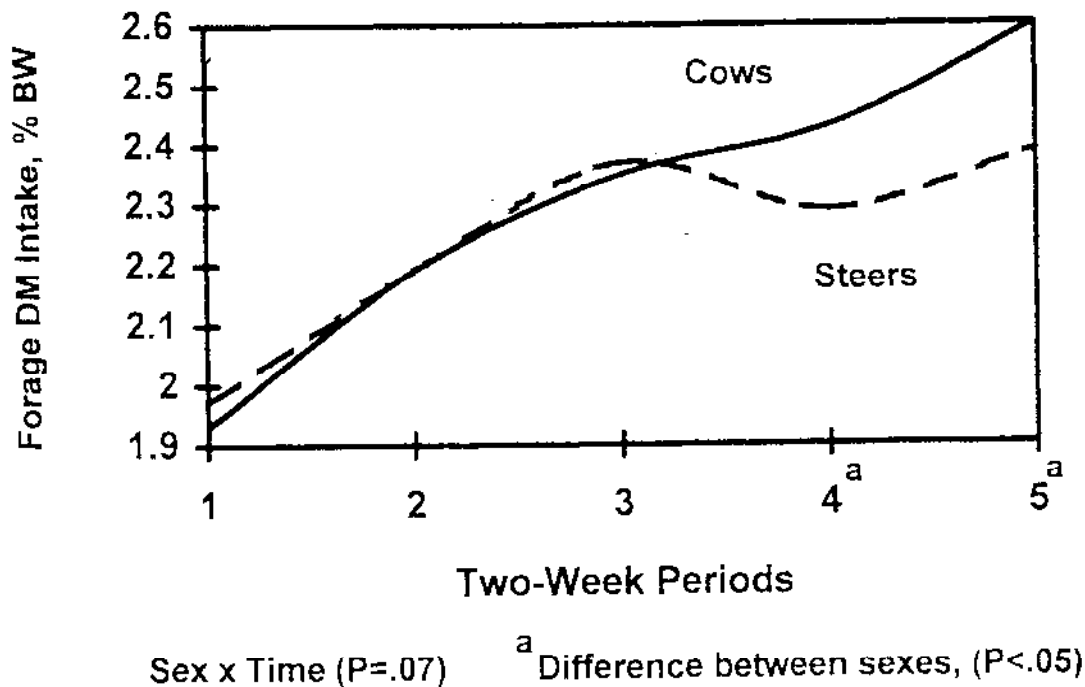
Figure 1. Effect of Sex on Forage Intake
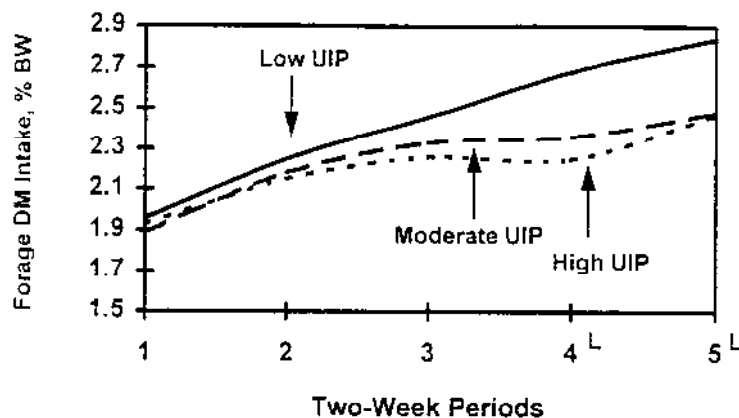
Treatment x Time (P<.05)   L = Linear Treatment Effect (P<.10)

Figure 2.   Effect of Undegradable Intake Protein (UIP) Level in Supplements on Forage Intake by Pregnant Cows

Table 1.   Effect of Level of UIP[a] in Supplements on Body Weight and Body Condition Score Changes

Item	Supplements			Contrasts[b]	
	Low UIP	Moderate UIP	High UIP	Linear	Quadratic
Initial BW, lb	1158	1158	1169		
Period BW change, lb:					
0 - 28 day	-4.23	-8.2	-4.3	.92	**.01**
28 - 56 day	9.8	11.1	7.6	.62	.53
56 - 84 day	9.4	9.2	3.8	.19	.44
84 - 103 day	-164.2	-157.4	-151.3	.29	.97
103 - 154 day	-71.4	-85.4	-77.1	.70	.40
154 - 194 day	178.1	190.8	193.9	.24	.66
Accumulative BW change, lb:					
0 - 56 day	5.6	2.9	3.3	.61	.69
0 - 84 day	14.9	12.1	7.1	.22	.82
0 - 103 day	-148.1	-144.6	-148.0	.99	.74
0 - 154 day	-71.4	-85.4	-77.2	.52	.30
0 - 194 day	-42.7	-44.3	-30.7	.40	.58
Initial body condition	5.2	5.2	5.4		
Period BC change:					
0 - 28 day	-.03	-.14	-.08	.55	.31
28 - 56 day	-.07	-.08	-.08	.97	.98
56 - 84 day	-.08	-.02	-.08	.95	.2
84 - 103 day	-.29	-.28	-.35	.27	.36
103 - 154 day	-.21	-.34	-.24	.72	.25
154 - 194 day	.55	.70	.71	.4	.65
Accumulative BC change:					
0 - 56 day	-.11	-.21	-.16	.61	.39
0 - 84 day	-.19	-.23	-.24	.5	.77
0 - 103 day	-.46	-.52	-.59	.09	.77
0 - 154 day	-.67	-.86	-.83	.06	.14
0 - 194 day	-.12	-.16	-.08	.83	.71
Calf data:					
Calf birth weight, lb	88.8	85.3	87.5	.61	.28
Calf ADG, lb/day	2.1	2.2	2.1	.72	.30

[a]UIP = undegradable intake protein.   [b]Probability of observing a larger F-value.   [c]Day 103 = average calving date, day 154 = 2 weeks before beginning of breeding season, day 194 = weaning.

Cattlemen's Day 1995

RADIOMETRIC MEASUREMENT OF FORAGE QUANTITY

K. C. Olson, R. C. Cochran, and G. Towne

Summary

A 16-band multispectral radiometer (MSR) was used to measure the amount of forage biomass present on several dates in native tallgrass prairie pastures during the 1992 to 1994 growing seasons. Reflectance data collected with the MSR were used as inputs for a neural network computer program. The neural network used the reflectance data to predict forage biomass. Biomass estimates made with the MSR were found to predict actual biomass, as measured by hand-clipping, across all plant growth stages with an error of approximately 6%. Radiometric determination of biomass is a reliable alternative to hand-clipping and can be accomplished in much less time.

(Key Words: Multispectral Radiometer, Biomass, Forage, Neural Network.)

Introduction

Measurement of pasture forage production (i.e., biomass) is essential for determining proper stocking rates and range condition. Current methods involve hand-harvesting of forage in some defined area (e.g., 1 m^2). This procedure must be repeated many times to adequately characterize the amount of forage in an entire pasture and is extremely slow and laborious. Multispectral radiometry (MSR) has the potential to predict forage biomass much more rapidly. It is based on the principle that every substance absorbs and reflects various wavelengths of electromagnetic radiation (i.e., sunlight) in a manner characteristic of its physical and chemical structures. The amount of sunlight reflected by a substance is directly proportional to its mass. Further development of this technology may allow estimation of chemical characteristics of forages, such as nitrogen.

Experimental Methods

One ungrazed and three grazed tallgrass prairie pastures, located at the Kansas State University Range Research Unit, were used in this study. Three soil types were identified within each pasture before the study began: loamy upland, limestone breaks, and thin claypan. Sampling times were late May, mid June, late July, late August, mid September, and mid October. At each sampling date, biomass on 30 to 120 plots was measured with the multispectral radiometer (MSR; Cropscan®, model MSR - 87). A total of 334 plots was measured. An equal number of samples was collected on each soil type. After a radiometric measurement was collected, a corresponding .25 m^2 area was clipped at ground level, and the forage was dried and weighed to determine actual biomass production. Reflectance information collected with the MSR was used as the input for a neural network. This is a computer program that simulates the inductive reasoning process in human beings. In this case, it was used to predict biomass from reflectance features of the forage. Biomass predicted via the MSR and neural network were compared with the actual weights of clipped samples.

Results and Discussion

Eleven categories of information relating to forage characteristics were used as inputs for the neural network (Figure 1). The categories that were most important in predicting biomass were reflectance at 510 nm, 610 nm, 660 nm, and 760 nm. The NDVI (normalized difference vegetation index; (810 nm – 610 nm)/(810 nm + 610 nm) was also important. The soil type

and sunlight intensity (IRR) appeared to be less important in the final prediction equation.

Biomass was predicted by the MSR/neural network combination across season and soil type with an overall estimation error of 6.04% (Figure 2). The MSR/neural network appeared to predict clipped biomass very accurately when lower amounts of standing forage dry matter were present. However, the relationship appeared to become weaker with greater amounts of standing dry matter. This may have been due to the limited number of measurements available for large amounts of biomass

and/or to forage growth characteristics. For example, more stem and leaf material is raised above ground level as biomass increases. As a result, leaves and stem material closer to the ground become shaded by the upper parts of the plant and may not reflect sunlight proportional to their surface area.

The MSR/neural network used in this study adequately predicted clipped forage biomass over a variety of forage growth stages and levels of biomass, although the accuracy of prediction appeared to be less with high amounts of forage biomass. Radiometers like the one used in our study should prove useful for rapid determination of forage biomass for stocking rate or rangeland monitoring purposes in the future.
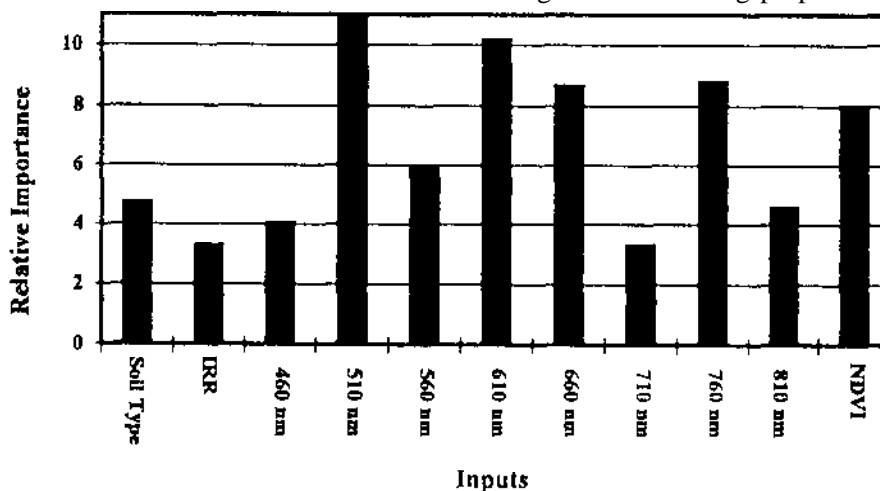
Figure 1. **Relative Importance of Different Inputs. IRR Is Sunlight Intensity. NDVI Is Normalized Difference Vegetation Index. Numbers Are Wavelengths of Light in Nanometers**
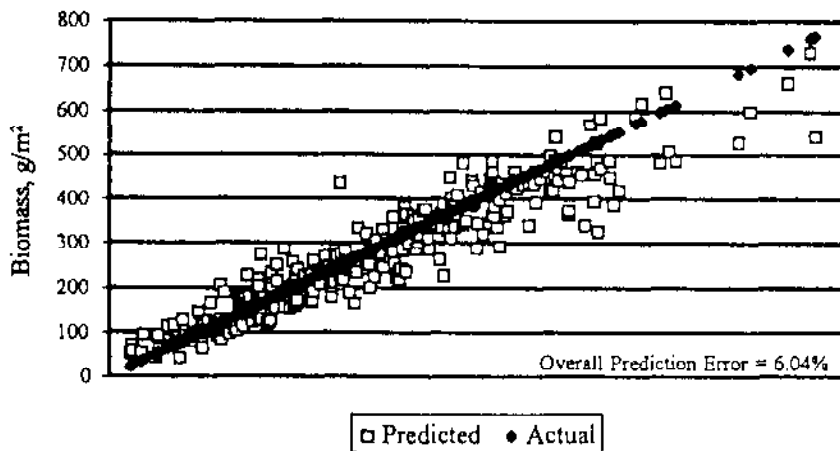
Figure 2. **Actual vs Predicted Biomass**

12

Cattlemen's Day 1995

THE EFFECT OF IMPLANTS ON GAIN OF HEIFERS GRAZING NATIVE GRASS [1]

F. K. Brazle[2] and D. L. Cook[3]

Summary

Three hundred-ninety crossbred heifers were allotted randomly to one of three implant treatments: 1) Implus-H®, 2) Synovex-H®, and 3) Ralgro®. The heifers grazed native grass pastures for 122 days, stocked at 4 acres per head. The heifers receiving the Implus-H tended to gain faster (P<.12) than the Ralgro heifers. No difference in gain occurred between the Implus-H and Synovex-H heifers.

(Key Words: Implant, Grazing Cattle, Native Grass.)

Introduction

Yearling cattle that graze native bluestem grass may be on pasture longer than the normal implant payout. The normal grazing season on native grass is 125 to 150 days. These cattle may graze in large pastures that are not equipped with catch pens and chutes to reimplant them. Therefore, the object of this study was to compare the effects of three implants on gains of grazing heifers for a 120- to 125-day grazing season on native bluestem grass.

Experimental Procedures

British × Continental crossbred heifer calves were purchased in December and January and were not implanted until time for native grass in April. The heifers had been selected for uniformity from a larger group and were allotted randomly by assigning every third heifer down the chute to each treatment. The implant treatments were: 1) Implus-H® implant, 2) Synovex-H® implant, and 3) Ralgro® implant injected in mid 1/3 of the ear.

The heifers were weighed individually on April 7 and 8 and August 9 and 10 in the early morning. They grazed burned native bluestem grass pastures and were stocked at 4 acres per head. The heifers had access to a free-choice salt-mineral mixture containing chlortetracycline (350 mg/animal/day).

Results and Discussion

Results of implant effects on gains of heifers are shown in Table 1. Heifers implanted with Implus-H showed a trend (P<.12) toward improved ADG for 122 days compared to heifers implanted with Ralgro. This trend in results most likely was a function of the length of time that the implants were at a desired payout level. Ralgro implants have an expected payout period of 90 days, whereas the payout period for the other two implants is longer. No difference in ADG occurred between Implus-H and Synovex-H implanted heifers.

Table 1.   The Effect of Implants on Gain of Heifers Grazing Native Grass Pastures

Item	Implus-H	Synovex-H	Ralgro
No. heifers	128	128	129
Starting wt. , lb	486	487	487
ADG, lb	1.78[b]	1.77[ab]	1.72[a]
Days	122	122	122

[a,b]Means in the same row with unlike superscripts are different (P < .12).

Shown below are a listing of implants, their approved use, their active ingredients, and their expected payout.

Brand	Sex	Phase[1]	Active Ingred.[2]	Payout, Days
Ralgro	Both	SGF	36 Zeronal	70-90
Synovex-C	Both	S	10 Est + 100 Prog	90-110
Calf-oid	Both	S	10 Est + 100 Prog	90-110
Synovex-S	Steers	GF	20 Est + 200 Prog	90-100
Implus-S	Steers	GF	20 Est + 200 Prog	90-100
Synovex-H	Heifers	GF	20 Est + 200 Test	90-100
Implus-H	Heifers	GF	20 Est + 200 Test	90-100
Compudose	Steers	SGF	24 Est	150-180
Compudose	Heifers	F	24 Est	150-180
Finaplix-S	Steers	GF	140 TBA	60-90
Finaplix-H	Heifers	GF	200 TBA	60-90
Revalor-S	Steers	F	120 TBA + 24 Est	100-120
Revalor-H	Heifers	F	140 TBA + 14 Est	100-120

[1]S=Suckeling, G=Growing, F=Finishing
[2]Est=Estradiol, Prog=Progesterone, TBA=Trenebolone Acetate, in mg

EFFECTS OF GRAZING SYSTEM AND USE OF A PASTURE-PHASE IMPLANT ON GRAZING AND FINISHING PERFORMANCE OF STEERS

R. T. Brandt, Jr., C. E. Owensby[1], and C. T. Milton

Summary

Results are presented from the first year of a 2-year study to evaluate the effects of grazing system (intensive-early stocking or IES vs season-long grazing or SLG) with or without a pasture-phase implant (Synovex-S®) on grazin g and subsequent finishing performance. Compared to a SLG system, IES resulted in faster rate of gain on pasture and more beef produced per acre, although SLG resulted in greater total pasture gain per animal. Implanting improved rate of gain and increased beef per acre, particularly for IES steers. In the feedlot, IES steers gained weight faster and more efficiently than SLG steers. However, SLG steers had greater final live weights and carcass weights at a common backfat thickness . Pasture-phase implanting did not affect feedlot performance. For heavier SLG steers, final feedlot weights combined with a higher proportion of total gain being made on pasture offset their slower gains and higher cost of production. Implanting IES steers prior to grazing resulted in a numerical improvement in final feedlot weight and net return.

(Key Words: Grazing System, Finishing, Steers, Implant.)

Introduction

Intensive-early stocking (IES) of cattle on Flint Hills range prior to finishing generally improves rate of gain and gain per acre over season-long grazing (SLG), resulting in lower costs of gain. Further, IES systems improve grazing distribution and forage species com- position. With heightened interest in retained ownership, custom grazing, and alliance programs, it is important to know whether the grazing system employed will affect subsequent feedlot performance and overall profitability of a combined grazing-finishing program. Also, if ownership is retained after grazing, it is important to know whether cattle should be implanted during grazing, or whether implantation should be deferred until feedlot placement. Therefore, we designed a 2-year study to evaluate the effects of grazing system (IES vs SLG) and pasture implanta- tion on grazing performance, feedlot perfor- mance, and net return for a combined graz- ing-finishing program. This paper reports results from the first year (1993-1994).

Experimental Procedures

One hundred forty-four predominantly British and Continental crossbred steers (594 lb) were selected on weight and breed type uniformity from a larger group of 256 head. Steers originated from sale barns in Oklaho- ma City. Upon arrival, they were individual- ly eartagged, treated for internal and external parasites, and vaccinated against IBR, PI_3, BVD and BRSV (modified live), and black- leg (4-way). Steers were fed receiving rations of either long-stem prairie hay plus a natural protein supplement or a 60% concen- trate milled ration for 22 days before the trial began. Steers were blocked by previous treatment and stratified by weight into one of 24 feedlot outcome groups of six head each, prior to grazing. Each group was assigned to one of four grazing treatments in a 2x2 factorially arranged experiment: 1) IES with

---

[1]Professor, Dept. of Agronomy.

no implant, 2) IES with implant (Synovex-S®, 3) SLG with no implant, and 4) SLG with implant. Steers in the SLG system were reimplanted when IES steers were removed from pasture. Steers in the IES and SLG systems grazed 70 and 147 days, respectively. Turnout date was May 10, 1993. Steers grazed one of eight contiguous 80-acre pastures, south of Manhattan (four IES and four SLG pastures). Feedlot outcome groups were blocked within pasture to remove pasture effects. Stocking rates were 2 acres per animal for IES and 4 acres for SLG. To minimize weighing errors, all steers were fed a standardized diet of 13 lb prairie hay plus 2 lb supplement in drylot for 4 days before on- and off-pasture weights were obtained.

After grazing, steers were moved to the KSU feedlot. Management of all steers from this point until slaughter was identical. Upon arrival, steers were dewormed, vaccinated, and implanted with Synovex-S, then reimplanted after 56 days with a combination of Synovex-S and Finaplix-S®. Steers were fed a 90% concentrate diet and slaughtered by treatment group when the average backfat thickness was approximately .45 inches (118 days on feed for IES and 127 for SLG.

Results and Discussion

No grazing system × pasture-phase implant interactions occurred for any pasture or feedlot performance variable. Pasture rate of gain and beef produced per acre were higher (P < .05) for the IES vs SLG system (Table 1). However, because SLG steers grazed 77 days longer, they gained an additional 103 lb per head (P < .05) on pasture, compared to IES steers. Implanting steers before grazing increased (P < .05) rate of gain and beef per acre. The improvement was more dramatic for IES steers, where implanting improved rate of gain and beef per acre 16 and 15%, respectively. This was expected, because growth responses to implants increase with higher planes of nutrition or, in this case, higher forage quality for the duration of the grazing period.

In the feedlot, IES steers gained faster and more efficiently (P < .05) than SLG steers. Similar results have been reported from Oklahoma State University. Although feedlot placement dates differed between IES and SLG steers, differences in incoming weights likely were responsible for feedlot performance differences. Steers grazed in the SLG system weighed 91 lb more (P < .05) than IES steers at a similar backfat depth (average of .44 in). Pasture-phase implantation had no effect on subsequent feedlot performance.

Carcass weights averaged 66 lb heavier (P < .05) for SLG steers than for IES steers at similar backfat endpoints (Table 2). Pasture-phase implantation slightly reduced dressing percentage of IES steers, but slightly improving that of SLG steers (interaction; P < .10). Measures of carcass fatness and quality grade were unaffected by treatment.

Implanting tended to improve net return per steer for IES but not SLG steers (interaction (P=.24); Table 3). Despite higher pasture, interest, and feedlot feeding costs, SLG steers showed net returns per steer equal to those of implanted IES steers and greater than those of nonimplanted IES steers. The higher final weights (live or carcass basis) and the value of the added weight offset the increased production costs for SLG steers . Faster rates of gain on pasture and in the feedlot resulted in faster rates of fat deposition and, thus, lower final weights at a similar fat thickness for IES steers. The percentage of combined grazing-finishing weight gain that was achieved on pasture averaged 21.3 vs 33.3% for the IES vs SLG systems . This economic analysis will not necessarily apply to areas where steers can be grazed longer in IES systems (e.g., southern Flint Hills). Also, because twice the number of animals was grazed on the same amount of land for the IES vs SLG system, net returns per 100 acres of pasture were highest for the implanted IES steers. Therefore, IES will be particularly attractive to highly capitalized operations with limited available pasture, but SLG may be preferable for less highly capitalized operations. Range ecology and pasture management or renovation also need to be considered in the decision-making process.

Table 1. **Effect of Native Range Grazing System and Pasture-Phase Implant on Grazing and Finishing Performance of Steers**

Item	Intensive-Stocked[a]		Season-Long[a]		SE
	Control	Implant[b]	Control	Implant[b]	
No. Steers	36	36	36	36	
No. Feedlot Pens	6	6	6	6	
Pasture Phase					
On weight, lb[c]	594	592	597	593	3.6
Off weight, lb[c,f]	713	730	823	830	8.9
Pasture gain, lb[f]	119	138	226	237	9.2
Pasture ADG, lb[f,g]	1.70	1.97	1.54	1.62	.08
Beef/acre, lb[f,g]	60	69	56	59	2.8
Feedlot Phase					
Starting weight, lb[c]	713	730	823	830	8.9
Final weight, lb[d,f]	1133	1162	1238	1239	15.9
Daily gain, lb[f]	3.56	3.65	3.27	3.22	.10
Daily feed, lb DM	22.7	23.5	22.4	23.2	.59
Feed/gain[e,f]	6.39	6.45	6.88	7.22	.15
Combined Phases					
Total gain, lb[f]	586	618	692	698	17.3

[a]Intensive-stocked steers grazed for 70 days (2 acres/head); Season-long grazed for 147 days (4 acres/head).

[b]Implanted before the pasture phase wit lSynovex-S®. Season-long steers reimplanted after 70 days on pasture.

[c]Weights obtained after 4 days of equalized feeding (13 lb prairie hay plus 2 lb soybean meal/head/day) in the feedlot.

[d]Final live weights pencil shrunk 4%.

[e]Calculated and analyzed statistically as gain/feed.

[f]Grazing system effect (P< .05).

[g]Pasture implant effect (P< .05).

Table 2.   Effect of Grazing System and Pasture-Phase Implant on Carcass Traits

| Item | Intensive-Stocked | | Season-Long | | SE |
	Control	Implant	Control	Implant	
Hot weight, lb[a]	722	733	789	798	10.4
Dressing % [b]	63.8	63.1	63.7	64.5	.43
Backfat, in.	.42	.42	.45	.46	.033
KPH, %	2.13	2.06	2.11	2.16	.083
Marbling Score[c]	5.25	5.19	5.62	5.26	.159
Percent Choice	72	66	71	68	

[a]Grazing system effect (P < .000l).
[b]Grazing system **x** pasture-phase implant (P< .l0).
[c]Slight 0=4.0, small 0=5.0, etc.

Table 3.   Effect of Grazing System and Pasture-Phase Implant on Returns to Grazing-Finishing Systems

| Item, $/head | Intensive-Stocked | | Season-Long | | SE |
	Control	Implant	Control	Implant	
Total Cost[a]	818.22	825.39	879.54	887.56	
Animal cost[b]	539.58	539.58	539.58	539.58	
Receiving cost[c]	40.00	40.00	40.00	40.00	
Pasture cost[d]	37.50	38.50	75.00	77.00	
Interest @ 9%	28.34	28.34	39.78	39.78	
Feed cost[e] (feedlot)	172.80	178.98	185.18	191.21	4.62
Value[a,f]	821.26	842.14	897.78	898.09	11.52
Return, $/head[g]	$3.04	$16.75	$18.25	$10.52	$8.59
Return, $/l00 acres	$152.00	$837.50	$456.25	$263.00	

[a]Intensive-stocked vs season-long (P < .000l).
[b]$95.50/cwt (laid in) on payweight of 565 lb.
[c]Feed, medicine, veterinary, death loss, misc.
[d]Pasture cost of $13/acre plus $11.50 vs $23.00 per head for IES vs SLG systems, respectively, to cover mineral, labor, etc. Implants @ $1.00 per dose.
[e]Charged at $.065 per lb of dry matter; Intensive-stocked vs season-long (P< .02).
[f]Cash price of $72.50 for fed steers.
[g]Grazing system × implant interaction (P=.24).

Cattlemen's Day 1995

WHEAT MIDDLINGS IN HIGH CONCENTRATE FINISHING RATIONS: CATTLE PERFORMANCE [1]

B. S. Dalke [2], R. N. Sonon, Jr. [3],
D. L. Holthaus [4], M. A. Young, and K. K. Bolsen,

Summary

One hundred tw enty medium-framed steers were fed one of six high (90%) concentrate ratio ns: control (0), 5, 10, or 15% pelleted wheat middlings (WM) replacing the concentrate (dry rolled corn) and 5 or 10% pelleted WM replacing the roughage (chopped alfalfa hay).   Increasing WM replacement of the concentrate increased both dry matter (DM) intake and feed/gain ratio linearly, without influencing daily gain or final weight. WM replacemen t of the roughage decreased DM intake linearly, but it ha d no effect on daily gain, final weight, or feed efficiency . The data indicate that WM could replace only 5% of the concentrat e without reducing cattle performance, but complete (100%) or partial (50%) replacemen t of the roughage with WM had no adverse effect on cattle performance.

(Key Words: Wheat Middlings, Beef Cattle, Performance, Feedlot.)

Introduction

In 1991, 11.0% of the flour milled in the United State s was produced in Kansas, yielding about 700,000 tons of mill feeds.   Wheat middlings (WM) are bypro ducts of flour milling comprising a m ixture of small particles of bran, germ, and the aleurone layer of the wheat kernel. Al though WM are used commonly as a feed source for livestock, very little information is available concerning their nutritive value when added to high conce ntrate, feedlot rations. In an earlier trial, we found that pelleted WM could replace about 10% of the corn without reducing the rate and efficiency of gain of finishing stee rs (KAES Report of Progress 497, page 21). We know of no publis hed studies that have determined the potential value of WM as a roughage source in beef cattle finishing rations.

Our objectives were to determin e the effects on cattle performance of WM fed as a replacemen t for either the concentrate or roughag e components in finishing rations for feedlot steers.

Experimental Procedures

One hundred twen ty medium-framed steers averagin g 805 lb were blocked by weight and rando mly allocated from each block to one of six treatment groups of 20 steers (four replicates of five steers per pen).   The treatment s consisted of the following high concentrat e rations (81.5% dry-rolled corn, 10% chopped alfalfa, 6% suppl ement, and 2.5% molasses on a DM basis): control ;5, 10, or 15% pelleted (.25 inch) WM replacing the concentrate; and 5 or 10% pelleted WM replacing either 50 or 100% of roughage. Daily NE_g intakes were estimated from the NRC NE_g values of the dietary ingred ients. After a 12-day adaptatio n to the rations, the steers were weighed on 2 consecuti ve days, and the average was used as the initial weight. Final weights

---

were determined in the same manner. At the termination of the trial (112 days), steers were slaughtered at Iowa Beef Packing, Emporia, Kansas, and standard carcass measurements were made at 24 hours postslaughter by Kansas State University personnel.

Data were analyzed using the SAS GLM procedure. The feedlot performance and carcass data were analyzed as a Randomized Complete Block design using orthogonal contrasts (linear, quadratic, and cubic) for specific treatment comparisons. Terms in the fixed effects model included the main effects of block (steer weight) and level of WM as a concentrate or roughage replacement.

Results and Discussion

The WM were from a single source and had the following composition (DM basis): 19.0% crude protein, 44.3% NDF, 10.7% ADF, 23.2% starch, .14% calcium, 1.2% phosphorus, and 1.0% potassium.

The effect of replacing the concentrate component with WM on performance and carcass characteristics in the feedlot steers is presented in Table 1. Both DM intake (P<.01) and feed/gain ratio (P<.05) increased linearly with increasing level sof WM in the ration. DM intake increased 9.2% and feed/gain ratio increased 10.1% for steers fed the 15% level of WM compared to controls. Daily gains and final weights were not influenced by WM replacing corn. Estimated daily NE_g intake increased (P<.01) in a linear manner as WM

replaced concentrate . The 10 and 15% replacements increased NE_g intake by 9.4 and 7.1%, respectively, compared to the control ration. In Figure 1 are the observed daily gains and those predicted from the daily NE_g intakes:

$$LWG = 13.91 \times NE_g^{0.9116} \times W^{-0.6837}.$$

Observed daily gains for steers fed the 10 and 15% levels of WM were 10.8 and 7.8% less than predicted gains, respectively. No statistical differences were detected in hot carcass weight, backfat depth, quality grade, or dressing percentage as WM replaced concentrate. Marbling score increased (P<.01) in a linear manner with increasing levels of WM.

The effect of replacing the roughage component with WM is also presented in Table 1. Intakes of both DM and NE_g were decreased (P<.05) in a linear manner with increasing levels of WM. This reduction in energy intake did not affect ADG because of the linear increase in nutrient digestibilities observed with increasing replacement of the roughage component with WM (see page 22 of this report). Final weight, ADG, and feed/gain were not affected by replacing the roughage with 5 or 10% WM. No liver abscesses were observed.

In summary, wheat middlings could replace only 5% of the concentrate in the finishing rations without reducing cattle performance, but complete (100%) or partial (50%) replacement of the roughage in finishing rations with wheat middlings did not affect growth performance of steers in this study.

Table 1. Effects of Replacing either the Concentrate or Roughage Components with Pelleted WM on Performance and Carcass Characteristics in the Feedlot Steers[a]

Item	Control	Middlings for Concentrate			Middlings for Roughage		SE	Probability [b]	
		5%	10%	15%	5%	10%		C	R
Initial wt, lb	869	862	877	877	869	869	7.14	NS	NS
Final wt, lb	1,210	1,217	1,224	1,217	1,215	1,199	10.74	NS	NS
ADG, lb	3.11	3.17	3.09	3.13	3.11	2.95	.09	NS	NS
DM intake, lb/day	21.6	22.0	23.4	23.6	20.9	19.6	.48	L**	L**
Feed/gain, DM basis	6.9	7.0	7.6	7.6	6.8	6.6	.22	L*	NS
NE, intake, Mcal/day	8.5	8.6	9.3	9.1	8.3	7.5	.30	L*	L**
Hot carcass wt, lb	758	750	750	750	747	736	5.93	NS	L*
Backfat depth, in.	1.30	1.31	1.34	1.27	1.28	1.30	.03	NS	NS
Marbling score[c]	5.3	5.5	5.4	6.2	5.6	5.5	.26	L**	NS
Quality grade[d]	8.3	8.4	8.6	8.6	8.5	8.5	.09	NS	NS
Dressing %	62.5	61.7	61.3	61.6	61.4	61.0	.43	NS	L*

[a]Values are least square means, and SE is the pooled standard error of the mean.
[b]C = replacement of concentrate, R = replacement of roughage, and L = linear effect of WM addition. NS = not different, *P<.05, and **P<.0l.
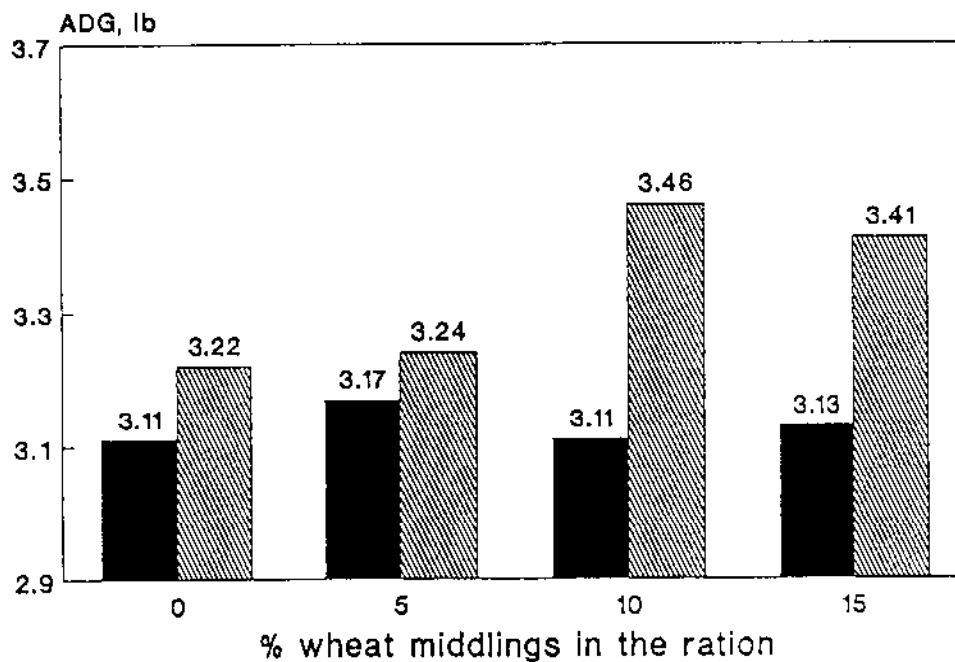[c]Slight = 4, small = 5, and modest = 6.
[d]Choice = 8.

Figure 1. Effect of Replacing the Concentrate Component of Finishing Rations with WM on Observed ADG (■) and ADG Predicted from Daily NE$_g$ Intake

21

WHEAT MIDDLINGS IN HIGH CONCENTRATE RATIONS: DIGESTIBILITY AND RUMINAL METABOLISM [1]

B. S. Dalke [2], K. K. Bolsen,
R. N. Sonon, Jr. [3], and M. A. Young

Summary

Six medium-framed steers, fitted with ruminal cannulae were used in a 6×6 Latin square design and fed the following six high concentrate (90%) rations: control; 5, 10, or 15% pelleted wheat middlings (WM) replacing the concentrate (dry rolled corn); and 5 or 10% pelleted WM replacing the roughage (chopped alfalfa hay). Dry matter (DM), organic matter (OM), and starch digestibilities decreased linearly when increasing levels of WM replaced the concentrate, but replacing the roughage increased DM and OM digestibilities linearly. WM could replace only up to 5% of the concentrate without reducing nutrient digestibilities, but complete (10% WM) replacement of the roughage increased nutrient digestibilities.

(Key Words: Wheat Middlings, Beef Cattle, Feedlot, Digestibility.)

Introduction

Wheat middlings (WM) are byproducts of flour milling and comprise a mixture of small particles of bran, germ, and the aleurone layer of the wheat kernel. The nutrient content of WM can be highly variable, but NRC publications indicate that they contain (dry basis) approximately .73 Mcal of NE_m/lb, .45 Mcal of NE_g/lb, 18.0% crude protein (CP), and high levels of rapidly degradable fiber.

Although WM commonly are used as a feed ingredient, little information is available concerning their nutritive value in high concentrate rations. Cattle performance results indicate that pelleted WM were more effective as a replacement of roughage than of concentrate in feedlot rations (page 19, this report).

Our objectives were to determine the effects of WM fed as a replacement for either the concentrate or roughage components in finishing rations on nutrient digestibilities and ruminal metabolism in feedlot steers.

Experimental Procedures

Six medium-framed steers, averaging 1,060 lb, were fitted with ruminal cannulae and utilized in a 6×6 Latin square design. They were fed the following six high concentrate rations (81.5% dry rolled corn, 10% chopped alfalfa, 6% supplement, and 2.5% molasses on a DM basis): control (0); 5, 10, or 15% pelleted (.25 inch) WM replacing the dry rolled corn; and 5 or 10% pelleted WM replacing the roughage. The rations were formulated to be isonitrogenous, supplied equal amounts monensin and tylosin, and were fed ad libitum, twice daily (8:00 AM and 3:30 PM) for the duration of the experimental periods. On day 1 of each period, the steers were allocated randomly to one of the six rations. The experimental periods were 14 days and consisted of a 9-day adaptation, a 4-day total fecal collection, and a 1-day rumen sampling. Ruminal digesta samples were collected before the first feeding (0 hour) and at 2, 4, 6, and 10

hours after the first feeding. The samples consisted of subsamples from the dorsal blind sac, mid-dorsal region, mid-ventral region, and the reticulum.

Data were analyzed using the SAS GLM procedure. Fermentation profiles were analyzed as a split-plot in time 6×6 Latin square design using contrasts (linear, quadratic, and cubic) for treatment comparisons. Terms in the fixed effects model included the main effects of ration, period, steer, ration $\times$ period $\times$ steer, time, and time $\times$ ration. Digestibility data were analyzed as a 6×6 Latin square design using contrasts (linear, quadratic, and cubic) for specific treatment comparisons. Terms in the fixed effects model included ration, period, and steer.

Results and Discussion

The WM were from a single source and had the following composition (DM basis): 19.0% crude protein, 44.3% NDF, 10.7% ADF, 23.2% starch, .14% calcium, 1.2% phosphorus, and 1.0% potassium.

The effects of replacing concentrate with WM on DM intake, intake of digestible DM (DDM), and nutrient digestibilities in the steers are presented in Table 1. Neither DM intake nor digestible DM intake were significantly influenced (P>.05) by replacing concentrate with WM. Dry matter, OM, and starch digestibilities decreased (P<.05) in a linear manner with increasing WM. Decreases of 5.7 and 5.3 percentage units in DM and starch digestibilities, respectively,

were observed at the 15% level of WM addition.

The effect of replacing concentrate with WM on ruminal fermentation characteristics is summarized in Table 2. Ruminal pH increased (P<.05) linearly with increasing levels of WM. Acetate and butyrate proportions increased (P<.05) and propionate proportions decreased (P<.05) as WM increased, resulting in a quadratic increase (P<.05) in the acetate/propionate ratio. Total VFA concentrations decreased 25% at both the 10 and 15% levels of WM compared to the control.

The effects of replacing roughage with WM on DM intake, intake of DDM, and nutrient digestibilities in the steers are summarized in Table 1. Daily intakes of DM and DDM were not affected (P>.05) by WM replacement of roughage. However, DM and OM digestibilities increased in a linear manner with increasing levels of WM.

The effects of replacing roughage with WM on ruminal fermentation characteristics is summarized in Table 2. Total VFA and propionate concentration and pH were not influenced (P>.05) by WM replacement of roughage. Acetate proportions and acetate/propionate ratio were decreased and butyrate proportions were increased as WM replaced roughage.

In summary, WM could replace only 5% of the concentrate without reducing nutrient digestibilities, but complete (10%) replacement of the roughage increased nutrient digestibilities.

Table 1.   Effects of Replacing either the Concentrate or Roughage Components with WM on Intake and Nutrient Digestibilities in Feedlot Steers [a]

| Item | Control | Middlings for Concentrate | | | Middlings for Roughage | | SE | Probability [b] | |
		5%	10%	15%	5%	10%		C	R
DM intake, lb/day	28.6	30.4	28.0	33.1	28.9	26.2	1.70	NS	NS
Intake of DDM, lb/day	22.0	23.8	21.2	23.8	23.6	22.0	1.56	NS	NS
Digestibility, %									
DM	77.1	78.7	74.3	72.7	77.1	84.1	1.69	L	L
OM	79.4	80.8	77.7	75.2	79.4	86.7	1.47	L	L
Starch	95.5	93.1	92.9	90.4	95.5	96.6	1.24	L	NS

[a]Values are least square means, and SE is the pooled standard error of the mean.
[b]C = replac ement of concentrate, R = replacement of roughage, and L = linear effect of WM addition (P<.05). NS = not different.

Table 2.   Effects of Replacing either the Concentrate or Roughage Components with WM on Ruminal Fermentation Characteristics in Feedlot Steers [a]

| Item | Control | Middlings for Concentrate | | | Middlings for Roughage | | SE | Probability [b] | |
		5%	10%	15%	5%	10%		C	R
pH	5.3	5.6	5.7	5.8	5.3	5.3	.04	L	NS
VFA, mol/100 mol									
acetate	47.0	48.0	51.0	51.0	43.0	44.0	.64	C	Q
propionate	40.0	39.0	32.0	28.0	40.0	41.0	.61	C	NS
butyrate	9.0	10.0	13.0	16.0	12.0	10.0	.38	C	Q
Total VFA, mM	111	105	83	83	113	94	3.51	Q	NS
Acetate/ propionate	1.3	1.4	2.0	2.1	1.1	1.1	.06	Q	Q

[a]Values are least square means, and SE is the pooled standard error of the mean.
[b]C = replac ement of concentrate, R = replacement of roughage, and L = linear effect of WM addition (P<.05), Q = quadratic effect of WM addition (P<.05), and C = cubic effect of WM addition (P<.05). NS = not different.

Cattlemen's Day 1995

OPTIMAL UREA LEVEL IN CORN-BASED FINISHING DIETS CONTAINING ALFALFA AS THE ROUGHAGE SOURCE

C. T. Milton and R. T. Brandt, Jr.

Summary

One hundred medium-growth potential, crossbred yearling steers (766 lb) were used to identify the optimal level of urea in finishing diets, based on growth and carcass traits. The corn-based diets had no urea or contained .35, .70, 1.05, or 1.40% urea (dry matter basis) and no other supplemental protein. Alfalfa hay (10% of DM) was the roughage source and contained 16% crude protein. Feed efficiency and gain were improved by .35% urea, with little improvement from higher additions. Regression analysis indicated that the optimal level of urea for gain and feed efficiency was .5% of dietary dry matter. Hot carcass weight and dressing percentage responded quadratically, being highest for steers receiving .7 and 1.05% urea. Fat thickness and yield grade responded cubically to the addition of urea; these traits were also highest for steers receiving .7 and 1.05% urea. Loineye area decreased linearly with increased urea in the diet. Marbling scores and KPH fat were unaffected by urea addition. The increased growth, carcass weight, and finish, with no improvements in loineye area, indicate that urea enhanced diet digestibility but did not increase metabolizable protein supply. Optimal urea levels (.5%) were less than those previously indicated for diets containing prairie hay as the roughage source (.9%), suggesting that alfalfa may supply a portion of the rumen degradable nitrogen requirement when utilized as a source of roughage in high grain diets.

(Key words: Urea, Finishing Steers, Performance, Metabolizable Protein.)

Introduction

Current information regarding requirements of finishing cattle for rumen degradable protein and metabolizable protein remains limited. Urea is a common source of rumen degradable protein in finishing diets. Previous research (Cattlemen's Day, 1994) suggested that the optimal level of urea for rate and efficiency of gain in corn-based finishing diets utilizing native grass hay for roughage (10% of dietary DM) was .91% of dietary dry matter.

Alfalfa is used commonly in finishing diets as a source of dietary roughage. Compared to native grass hay, alfalfa contains more rumen degradable protein. Although typically included as 10% or less of finishing diets, alfalfa may reduce the amount of dietary urea needed to meet microbial demands for ammonia. Our objective was to identify the optimal level of urea for performance and carcass traits of finishing yearling steers fed high grain diets containing alfalfa hay as the roughage source.

Experimental Procedures

One hundred medium-growth potential, crossbred steers (766 lb) were received from Flint Hills grass in July 1994. Steers were allotted to one of four weight replicates and stratified into one of five pens within each replicate. They were stepped up to an 80% concentrate diet prior to beginning the experiment. A single initial weight was taken following a 3-day period of equalized intake. Steers were implanted with Revalor-S® and fed diets without urea or containing .35,

.70, 1.05, or 1.40% urea (dry matter basis). Diets contained no other supplemental protein. All diets contained alfalfa (16% crude protein) at 10% of the dietary dry matter and were formulated to conta in .75% Ca, .35% P, .7% K, and a 10:1 N:S ratio. Steers were fed 275 mg Rumensin® and 90 mg T ylosin® per head daily . Crude protein levels ranged from 9.9 to 13.9%. Experimental diets were fed for an average of 144 days. The largest weight block was slaughtered following 109 days on feed, and the three remaining blocks were fed for an additional 44 days. Because the smallest block was not ready for slaughter when the trial was terminated, carca ss data were collected for only three of the four weight blocks. Final weights were pencil shrunk 4% for calculation of daily gain and feed efficiency. Steers were slaughtered at a commercial plant, and carcass data were obtained following a 24-hour chill.

Results and Discussion

Daily gain (P<.05), fee dintake (P=.11), and feed efficienc y (P<.05) responded quadratically to the addition of urea (Table 1). Both daily gain and feed efficiency were improved by the first increment of urea (.35%) with little or no improvemen t from subsequent urea additions. As dietary urea increased, hot carcass weight responded qu adratically (P<.05), being greatest at .7% dietary urea. A quadratic trend (P=.11) also was observed for dressing percentage, which was also greatest at 7% dietary urea. Fat thickness (12th rib) and calculated yield grade responded cubically (P<.05) to the addi-

tion of urea, a reflection of lower intake and performance for the highe rurea levels. Loineye area decreased linearly (P<.02) with dietary level of urea. Kidney, heart, and pelvic fat and marbling scores were unaffected (P>.18) by the addition of urea. Predicted crude protein requirements of steers in thi sstudy (1.87 lb/day) were met by the control diet. Improvements in performanc e and increases in carcass weight and finish, with no improvem ent in loineye area, sugges t that urea enhanced energy utilization (diet digestibility) but did not increase protein supply to the smal l intestine. These results are consisten t with previous research conducted at Kansas State (Cattlemen's Day, 1994).

The Iowa State metabolizable protein system predicted the urea fermentation potential for the basal diet in this study to be .7%. Regression analysis (model Y=urea + ure a^2) predicted the optimal level of urea for gain (r^2=.30) and feed efficiency (r^2=.40) to be .5% of dietary dry matter. When final weight was determined as carcass weigh tadjusted by a 62% dressing percentage, the optimal level of urea for gain and feed eff iciency was .57% of dietary dry matter (r^2=.27 and .35, respectively). Optimal levels of urea (.5%) were less than those previously reported for diets containing prairie hay as the roughage source (.91%), suggesting that alfalfa, used as source of roughage in high grain diets, can supply a portion of the degradable protein requirement for finishing steers.

26

Table 1.   Effect of Dietary Urea Level on Performance and Carcass Traits o f   Finishing Yearling Steers

| | Urea (% of Dry Matter) | | | | | |
Item	0	.35	.70	1.05	1.40	SEM
No. pens	4	4	4	4	4	
No. steers	20	20	20	20	20	
Initial wt, lb	766	753	771	771	766	3.5
Final wt[a], lb	1140	1148	1169	1152	1101	19.0
Daily feed[b], lb	20.15	19.95	20.55	20.95	19.36	.46
Daily gain[a,c], lb	2.67	2.80	2.83	2.70	2.36	.12
Feed/gain[c,d]	7.59	7.14	7.29	7.75	8.26	.25
Carcass traits						
Hot carcass wt, lb	742	743	762	753	701	11.3
Dressing %[b]	62.9	63.2	64.8	64.2	63.3	.66
Fat 12th rib[e], in	.32	.31	.40	.45	.29	.04
KPH, %	2.17	2.05	2.13	2.20	2.10	.10
Loin eye area[f], in^2	14.2	14.0	14.3	12.9	13.1	.30
Marbling score[g]	4.87	4.81	4.80	4.67	4.82	.17
Yield grade[e]	2.02	1.99	2.29	2.76	2.09	.13

[a]Final live weight pencil shrunk 4%.
[b]Quadratic (P=.11).
[c]Quadratic (P<.05).
[d]Feed/gain was analyzed as gain/feed and reported as the reciprocal.
[e]Cubic (P<.05).
[f]Linear (P<.02).
[g]4= slight, 5= small.

Cattlemen's Day 1995

COMBINATIONS OF RUMINALLY DEGRADABLE AND ESCAPE PROTEIN FOR IMPLANTED FINISHING STEERS

C. T. Milton, R. T. Brandt, Jr., and E. C. Titgemeyer

Summary

One hundred forty-four crossbred medium framed steers (738 lb) were used to compare urea and soybean meal as basal supplemental nitrogen sources and sources of high (blood meal:corn gluten meal; BMCG) or low (soybean meal; SBM) ruminal escape proteins as additional protein supplementation. Basal diets were formulated to contain 10.8% crude protein (CP) and were supplemented with either urea or SBM (.91% and 5.55% of DM, respectively). An additional 2 percentage units of CP were either provided or not provided as SBM or as a 50:50 combination (protein basis) of BMCG. Steers were implanted with Revalor-S® and fed experimental diets for 113 days. Steers fed urea diets consumed 3.9% more feed than those fed SBM as the basal N source. Average daily gain was unaffected by treatment. Soybean meal improved feed efficiency 3.8% compared to urea as a basal nitrogen source. Supplying additional CP from SBM increased feed efficiency 4.4% compared to BMCG. Hot carcass weight and dressing percentage were not affected by treatment. Supplementing basal diets with 2 percentage units of CP increased percentage of carcasses grading choice, KPH fat, and yield grade. High dry matter intakes resulted in metabolizable protein intakes above the predicted requirements (760 g/d) for steers in this experiment, which may have precluded a response to supplemental protein.

(Key Words: Degradable Protein, Escape Protein, Finishing Steers, Performance.)

Introduction

Finishing steers receiving growth promotants, especially the combination of estradiol and trenbdone acetate, have enhanced growth rates, which may increase their requirements for metabolizable protein. Protein presented to the small intestine can be increased by using protein sources such as blood meal and corn gluten meal, which escape rumen degradation, whereas the rumen nitrogen requirement can be met with sources susceptible to degradation.

Previous studies (Cattlemen's Day, 1994) demonstrated that supplementing high grain diets with urea enhances rumen organic matter digestion with little or no improvement in microbial protein production. A source of natural, ruminally degradable protein may be required to increase microbial protein presented to the small intestine and subsequently increase animal performance. Those reports suggested that, in corn-based finishing diets, the level of urea for optimal rate and efficiency of growth is .91% of dietary dry matter. In this study, our objectives were to compare urea (non-protein nitrogen) versus soybean meal (natural, degradable protein source) as basal, supplemental nitrogen (N) sources and evaluate additional N supplementation from high- versus low-escape proteins on performance and carcass characteristics of implanted, finishing steers.

Experimental Procedures

One hundred forty-four crossbred, medium-framed steers (738 lb) were allotted to one of four weight replicates and stratified into one of six pens within each replicate in a 2 × 3 factorially arranged experiment. Basal diets (90% concentrate, 10.8% CP; Table 1) contained either .91% urea or an equivalent amount of N as SBM (5.55% of diet DM). An additional two percentage units of CP were either provided or not provided by a 50:50 combination (protein basis) of BMCG (high escape) or SBM (low escape). All diets were formulated to contain .7% Ca, .35% P, and .7% K. Steers were fed 275 mg Rumensin® and 90 mg Tylosin® per head daily. Steers were stepped up to an 80% concentrate diet prior to the start of the experiment. Initial weights were the average of two consecutive early morning weights taken before feeding. Steers were implanted with Revalor-S® and fed experimental diets for 113 days. Final weights were computed from hot carcass weights, assuming a dressing percentage of 62 for calculation of daily gain and feed efficiency. Steers were slaughtered at a commercial plant, and carcass data were obtained following a 24-hour chill. Statistical analysis allowed comparisons of: 1) basal supplemental N source, 2) basal versus additional supplemental protein (i.e., 10.8 vs 12.8% CP diets), 3) additional N supplementation in the form of high (BMGG) or low (SBM) escape protein, and 4) interaction between basal and additional N sources.

Results and Discussion

Steers fed urea diets consumed 3.9% more feed (P<.07) than those fed SBM as the basal N source (Table 2). Average daily gain was not affected by treatment. Steers supplemented with SBM as the basal N source were 3.8% more efficient (P<.05) than those supplemented with urea; additional N supplementation from SBM improved feed efficiency 4.4% (P<.09) versus BMCG. The improvement in feed efficiency from SBM suggests that provision of natural, degradable protein to rumen microorganisms improved fermentation. Hot carcass weight and dressing percentage (62.6%) were unaffected (P>.2) by treatment. A basal × additional N source interaction (P<.02) was observed for 12th rib fat thickness. When steers were fed the urea basal diet, fat thickness was increased by additional BMCG, whereas fat thickness of steers fed the SBM basal diet was decreased by additional BMCG. Loin eye area (LEA) was decreased (P<.05) by the addition of supplemental N to the basal diets, and this depression in LEA was more severe when steers received additional N from BMCG than from SBM. Observed differences in LEA may be somewhat trivial because of the small differences noted across treatments. Percentage of carcasses grading choice, KPH fat, and calculated yield grade were increased (P<.09) when additional N was provided to the basal diets. Metabolizable protein requirements for steers in this experiment were calculated to be approximately 760 g/d. High dry matter intakes resulted in metabolizable protein intakes ranging from 949 to 1112 g/d, which may have precluded responses to basal and supplemental N sources in this study.

29

Table 1.   Diet Composition (% of Dry Matter)

| | Treatment [a] | | | | | |
| | Urea | | | SBM | | |
Item	0	BMCG	SBM	0	BMCG	SBM
Rolled corn	85.5	82.6	81.0	81.2	78.3	76.6
Prairie hay	8.0	8.0	8.0	8.0	8.0	8.0
Urea	.91	.91	.91	--	--	--
Soybean meal	--	--	4.54	5.55	5.55	10.1
Blood meal	--	1.19	--	--	1.19	--
Corn gluten meal	--	1.71	--	--	1.71	--
Vitamins/minerals [b]	3.09	3.09	3.05	2.75	2.75	2.80
Molasses	2.5	2.5	2.5	2.5	2.5	2.5
% Crude protein	10.8	12.8	12.8	10.8	12.8	12.8

[a]Dietary tre atments (basal N source/supplemental N source). SBM= soybean meal; 0= no supplemental protein; BMCG=blood meal:corn gluten meal . [b]Provided dietary levels of 1500 IU/lb Vitamin A, 20 IU/lb Vitamin E, .7% Ca, .35% P, and .7% K.

Table 2.   Effect of Basal and Supplemental Nitrogen S o urce on Performance and Carcass Traits of Implanted Finishing Steers

| | Treatment | | | | | | |
| | Urea | | | SBM | | | |
Item	0	BMCG	SBM	0	BMCG	SBM	SEM
No. pens	4	4	4	4	4	4	
No. steers	24	24	24	24	24	24	
Initial wt, lb	741	742	745	744	743	741	1.4
Final wt[a], lb	1156	1156	1178	1167	1162	1165	13.7
Daily fee d[b], lb	25.47	24.51	24.87	23.92	24.36	23.61	.61
Daily gain, lb	3.72	3.70	3.88	3.79	3.71	3.79	.12
Feed/Gain [c,d,e]	6.86	6.64	6.41	6.32	6.56	6.25	.14
Carcass Traits							
Hot carcass wt, lb	717	717	731	724	721	722	8.5
Fat 12th ri b[f], in	.45[g]	.55[h]	.48[gi]	.51[hi]	.46[g]	.53[hi]	.02
KPH[j], %	2.05	2.09	2.25	2.13	1.98	2.13	.06
Loineye are a[e,j], sq in	12.8	12.1	12.4	12.3	12.1	12.4	.15
Marbling score [k]	4.77	5.21	5.12	4.98	4.85	5.06	.16
Yield grade	2.73	3.08	2.96	3.02	2.93	3.02	.08
Pct. Choice [j]	37.5	75.0	66.7	45.8	54.2	66.7	
Metabolizable protein intake, g/d	983	1112	1076	840	1029	949	

[a]Hot carcass weight/.62.

[b]Urea vs SBM (P<.07).

[c]Feed/gain was analyzed as gain/feed and reported as the reciprocal.

[d]Urea vs SBM (P<.05).

[e]SBM vs BMCG (P<.09).

[f]Basal by additional N source interaction (P<.02).

[ghi]Means in the same row with different superscripts differ (P<.10).

[j]Supplemental vs no supplemental protein (P<.08).

[k]4 = slight, 5 = small, 6 = modest.

Cattlemen's Day 1995

EFFECT OF RUMEN ESCAPE AMINO ACIDS AND MULTIPLE TBA IMPLANTS ON FEEDLOT PERFORMANCE OF LIGHTWEIGHT HOLSTEIN STEER CALVES

B. J. Healy, R. T. Brandt, Jr., and E. C. Titgemeyer

Summary

Two hundred forty Holstein steers (343 lb) were stratified by weight and allotted to one of eight treatment combinatio ns in a 2×4 factorial arrangement. Main effects were implant (Synovex-S (S) or Sy novex-S + Finaplix-S (SF) on day 0, 87, 168, and 238 and level of rumen escape amino acids (Smartamine-ML (SML) at 0, 5, 10, or 15 grams/head/day). These levels of SML supplied 0, 2.75, 5.5, and 8.25 g/day of L-lysine and 0, .75, 1.5, and 2.25 g/day of DL-methionine. Steers implanted with SF gained 4% faster, had a 4% improvement in feed:gain, a lower dressing percentage, 12% less backfat, 3.4% more rib-eye area, a lower yield grade, less marbling, and fewer Choice grades (P<.05) compared to S-implanted steers. Overall feed intake and carcass weights were similar between S- and SF-implanted steers. Use of SML resulted in a linear decline in hot carcass weight (P<.10) and KPH (P<.05), with other carcass traits unaffected. Increasing the level of SML tended to increase feed intake (P<.15), and quadratically degraded feed:gain (P<.10). Repeated implants of SF did not improve carcass worth and the use of rumen escape amino acids did not improve performance, suggesting that the basal diet was not first-limiting in lysine and(or) methionine.

(Key Words: Estradiol, Trenbolone Acetate, Rumen Escape Amino Acids, Holstein, Steers.)

Introduction

Cattle implanted with combinations of estradiol (E_2) and trenbolone acetate (TBA) typically have greater rates of lean deposition than those implanted with E_2 alone, which may increase amino acid requirements. Because lysine may be the first limiting amino acid in high-grain growing-finishing diets, synthetic lysine coated to resist ruminal degradation may provide a means to meet the added amino acid needs of steers implanted with an E_2/TBA combination. Some research has shown dramatic responses in Holstei n steers to a protected amino acid product (Smartamine-ML). Multiple TBA implants may enhance the demand of essential amino acids for growth. Our objectives were: 1) to determine if implanting with multiple doses of TBA in addition to E_2 enhanced the response to added rumen escape amino acids and 2) to determine if lightweight Holstein steers fed for over 300 days responded to repeated E_2/TBA implants, compared to E_2 alone.

Experimental Procedures

Two hundred forty Holstein steers (343 lb) were stratified by weight and allotted to pens (10 steers/pen, 3 pens/treatment) based on weight and previous treatment. Pens were assigned to one of e ight treatment combinations in a 2×4 factorial arrangement. Main effects were implant (E_2 (Synovex-S) or E_2/TBA (Synovex-S + Finaplix-S) on day 0, 87, 168, and 238 and level of Smartamine-ML (SML) (0, 5, 10, or 15 grams/head/day). These levels of SML supplied 0, 2.75, 5.5, and 8.25 g/day of L-lysine and 0, .75, 1.5, and 2.25 g/day of DL-methionine. Steers were processed using standard procedures and were stepped up to the final diet in 14 days. The basal diet contained (as a percentage of DM) 81.1% dry-rolled corn, 10% alfalfa hay, 2.7% molasses, and 6.3% supplement. The supplement was formulated so that the complete diet contained 2.4% soybean meal, .75% urea, and 13% CP. Initial weights were the averages of two consecutive, early morning weights. Final weights were taken on the morning when steers were shipped. At

31

slaughter, hot carcass weights were taken immediately. Carcass data were obtained after a 36-hour chill. Steers were on feed for 318 days (July 1, 1993 to May 16, 1994). Pre-planned orthogonal contrasts compared: 1) S vs SF, 2) linear effect of SML, 3) quadratic effect of SML, and 4) cubic effect of SML. Comparison of 5), 6), and 7) were linear, quadratic, and cubic interactions of SML and implant type.

Results and Discussion

Because few significant interactions occurred between implant type and SML level, only main effect means are presented (Tables 1 and 2). For days 0 to 87, SF-implanted steers gained 4.7% faster and were 5.5% more efficient than S-implanted steers (P<.01), but feed intakes were similar. Feed intake responded quadratically to increasing SML (P<.10), but daily gains were similar, which resulted in a quadratic response in feed:gain (P<.10). Steers fed the intermediate levels of SML had poorer feed:gain ratios than those fed 0 or 15 g/d. For days 88 to 168 and days 169 to 238, daily gain, feed intake, and feed:gain were unaffected by implant or level of SML, with the exception of a quadratic response in feed intake (P<.10) to level of SML from days 169 to 238. For days 239 to 318, SF-implanted steers gained 11% faster and were 9% more efficient than S-implanted steers (P<.01) but had similar feed intakes. Although daily gain and feed intake were unaffected by level of SML (P>.30), the numerical increase in feed intake while daily gain remained similar resulted in a linear degradation in feed:gain (P<.10) as level of SML was increased.

Final weights and overall rate and efficiency of gain were improved for steers implanted with SF (P<.05). Overall daily gain was unaffected by SML level, whereas feed intake tended to respond quadratically (P< .15), with greater feed intake at 5 and 10 g/d of SML than at 0 and 15 g/d. As a result, feed:gain deteriorated quadratically as level of SML increased from 0 to 15 g/d (P<.10). Dressing percentage was lower for steers implanted with SF than for S-implanted steers (P<.05), resulting in similar hot carcass weights. Percentage of kidney, pelvic, and heart fat (KPH) was unaffected by implant, but steers implanted with SF had 13% less

backfat, a greater muscling score, 3.3% more rib-eye area, and consequently a lower yield grade (P<.05) than S-implanted steers. However, SF-implanted steers had less marbling (P<.05), resulting in 35% fewer SF-implanted steers reaching the Choice grade (P<.01). Dressing percentage declined linearly and cubically (P<.05) as level of SML increased, ranging from 60.17% for 5 g/day SML to 59.11% for 15 g/day SML. This might be explained partially by the linear decline (P<.05) in KPH as level of SML increased. Hot carcass weights declined linearly (P<.10) as level of SML increased. Backfat, rib-eye area, muscling, marbling, and percent reaching the choice grade were unaffected by level of SML. Reduced marbling with repeated SF implants agrees with previous research (1993 KSU Cattlemen's Day) but differs in that carcass weights were similar between steers repeatedly implanted with S or SF. Although carcass leanness was improved by the use of SF implants, the percentage of steers reaching the Choice grade was reduced. We expected that using four TBA implants would reduce carcass quality grade. Our rationale was to increase muscling and, thus, increase demands for amino acids. Use of SML in this study resulted in lower carcass weights, although steers fed the 5 and 10 g/day levels consumed more feed. Carcass traits were mostly unaffected, with the only noted improvements from feeding SML being a reduction in KPH, a slight numerical increase in rib-eye area, and a trend for an improvement in yield grade. We conclude that repeated use of Finaplix-S implants as an addition to Synovex-S implantation increased muscling, but because fewer graded Choice, did not increase carcass value, and that lysine and(or) methionine were not first limiting in the basal diet.

Table 1. Effects of Implant and Smartamine-ML on Performance of Holstein Steers

Item	Implant[a] S	SF	SEM	Smartamine-ML, g/d 0	5	10	15	SEM
Initial wt, lb	343	343	1	342	344	344	343	1
Final wt, lb [b]	1251	1287	7	1275	1269	1266	1266	10
Days 0-87								
ADG, lb [b]	3.17	3.32	.03	3.19	3.24	3.25	3.29	.04
ADFI, lb [d]	14.8	14.6	.2	14.4	15.1	14.8	14.6	.2
Feed:gain [b]	4.67	4.41	.04	4.52	4.65	4.56	4.43	.06
Days 88-168								
ADG, lb	3.24	3.32	.05	3.25	3.31	3.31	3.26	.06
ADFI, lb [d]	18.8	18.7	.4	18.0	19.2	19.4	18.3	.6
Feed:gain	5.80	5.64	.15	5.54	5.82	5.88	5.63	.21
Days 169-238								
ADG, lb	2.43	2.41	.06	2.52	2.32	2.42	2.44	.09
ADFI, lb	19.4	19.0	.5	18.6	19.4	19.5	19.2	.7
Feed:gain [d]	8.02	7.91	.23	7.41	8.45	8.09	7.91	.32
Days 239-318								
ADG, lb [b]	2.45	2.72	.06	2.63	2.66	2.53	2.53	.09
ADFI, lb	20.6	20.8	.4	20.3	21.1	20.6	20.6	.5
Feed:gain [b,c]	8.43	7.65	.14	7.76	7.97	8.19	8.24	.20
Days 0-318								
ADG, lb [b]	2.85	2.97	.02	2.93	2.91	2.90	2.90	.03
ADFI, lb	18.2	18.1	.3	17.7	18.6	18.4	18.1	.4
Feed:gain [b,d]	6.40	6.11	.09	6.04	6.38	6.36	6.23	.12

[a]S=Synovex-S, SF = Synovex-S + Finaplix-S. [b]Effect of implant (P<.01). [c]Linear effect of Smartamine-ML (P<.10). [d]Quadratic effect of Smartamine-ML (P<.10).

Table 2. Effects of Implant and Smartamine-ML on Carcass Traits of Holstein Steers

Item	Implant[a] S	SF	SEM	Smartamine-ML, g/d 0	5	10	15	SEM
Hot wt, lb [d]	751	760	4.6	762	764	749	748	6.5
Dressing % [b,c,e]	60.06	59.04	.16	59.76	60.17	59.16	59.11	.23
Backfat, in. [b]	.222	.196	.006	.211	.209	.209	.206	.008
KPH, % [c]	2.52	2.52	.02	2.56	2.55	2.49	2.47	.02
REA, sq. in. [b]	12.15	12.57	.12	12.28	12.32	12.48	12.36	.17
Yield grade [b]	2.53	2.38	.04	2.52	2.48	2.39	2.42	.05
Muscling [b,f]	3.00	3.26	.07	2.99	3.25	3.12	3.16	.09
Marbling [g]	5.20	5.01	.04	5.13	5.09	5.09	5.10	.05
% Choice [h]	72	47		55	57	62	63	

[a]S=Synovex-S, SF = Synovex-S + Finaplix-S. [b]Effect of implant (P<.05). [c]Linear effect of Smartamine-ML (P<.05). [d]Linear effect of Smartamine-ML (P<.10). [e]Cubic effect of Smartamine-ML (P<.05). [f]Muscling score: 1=very light muscling, 3=average muscling, 5=very heavy muscling. [g]Marbling score: 4=slight [0], 5=small [0], 6=modest [0]. [h]Chi-square analysis, S vs SF (P<.01).

Cattlemen's Day 1995

COMBINATIONS OF NONPROTEIN NITROGEN AND NATURAL PROTEIN AFFECT PERFORMANCE OF FINISHING STEERS FED FLAKED CORN DIETS [1]

B. J. Healy, R. T. Brandt, Jr., and T. P. Eck [2]

Summary

Two hundred crossbred steers (7 85 lb) were used to evaluate the effects of the relative proportion of supplemental nitrogen derived from soybean meal (SBM) and urea. Treatments included an unsupplemented negative control and four 13% CP diets containing SBM:urea proportions (nitrogen basis) of 100:0, 67:33, 33:67, and 0:100. Steers fed the control diets gained 38% slower (P<.01); ate 4% less feed (P<.10); were 33% less efficient (P<.01); and had lighter carcasses (P<.01) with less backfat (P<.01), less kidney, pelvic, and heart fat (KPH; P<.12), less ribeye area (REA; P<.11), and less marbling (P<.01) than nitrogen-supplemented steers. Among steers fed supplemented diets, feed intake increased linearly as proportion of SBM increased (P<.01). Daily gain (P<.05) and feed:gain (P<.05) responded quadratically and was best for steers fed combinations of the nitrogen sources. Similarly, hot carcass weights and backfat thickness were greater (P<.06) for steers fed the mixed supplements. There was a tendency for a linear increase in KPH as proportion of urea in the diet was increased (P<.14). Yield grade, r beye area, and marbling were unaffected by SBM:urea proportions. In high-concentrate finishing diets, at least some of the supplemental nitrogen should be derived from a natural, degradable-protein source.

(Key Words: Soybean Meal, Urea, Finishing Steers.)

Introduction

Nitrogen (protein) supplementation of feedlot diets can be viewed as meeting three "requirements": 1) ammonia for ruminal microbes, 2) peptide/amino acid for ruminal microbes, and 3) postruminal digestible amino acids (metabolizable protein) for the animal. Urea can supply ruminal ammonia and, indirectly, digestible amino acids as microbial protein. Because a portion of SBM protein is degraded in the rumen, it can contribute to all three requirements. Some research has shown that starch-digesting bacteria derive two-thirds of their nitrogen from peptides and(or) amino acids. Because corn protein is largely resistant to ruminal degradation, supplying a natural, degradable protein in high-corn finishing diets may be beneficial. Although nitrogen supplementation of feedlot diets has both qualitative and quantitative dimensions, practical formulation still centers on a total nitrogen (crude protein) system with limited consensus on ruminal degradability and on the usefulness of supplying natural, degradable protein to the ruminal ecosystem. Previous research (1994 KSU Cattlemen's Day) showed that urea can meet only part of the total protein needs of feedlot steers. Our objective was to better establish the relative contributions of nonprotein nitrogen and natural protein to performance of steers fed diets based on steam-flaked corn.

Experimental Procedures

Two hundred Continental × British steers (785 lb) were allocated to one of four weight blocks. Within each block, steers were allotted to one of five pens. Treatments included an unsupplemented negative control and four 13% CP diets containing SBM:urea proportions (nitrogen basis) of 100:0, 67:33, 33:67, and 0:100 (Table 1). Steers were processed using standard procedures, implanted with Revalor, and stepped up to the final rations in 21 days. Initial weights were the averages of two consecutive, early morning weights. Because treatment affected dressing percentage (control vs. others; P < .01), final weights were calculated from hot carcass weights using the average dressing percent (61.54%). These adjusted final weights were used to calculate overall gain and feed efficiency. Hot carcass weights were taken immediately after slaughter and carcass data obtained following a 48-hour chill. The heaviest block was slaughtered after 126 days on feed, and the remaining three blocks after 150 days. The experiment was conducted from July 1 to November 28, 1994 at the Southwest Research-Extension Center, Garden City. Preplanned orthogonal contrasts compared control vs. supplemented diets and the linear, quadratic, and cubic effects of altering SBM:urea nitrogen.

Results and Discussion

Nitrogen-supplemented steers gained 38% faster (P<.001) than unsupplemented controls, while consuming only 4% more feed (P<.10). Consequently, the supplemented steers were 33% more efficient (P<.01). As a result of their slower growth, steers fed the control diet were 124 lb lighter (P<.01) at slaughter and had 38% less backfat (P<.01), 10% less KPH (P<.12), 5% less ribeye area (P<.11), and lower yield grades (P<.04). In addition, control steers had less marbling (P<.01) and tended to have fewer grading Choice (P<.16).

Within the supplemented diets, daily gain responded quadratically (P<.05), with great-er gains for diets containing both protein sources. As the proportion of SBM nitrogen increased, feed intake increased linearly (P<.02). Consequently, feed efficiency improved curvilinearly (P<.05) as the proportion of urea increased. The lowest feed:gain ratio was at 33% SBM:67% urea. The increased gain on the mixed-nitrogen supplements translated into 17 lb additional carcass weight or 28 lb additional final live weight (P<.06) compared to those supplemented with only SBM or urea. Backfat also responded quadratically (P<.05) to the increasing proportion of urea, with 20% greater fat depth for steers fed SBM-urea combinations vs. SBM or urea alone. In contrast, KPH tended to increase linearly (P<.14) as urea increased. Although small increases occurred in ribeye area for steers fed the mixed-nitrogen sources, they were not statistically significant. Yield grades, marbling, and percent grading choice were similar among steers fed the supplemented diets.

Steers fed combinations of SBM and urea in 13% CP flaked corn-based diets performed better than those supplemented with SBM or urea alone. Although fat thickness also increased for these intermediate levels, yield grade was unaffected. Because carcass weight also increased, these data suggest that the composition of the extra gain is similar to gains of steers fed single-source supplements. The greater feed intake observed with SBM agrees with previous research (1994 KSU Cattlemen's Day). Soybean meal has less utilizable energy than steam-flaked corn and this likely caused poorer efficiency as the proportion of SBM was increased. The diet supplemented with only urea probably had greater utilizable energy, but performance was improved by small additions of SBM, which may have contributed to the supply of protein postruminally or alternatively may have provided needed peptides and(or) amino acids to the rumen microbes. These data suggest that, in high-concentrate finishing rations, at least some of the supplemental nitrogen should be derived from a natural, degradable-protein source such as SBM.

35

Table 1.   Composition of Experimental Diets [a]

		Soybean Meal:Urea			
Item	Control	100:0	67:33	33:67	0:100
Flaked corn	80.0	69.2	73.0	76.7	80.0
Ground corn [b]	7.1	7.6	6.8	6.0	5.5
Silage [c]	10.0	10.0	10.0	10.0	10.0
Soybean meal [d]	----	10.8	7.0	3.3	----
Urea [b]	----	----	.6	1.2	1.7
Vit-min mix [be]	2.9	2.4	2.6	2.8	2.8
Crude protein [f]	8.3	13.0	13.0	13.0	13.0

[a]Dry matter basis.
[b]Ground corn, urea, and vitamin-mineral mix were mixed into a supplement included at 10% of diet dry matter.
[c]Sorghum silage was fed from day 0 to 83, then corn silage to end of trial.
[d]Contained 44% CP (as-fed basis).
[e]Formulated so that complete diets contained .7% Ca, .35% P, .7% K, 1465 IU/lb   Vitamin A, 16 IU/lb Vitamin E, 27 ppm monensin, 10 ppm tylosin, and a N:S ratio of 10:1.
[f]Calculated.

Table 2.   Effect of Soy bean Meal:Urea Nitrogen on Performance and Carcass Traits of Steers Fed a Steam-Flaked Corn-Based Diet

		Soybean Meal:Urea					Statistical Contrasts [a]		
Item	Control	100:0	67:33	33:67	0:100	SEM	C vs. S	L	Q
No. pens	4	4	4	4	4				
No. steers	40	40	40	40	40				
Initial wt, lb	785	787	786	783	783	2.7			
Final wt, lb [b]	1118	1226	1255	1257	1230	13.3	.001	---	.06
ADFI, lb	19.6	20.8	20.7	20.1	19.7	.33	.10	.02	---
ADG, lb	2.31	3.05	3.26	3.29	3.11	.08	.001	---	.05
Feed:gain	8.53	6.82	6.33	6.11	6.33	.16	.001	.04	.05
Carcass									
Hot wt, lb	688	754	772	773	757	8.2	.001	---	.06
Dressing %	60.6	61.6	61.9	61.9	61.8	.24	.001	---	---
Backfat, in	.36	.44	.52	.56	.46	.04	.01	---	.05
KPH, %	1.79	1.88	1.94	1.98	2.10	.10	.12	.13	---
REA, sq. in	11.71	12.13	12.48	12.50	12.05	.29	.11	---	.20
Yield grade	2.61	2.95	3.14	3.24	3.01	.17	.04	---	---
Marbling [c]	4.82	5.28	5.23	5.26	5.22	.09	.01	---	---
Choice, % [d]	45	60	68	65	70				

[a]Statistical contrasts: C vs. S = control vs. supplemented, L =   linear effect of SBM:urea, Q = quadratic effect of SBM:urea. Dashes indicate (P>.20). All cubic effects were nonsignificant (P>.60).
[b]Final weight = hot carcass weight/.6154.
[c]Marbling scores: 4 = sligh t^0, 5 = smal l^0, 6 = modes t^0.
[d]Analyzed by chi-square analysis, treatment difference (P<.16).

36

Cattlemen's Day 1995

SULFUR AMINO ACID UTILIZATION
BY GROWING STEERS

C. G. Campbell, E. C. Titgemeyer, and G. St. Jean [1]

Summary

Two studies were conducted to evaluate sulfur amino acid requirements of growing steers. In trial 1, six ruminally cannulated steers (352 lb) were used to determine methionine requirements. Treatments were abomasal infusions of 0, 2, 4, 6, 8, or 10 g/day of L-methionine. Steers were fed 5.8 lb of a soyhull and wheat straw based diet. Continuous infusions of acetate, propionate, and butyrate into the rumen and of dextrose into the abomasum were made to increase energy. Amino acids other than methionine were infused into the abomasum to ensure that they did not limit steer performance. Nitrogen retention increased dramatically as methionine supplementation increased and, in the presence of excess cysteine, predicted a requirement of 4 g/day of supplemental L-methionine. Plasma methionine rose with methionine supplementation and predicted a supplemental methionine requirement of 2 g/day. In trial 2, five ruminally cannulated steers (429 lb) were used to determine how efficiently methionine is converted to cysteine in growing cattle. The experimental procedures were similar to those of trial 1, except steers received a basal supplement of amino acids containing 4 g/day L-methionine (requirement in the presence of excess cysteine established in trial 1) and no cysteine. Treatments consisted of abomasal infusions of 0, 1.62, or 3.25 g/day of L-cysteine or 2 or 4 g/day of additional L-methionine. Nitrogen retention was increased by methionine, but not by cysteine, suggesting that cysteine could supply less than one-half of the total sulfur amino acid requirement (methionine + cysteine) of growing steers.

(Key Words: Methionine, Cysteine, Steers, Requirement, Nitrogen Retention.)

Introduction

Methionine currently is thought to be potentially limiting for growth in cattle, but much previous research has relied on plasma amino acid levels as the sole response criteria. That research needs verification, because several factors other than amino acid status can affect plasma amino acid levels. Nitrogen retention provides a more precise estimate of the methionine requirement of growing cattle and also allows extrapolation to given levels of performance.

Cysteine is considered nutritionally non-essential, because the cysteine requirement of most species can be supplied by methionine via transsulfuration (methionine conversion to cysteine). It is important to know the efficiency of transsulfuration in growing cattle, so that we can better predict total sulfur amino acid (methionine plus cysteine) requirements. For most species, the cysteine requirement is about one-half of the total sulfur amino acid requirement and transsulfuration is assumed to be efficient, but little information exists for cattle. Our objective was to quantitate sulfur amino acid requirements of growing steers.

---

[1]Department of Clinical Sciences.

Experimental Procedures

Trial 1. Six ruminally cannulated Holstein steers (352 lb) were utilized in a 6 × 6 Latin Square design, with treatments being graded levels of L-methionine (0, 2, 4, 6, 8, and 10 g/day). Each period was 6 days long, with 2 days used for treatment adaptation and 4 days for total collection of urine and feces. Blood samples were collected on the last day of each period. Steers were fed 5.8 lb of a diet containing 83% soyhulls, 8% wheat straw, and 1% urea. Volatile fatty acids (225 g acetate, 225 g propionate, and 56 g butyate/day) were infused continuously into the rumens and dextrose (150 g/day) was infused into the abomasums of steers to ensure that energy would not limit their ability to deposit protein. To ensure that amino acids other than methionine would not limit nitrogen retention, L-valine (21.2), L-leucine (29.6), L-isoleucine (21.6), L-lysine (41.1), L-histidine (9.2), L-arginine (19.6), L-threonine (21.2), L-phenylalanine (38.0), L-tryptophan (6.5), L-glutamate (152.8), and glycine (50.8 g/day) were infused into the abomasum. To estimate the specific requirement for methionine (i.e., under conditions where no methionine would be needed to meet cysteine needs), cysteine was included in the amino acid mixture at 12 g/day, a level assumed to exceed the steer's require-ment. Problems with infusions resulted in less than six observations per treatment (Table 1).

Trial 2. Five ruminally cannulated Holstein steers (429 lb) were used in a 5 × 5 Latin Square design. Conditions for this trial were similar to those used in trial 1, except the amount of supplemental L-methionine found to maximize nitrogen retention in the presence of excess cysteine in trial 1 (4 g/day) was provided to all steers in the basal amino acid infusions. Also, cysteine was deleted from the basal amino acid infusions. Treatments were abomasal infusions of 0, 1.62, or 3.25 g/day of L-cysteine or 2 or 4 g/day of additional L-methionine. Cysteine was supplied in equimolar amounts to methionine. Diets were similar to those in trial 1.

Ruminal infusions of 180 g acetate, 180 g propionate, and 45 g butyrate (per day) and abomasal infusions of dextrose (300 g/day) were provided. Nonsulfur amino acids were abomasally infused in amounts similar to those used in trial 1.

Results and Discussion

Trial 1. All increases in nitrogen retention resulted from decreased urinary nitrogen excretion. Nitrogen retention increased the most when steers were infused with up to 4 g/day of L-methionine, with some additional response as methionine supplementation increased to 10 g/day (Table 1). We conclude that the supplemental methionine requirement of these steers is 4 g/day in the presence of excess cysteine. Plasma methionine levels were lowest when steers were infused with 0 or 2 g/day of methionine, and increased linearly when higher levels were infused, which predicted a supplemental requirement of 2 g/day, a level below that predicted by the nitrogen retention data.

Trial 2. Nitrogen retention for growing steers increased in response to methionine infusion and was maximized at a total methionine level of 6 g/day (4 g basal plus 2 g supplemental; Table 2). Nitrogen retention was not affected by cysteine supplementation. The lack of response to cysteine supplementation suggests that cysteine did not spare any of the steers' requirement for methionine. Plasma methionine levels increased with methionine supplementation, but not with cysteine supplementation. If cysteine did spare methionine, we might expect an increase in plasma methionine levels as cysteine supplementation increased. Sulfur amino acid supplementation as methionine supported protein deposition better than did cysteine supplementation. The nonprotein functions of methionine (e.g., methyl group donor) may be quantitatively important enough to result in the higher requirement for methionine relative to cysteine. However, this conclusion may be limited to steers maintained under our experi-mental protocol.

Table 1.   Effects of Supplementing L-Methionine to Growing Holstein Steers

Item	L-Methionine, g/day						SEM
	0	2	4	6	8	10	
Steers/treatment	4	4	4	4	3	4	
Intake N, g/d	100.1	97.8	99.5	95.3	100.2	102.9	
Fecal N, g/d	19.7	18.6	18.6	18.1	20.1	22.3	2.0
Urinary N[a], g/d	57.4	53.0	49.6	46.0	46.8	42.1	3.1
Retained N[a], g/d	22.9	26.2	31.3	31.1	33.2	38.5	4.1
Plasma methionine[a], μM	11.9	11.7	20.4	20.8	31.1	36.7	2.9

[a]Linear effect of methionine (P<.01).

Table 2.   Effects of Supplementing L-Methionine or L-Cysteine to Growing Steers

Item	L-Methionine, g/d			L-Cysteine, g/d		SEM
	0	2	4	1.62	3.25	
Intake N, g/d	107.7	107.9	108.1	107.9	108.1	
Fecal N, g/d	20.8	20.8	20.7	20.5	21.0	.6
Urinary N[a], g/d	52.3	48.1	48.9	52.1	50.9	1.4
Retained N[b], g/d	34.6	39.0	38.5	35.3	36.2	1.3
Plasma methionine[c], μM	13.1	19.9	24.8	18.1	17.3	2.3

[a]Linear effect of methionine (P=.07), Quadratic effect of methionine (P=.11).
[b]Linear effect of methionine (P=.03), Quadratic effect of methionine (P=.09).
[c]Linear effect of methionine (P=.001).

Cattlemen's Day 1995

THE EFFECT OF A CORE ANTIGEN VACCINE ON HEALTH AND PERFORMANCE OF CATTLE DIAGNOSED WITH BOVINE RESPIRATORY DISEASE

G. L. Stokka, R. T. Brandt, Jr.,
K. Kreikemeier, and T. Milton

Summary

When studied in receiving trials at three locations, health or performance of calves receiving a core antigen vaccine was not improved.

(Key Words: Core Antigen, Vaccine, Health, Performance.)

Introduction

Undifferentiated bovine respiratory disease results in millions of dollar s lost each year to the beef cattle industry. The cause is often multifactorial but may involve viral or bacterial agents, or both, in addition to risk factors that increase susceptibility to the disease. Gram negative bacteria such as *Pasteurella hemolytica* and *P. multocida* are often involved. Disease conditions caused by gram negative bacteria are most often consequences of the animal's reaction to a lipopolysaccharide component of bacterial cell walls called endotoxin. Effects of endotoxin include increased heart rate with decreased cardiac output, decreased systemic blood pressure, and hyperthermia followed by hypothermia, respiratory distress, and diarrhea.

Numerous commercial vaccines have been developed to prevent respiratory disease, but the success of vaccination with some of these products has been debatable. Recent developments have made it possible to prepare vaccines from isolated bacterial cell wall components called core antigens. Limited information is available on the efficacy of these products in reducing the effects of gr am negative infections, particularly respiratory disease. These trials were designed to evaluat e the efficacy of *E. coli* J5 core antigen vaccine on health and perfor-

mance of beef cattle under the difficult conditions surrounding their arrival at feedlots that result in respiratory disease.

Experimental Procedures

Approximately 115-200 calves at each of three different sites were used in the study. Each site represented a different set of risk factors for respiratory disease. Trial 1 represented long haul, moderately to highly stressed calves weighing approximately 500-550 pounds. Trial 2 represented freshly weaned, short haul, moderately stressed calves weighing approximately 51 6 pounds. Trial 3 represented long haul, highly stressed bull calves weighing approximately 550 pounds.

Trial 1. This trial was a completely randomized design with a four-way treatment structure. Treatment 1 was tilmicosin (Micotil® 8cc) given subcutaneously as a mass medication on arrival, plus the *E. coli* core antigen vaccine. Treatment 2 was 20 cc of 100 mg oxytetracycline given intramuscularly as a mass medication on arrival, plus core antigen vaccine. Treatm ents 3 and 4 were tilmicosin or oxytetracycline without the core antigen vaccine. All calves received IBR, PI3, BVD, BRSV (MLV), and a clostridial 7-way vaccine and were dewormed on arrival. Calves were purchased in Mississippi, processed on the day of arrival, and randomly assigned to one of the four treatments.

Trial 2. This trial was a completely randomized design with calves randomly assigned to one of two treatments and one of four pens. Calves were removed from the cows, held off feed and water overnight and processed the following morning. Treatment 1 received the *E. coli* core antigen vaccine, and treatment 2 did

not. All calves were given IBR, PI3, BVD, BRSV (MLV), and 7-way clostridial vaccines and were dewormed at processing.

Trial 3. This trial was a completely randomized design, with calves assigned to one of two treatments across pens. One hundred fifteen bull calves weighing approximately 550 pounds were purchased from Missouri. Calves were processed approximately 2 1/2 days after arrival and subsequently monitored for signs of illness. Treatment 1 received *E. coli* core antigen vaccine on arrival; treatment 2 calves did not. All calves received IBR, PI3, BVD, BRSV (MLV), and 7-way clostridial vaccine and were dewormed on arrival.

Results and Discussion

Trial 1. One hundred ninety five calves were included in this study. Thirty five were diagnosed with respiratory disease, for a morbidity rate of 17.9%. Data are shown in Table 1. Peak incidence of morbidity occurred on day 5. No calves died.

There was a significant treatment effect in the number of pulls. The comparison favored the cattle that were mass medicated on arrival with tilmicosin (P=.0074), regardless of the effect due to the core antigen vaccine. Micotil® is a long acting, macro-

lide antibiotic, that has been proven to reduce morbidity when used as a mass medication on arrival. Growth performance data was not collected at this site.

Trial 2. Peak incidence of morbidity occurred approximately day 9 post weaning. A total of 107 calves were diagnosed as ill out of 243, and one calf died of bloat. Data are shown in Table 2. There were no significant differences in morbidity due to treatment.

Trial 3. A total of 94 calves out of the 115 were diagnosed and pulled for respiratory disease. Peak incidence of morbidity occurred on day 10. Results are shown in Table 3. No significant differences occurred in the number of pulls or deaths for those calves receiving or not receiving the core antigen vaccine.

No differences occurred in growth performance of calves in the first 21 days of the receiving phase.

The use of respiratory vaccines to prevent undifferentiated bovine respiratory disease is a well accepted practice in the beef industry. There is recent interest in the use of core antigen vaccines to prevent the effects of endotoxemia, which accompanies gram negative respiratory infections. Our work indicates that, in several different stress categories and types of cattle, there is no benefit to the use of *Escherichia coli* core antigen vaccine against undifferentiated bovine respiratory disease.

Table 1. **Effect of a Core Antigen Vaccine on Morbidity of Moderately Stressed Long-Haul Calves**

Treatment	No. of Pulls[a]	% Morbid.	No. of Calves
tilmicosin + core antigen	4	8.2	49
oxytetracycline + core Antigen	11	22.4	49
tilmicosin	6	12.5	48
oxytetracycline	14	28.6	49

[a]Removal from pens for treatment of respiratory disease.

Table 2.   Effect of a Core Antigen Vaccine on Morbidity and Growth Performance of Moderately-Stressed, Weaned Calves

Treatment	No. of Pulls[a]	% Morbid.	ADG (30 Days)	No. of Calves
Core antigen	52	48.6	1.70	121
No antigen	55	51.4	1.58	122

[a]Removal from pens for treatment of respiratory disease.

Table 3.   Effect of a Core Antigen Vaccine on Morbidity, Mortality and Growth Performance of Highly Stressed Bull Calves

Treatment	No. of Pulls[a]/Deaths	Percent Morbid./Mort.	Mean ADG (21 days)	No. of Calves
Core antigen	49/3	87.5/5.4	0.6	56
No antigen	45/5	76.3/8.5	0	59

[a]Removal from pens for treatment of respiratory disease.

Cattlemen's Day 1995

FEEDER CATTLE PRICE DIFFERENTIALS: HOW MUCH DID THEY CHANGE OVER TIME? [1]

J. Mintert [2], T. Schroeder [2], F. Brazle,
J. Sartwelle, III [2], R. Bolze, Jr., and M. Langemeier [2]

Summary

Results from mathematical mode s of feeder cattle price/characteristics using data collected in Kansas and Missouri in 1986/1987 and from 1993 using the same data collection and modeling procedures indicate that the implicit values of many feeder cattle characteristics changed over time. Characteristic values often changed whether their value was measured in dollars per hundredweight or as a percentage of the mean feeder price during the data collection period. Directional impacts of characteristics on feeder cattle price were generally consistent from 1986/1987 to 1993. These results imply that, as market conditions change, new feeder cattle price/characteristic relationships need to be estimated.

(Key Words: Feeder Cattle, Prices, Physical Characteristics.)

Introduction

Prices paid for lots of feeder cattle vary because of changing market conditions and also because of differences in their physical characteristics. Price differences associated with changes in various physical characteristics are referred to as implicit values of those characteristics. This study examined whether implicit values of feeder cattle characteristics vary over time, when the characteristics are measured and modeled in the same manner for the same geographical area. Previously, it has been difficult to determine whether changes in feeder cattle characteristic values across studies were attributable to structural changes in demand for feeder cattle characteristics, differences in data collection and modeling procedures, or geographical differences. Many feeder cattle buyers and sellers use publicly available research results on characteristic values to improve their management and marketing decisions. If characteristic values change appreciably over time, estimates should be updated periodically and cattle market participants should be wary of relying on dated characteristic-value information.

Experimental Procedures

To test whether feeder-cattle characteristic values changed over time, data were collected at two different stages in the cattle cycle; fall 1986/spring 1987 and spring and fall of 1993. Data were collected at seven weekly Kansas feeder cattle auctions in 1986/1987 and at seven Kansas auctions and one Missouri auction in 1993. Evaluators for both data collection periods received the same training. Fall 1986 data were collected from October 29, through December 13, and spring 1987 data were collected from March 19 through April 15. Data collection during 1993 took place from March 15 through April 17 and again from November 1 through December 11 with November 22-27 omitted because of the Thanksgiving holiday. Evaluators recorded price per hundredweight for each lot, and individual lots of cattle were evaluated with respect to nine animal characteristics (breed,

---

frame size, muscling, fill, condition, horns, health, uniformity, and average weight per head). Data recorded for each lot also included the time of sale, lot size, market location, and feeder-cattle futures price. The settlement price for nearby feeder-cattle futures contract from the day prior to the sale was recorded for cattle sold before 1 p.m., and the current day's closing price was recorded for cattle sold after 1 p.m.

The data set consisted of information collected on 38,788 lots of steers and heifers weighing between 300 and 899 lb for a total of 362,858 head. Forty-four percent of the lots were sold in 1986/1987 and 56 percent were marketed during 1993. Cattle prices were substantially higher during 1993 than in 1986/1987. For example, the mean price for a 700-799 lb steer in the 1993 data was $81.35 per hundredweight compared to a mean price in the 1986/1987 data of $63.46 per hundredweight, a 28% price increase for that weight class. Fifty-five percent of the cattle were steers and 45% were heifers in 1986/1987 compared to 54% steers and 46% heifers in 1993. During 1986/1987, 58% of the cattle were sold in the fall and 42% in the spring, whereas 49% of the cattle were sold in the fall and 51% in the spring during 1993.

Demand for a lot of feeder cattle will be affected by each lot's physical traits. Therefore, feeder-cattle price was modeled as a function of the physical characteristics possessed by the particular lot and the fundamental market forces reflecting feeder-cattle supply and demand changes over the observed time period. Feeder-cattle futures prices were used to capture the effect of changes in fundamental market forces. Separate models were estimated for steers weighing 300-599 lb, steers weighing 600-899 lb, heifers weighing 300-599 lb and heifers weighing 600-899 lb.

Results and Discussion

Selected results from the four steer models are reported in Table 1. Heifer models are not reported to conserve space, so the discussion will focus primarily on the steer models results. All parameter estimates represent price changes from a reference lot of uniform, heavily muscled, Hereford steers in good health, average condition and fill, without horns, and sold during the first quarter of the sale at auction market 1. The steer and heifer models explained 59 to 74% of the variation in feeder-cattle prices. Statistical tests indicated that the feeder-cattle price/characteristics relationship did change from 1986/1987 to 1993, but that the degree of change varied by characteristic.

The impact of lot size was more pronounced in 1993 than in 1986/1987 (Figure 1). During 1986/1987, heavyweight steers received the highest lot-size premium when sold in lots ranging from 60 to 70 head. In 1993, buyers preferred cattle sold in slightly larger lots as the highest lot-size premium occurred for lots of 65 to 75 head. More importantly, the price premium associated with each lot size was larger in 1993 than in the previous time period. For example, at a lot size of 65 head, the lot-size premium for heavyweight steers was $6.37 per hundredweight in 1993 compared to $4.16 in 1986/1987.

Lot-size premiums for lightweight steers increased more markedly from 1986/87 to 1993 than those for heavyweight steers (Figure 2). During both time periods, lot sizes of 40 to 50 head received the highest lot-size premiums, with the highest occurring at 43 head in 1993 vs. 46 head in 1986/1987. At a lot size of 45 head, the maximum lot-size premium for steers weighing 300-599 lb in 1993 was $11.52 vs. $6.27 in 1986/1987. These results indicate that buyers still prefer to buy lighter-weight cattle in smaller lot sizes than heavyweight cattle and that they were willing to pay much larger premiums

in 1993 than in 1986/1987 to buy cattle in truckload lots.

Feeder-cattle buyers prefer heavy-muscled cattle. Consequently, light- and medium-muscled cattle were discounted compared to heavy-muscled cattle. The discounts for medium muscling changed little over the 6 years between samples, but the discount for light-muscled animals increased sharply for both lightweight and heavyweight steers measured in both dollars per hundredweight and as a percentage of the average price. For example, the percentage discount for heavy weight light-muscled steers increased from 7% in 1986/1987 to 19% in 1993. This shift in discounts could be indicative of increasing concern by feeder-cattle buyers about carcass quality.

Feeder-cattle buyers tend to prefer cattle classified in the upper medium or large frame categories. Steers in the lower medium category in both weight classes received discounts compared to large framed steers, but the discounts were smaller in 1993 than in 1986/1987. Lightweight, small-framed feeder steers were discounted between $9 and $10 per hundredweight in both time periods, but the discount for heavyweight small-framed feeder steers more than doubled from 1986/1987 to 1993. This shift in discounts could indicate that feeder-cattle buyers became more concerned about purchasing feeder cattle that will produce carcasses desired by packers and that will perform well when placed on a finishing ration.

Table 1.   Estimated Premiums and Discounts[a] Associated with Feeder Steer Characteristics, Fall 1986/Spring 1987 and 1993 [b]

Characteristics	1986-1987 Steers 300 - 599 lb	1993 Steers 300 - 599 lb	1986-1987 Steers 600 - 899 lb	1993 Steers 600 - 899 lb
	---------------------------------- ($CWT) ----------------------------------			
Muscling				
Heavy muscling (base)	0	0	0	0
Medium muscling	-4.34**	-5.05**	-3.36**	-3.46**
Light muscling	-14.56**	-20.61**	-4.28*	-15.46**
Frame Size				
Large frame (base)	0	0	0	0
Medium upper 1/2	.60*	.95**	-.073	.08
Medium lower 1/2	-1.46**	-1.09*	-1.80**	-1.13**
Small	-9.11**	-9.88**	-4.17**	-8.90**
Adjusted R-squared	.71	.60	.74	.59
Observations	5306	6291	4071	5475
Dependent variable mean	$68.33	$92.15	$63.47	$81.85

*Different from zero (P<.05).

** Different from zero (P<.01).

[a]All premiums and discounts are relative to the reference lot of heavily muscled Hereford steers in healthy condition, average fill and condition, large frame size, without horns, in a uniform lot, and sold during the first quarter of the sale at market 1.

[b]The seven markets from which data were collected in 1986/1987 were Dodge City, Fort Scott, Manhattan, Parsons, Pratt, Russell and Salina, Kansas. The eight markets from which data were collected in 1993 were Dodge City, Junction City, Manhattan, Oakley, Parsons, Pratt and WaKeeney, Kansas, in addition to Joplin, Missouri.
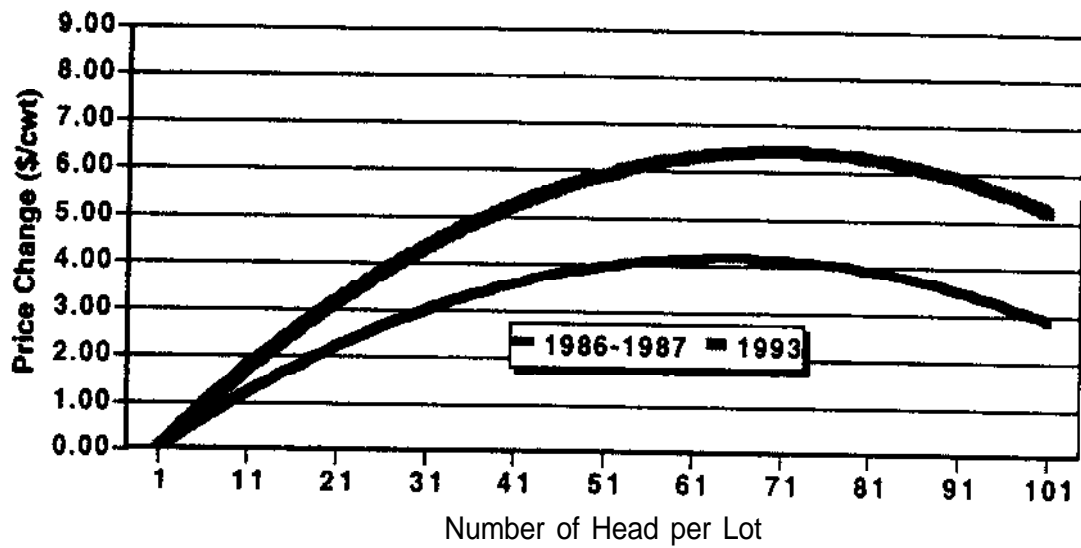
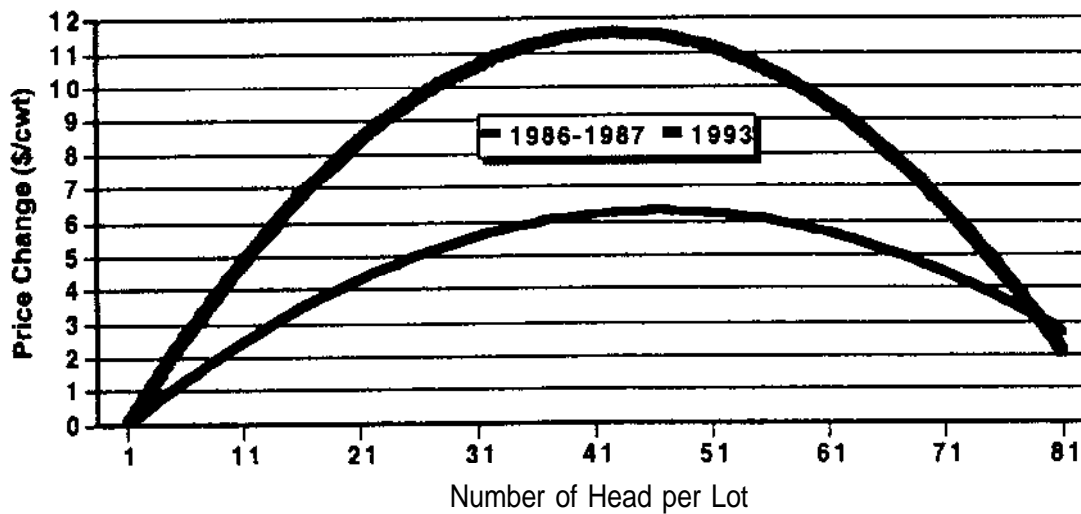**Figure 1.   Lot Size Impact on Prices for 600- to 899-lb Steers**

Figure 2.   Lot Size Impact on Prices for 300-to 599-lb, Steers

46

Cattlemen's Day 1995

HOW THE PRICE OF DIFFERENT BREEDS OF FEEDER CATTLE HAS CHANGED OVER TIME [1]

F. K. Brazle [2], J. R. Mintert [3], J. Sartwelle, III [3]
T. Schroeder [3], and R. P. Bolze, Jr. [2]

Summary

Data on feeder steer characteristics, breeds, and prices were collected in 1986/87 and 1993 at Kansas and Missouri feeder cattle auctions to identify changes in buyers' preferences for various breeds. Results from models of feeder steer price/characteristics indicate that the relative value of many breeds changed over time. Relative to Hereford steers, Angus, Hereford × Angus cross, Continental cross, and low percentage Brahman steers all gained in price from 1986/87 to 1993. Longhorn Cross steers' price declined relative to Hereford steers over the same time period.

(Key Words: Feeder Steer, Prices, Feeder Steer Characteristics, Breeds.)

Introduction

This study examined whether buyers' preferences for various breeds of feeder cattle changed from 1986/87 to 1993. A number of structural changes have occurred in the cattle industry in recent years. In particular, many cattle feeders are more interested in the carcass quality and relative feeding efficiency of feeder cattle they purchase. Increased emphasis on relative feeding efficiency and carcass quality could impact prices paid for various breeds of feeder cattle.

Experimental Procedures

The data set for this study was the same as in the previous paper, so the experimental procedures are not repeated.

Results and Discussion

All parameter estimates represent price changes from a reference lot of uniform, Hereford steers in good health, average condition and fill, heavily muscled, without horns, and sold during the first quarter of the sale at auction market 1. The feeder steer price/characteristic models explained from 59 to 74% of the variation in feeder steer prices, depending on steer weight and time of year.

Results indicated that Angus steer calves (300 to 599 lb) sold at a discount of $1.75/cwt relative to Hereford steer calves in 1986/87, but earned a premium of $1.40/cwt in 1993. Similarly, yearling Angus steers (600 to 899 lb) received a discount of $.89/cwt compared to Hereford steers in 1986/87, but sold at a premium of $1.77/cwt in 1993. Continental cross calves (primarily Limousin cross, Charolais cross, Gelbvieh cross, Simmental cross) earned larger premiums in 1993 compared to Hereford steers, in both the lightweight and heavyweight steer categories, than in 1986/87. Steers with less than 1/4 Brahman breeding based on visual appraisal sold for prices that were not

significantl y different from those for Hereford steers in 1993, compared to a discount in 1986/87 . However, steer s identified as having more than 1/4 Brahman breeding received discounts in 1993 that were similar to those received in 1986/87.

Little change occurred in price/cwt for lightweight dairy-type steers; however, the discount for yearling dairy steers increased

in 1993. The increased d iscount may have been a function of the high cost of gain of dairy steers in the winter of 1992-1993 or a change that occurred in basis specifications of dairy steers on packers' slaughter cont acts. Longhorn cross steers sold at greater discounts in 1993. This may have been associated with poorer feedlot performanc e and a lack of muscling compared to other beef breeds of cattle.

Table 1.   Estimated Steer Price Changes Associated with Change in Breed Type Relative to Herefords, Fall and Spring 1986-87 and 1993

Item	1986-87 Steers 300 to 599 lb	1993 Steers 300 to 599 lb	1986-87 Steers 600 to 900 lb	1993 Steers 600 to 900 lb
	- - - - - - - - - - - - - - - - - - - \$/cwt - - - - - - - - - - - - - - - - - - -			
Hereford	00.00	00.00	00.00	00.00
Angus	– \$1.75	+ \$1.40	– \$ .90	+ \$1.77
Hereford × Angus cros s	+ .60	+ 2.73	---.--	+ 1.77
Continental cross	+ .83	+ 3.64	---.--	+ 1.95
Brahman less than 1/4	– 1.78	---.--	– 1.52	---.--
Brahman more than 1/4	– 7.17	– 8.20	– 3.90	– 3.54
Dairy	– 8.58	– 8.42	– 7.32	– 8.93
Longhorn cross	– 7.05	– 9.21	– 5.29	– 7.99

Cattlemen's Day 1995

DETERMINANTS OF PRICES FOR COW-CALF PAIRS

J. L. Parcell[1], T. C. Schroeder[1], and F. D. Hiner[1]

Summary

A study of price determinants for cow-calf pairs was undertaken at a local Kansas auction company during 1993. Cow breed, age, health, condition score, horns, frame size, and whether the cow had been bred back impacted cow-calf pair values, as well as calf weight, health, and frame score. Additionally, pairs per pen significantly impacted prices. Young healthy cows with healthy large calves received the highest prices.

(Key Words: Cow-Calf Pair Prices, Cow-Calf Traits.)

Introduction

Our purpose was to estimate market values of characteristics of individual cow-calf pairs to assist producers in making informed management and marketing decisions. Prices paid for pairs ranged from $475 to $1350, with an average price per pair of $947.39. Typical price range on any given day at a cow-calf auction during 1993 was $700/pair (78% of the average price). This large variability indicates that producers have significant incentive to supply desirable pairs.

Experimental Procedures

Data on prices and physical characteristics of cow-calf pairs were collected from seven cow-calf auctions held at a local commission company. Average price per pair is the amount paid for a cow-calf pen divided by the number of pairs in the pen. A total of 496 pens was evaluated, consisting of 2092 pairs. The date; price; pairs per pen; cow breed; cow condition; cow age; cow health; existence of horns on cows; cow frame size; type of buyer; whether the cow was registered; whether the cow was bred back; order of sale; twin calves; and calf age, weight, breed, health, frame size, and muscling were recorded for each cow-calf pen. Regression analysis was used to determine the values associated with various pair characteristics.

Results and Discussion

The regression analysis was able to explain approximately three fourths of the variation in pair prices. With all else constant and using Angus as the standard, average discounts per pair were $62.81 for Herefords, $35.05 for other English breeds, $36.96 for continentals, and $499.24 for Longhorns. Dairy breed pairs received a $201.77 premium relative to Angus.

Figure 1 illustrates that price per pair changes little until calves weigh about 200 lb and then increases at an increasing rate. Calves weighing below 200 lb are riskier for buyers, because growth potential and health conditions may not be apparent at this young age. Figure 2 shows that buyers prefer to fully utilize the capacity of their available transportation. Straight trucks and stock trailers were typical at this auction site, which corresponds to the optimal number of pairs per pen. Figure 3 illustrates that older cows are discounted because of fewer remaining reproductive years.

Lameness discounts were $67.69/pair for a cow and $389.73/pair for a calf. Cows with bad udders were discounted $65.34/pair. Cows that

---

[1]Department of Agricultural Economics.

were bred back received premiums representing the cost associated with breeding the cow; $68.24/pair. Cows with horns were discounted $66.64/pair.

Table 2 indicates premiums and discounts for cow condition, cow frame, and calf frame. A premium was paid for large-frame cows, which sold higher than medium-frame cows. Small-frame calves were discounted, but there was no premium for large-frame calves.

Wide variation in price received at cow-calf pair auctions makes it imperative that producers understand values of animal traits. This study found an unhealthy cow or calf to be of little value to the buyer. Smaller and thinner cows and calves were discounted relative to average-condition animals. Marketing pairs in sufficient number for efficient transportation increased the price. Heavier weight calves represent lower risk for the buyers than lighter weight calves.

Table 1.   Effect of Selected Traits on Price for Cow-Calf Pairs

Characteristic	Percent of Pens	Price Change ($/pair)
Cow		
Healthy	96.6	Default
Bad Eye	.6	-79.87
Lame	1.6	-67.69**
Bad Udder	1.2	-65.34*
Calf		
Healthy	98.8	Default
Bad Eye	.4	45.14
Lame	.4	-389.73**
Other	.4	-47.37
Horn	7.9	-66.64**
Bred Back	15.7	68.24**

**Significantly different from zero at the .05 level.
*Significantly different from zero at the .10 level.

Table 2.   Effect of Frame and Grade on Price for Cow-Calf Pairs

Characteristic	Percent of Pens	Price Change ($/pair)
Cow Frame		
Small	14.1	1.94
Medium	58.0	Default
Large	27.8	57.91**
Cow Grade		
Very Thin	6.6	-41.42*
Thin	40.9	-56.90**
Average	49.2	Default
Fat	3.2	4.85
Calf Frame		
Small	30.6	-46.37**
Medium	55.8	Default
Large	13.5	-1.38

**Significantly different from zero at the .05 level.
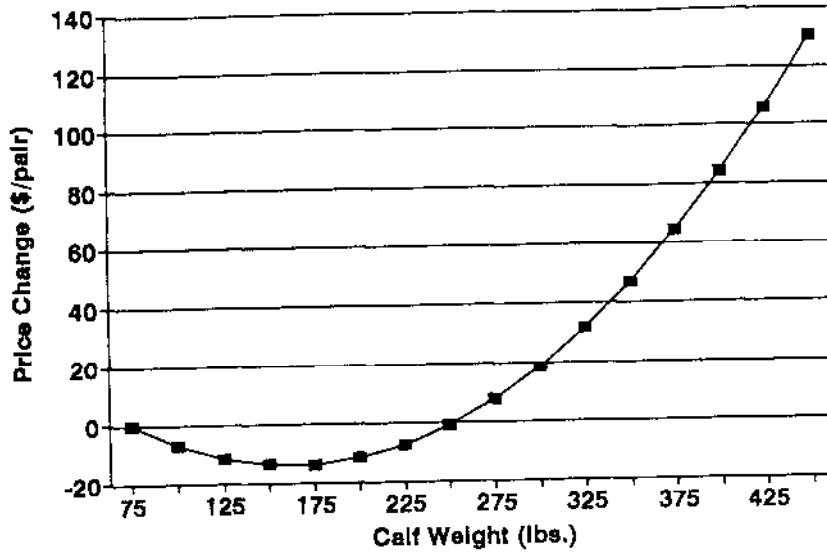*Significantly different from zero at the .10 level.

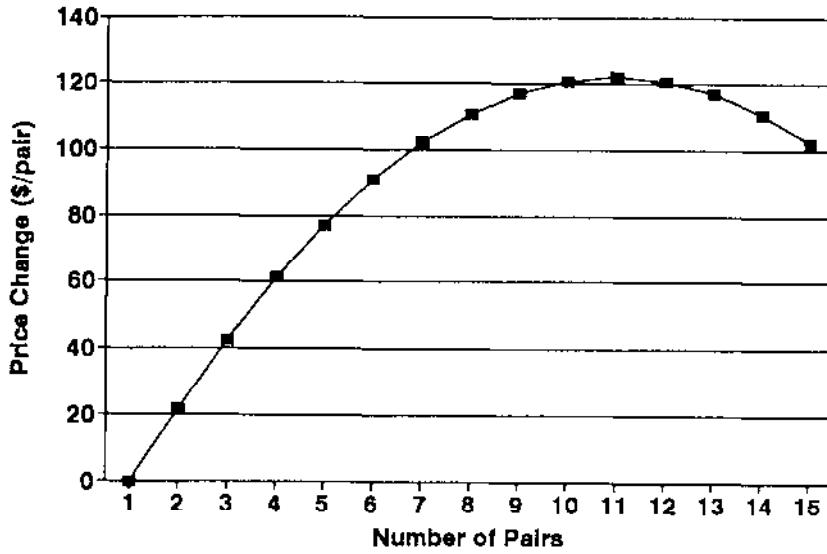**Figure 1.   Effect of Calf Weight on Price for Cow-Calf Pairs**

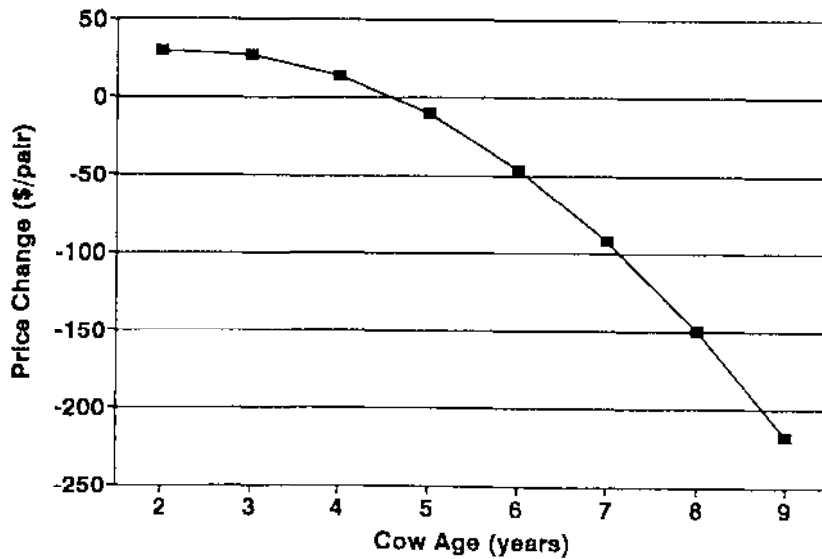**Figure 2.   Effect of Pairs per Pen on Price per Cow-Calf Pair**

Figure 3.   Effect of Cow Age on Price per Cow-Calf Pair

51

CASH OPERATING INCOME AND LIQUIDITY MANAGEMENT FOR FEEDER CATTLE OPERATIONS

B. D. Elliott[1], M.R. Langemeier[1], and A.M. Featherstone[1]

Summary

Net cash flow measures the amount of cash remaining after all cash expense obligations are satisfied. This cash is available for additional farm investment, off-farm investment, family living, and additional debt repayment. A 5-year, average, monthly, cash-flow statement was used to determine net cash flow for 18 feeder cattle farms .Results indicate that excess cash was used primarily to invest in equipment, vehicles, and nonfarm assets. Investments in buildings increased moderately over the study period, while investment in land was minimal.

(Key Words: Cash Flow, Liquidity, Investment, Feeder Cattle.)

Introduction

Liquidity and cash-flow management tools are essential components used in the implementation of financial control. Liquidity refers to the ability of the farm business to meet financial obligations as they come due and typically is measured using a cash-flow statement. Monthly cash-flow statements provide information necessary t o assess seasonal credit requirements . Long-term cash flow projections also can provide information pertaining to a firm's ability to repay intermediate and long-term loans.

The objective of this study was to determine how excess cash profits (if present) were used on feeder cattle farms in Kansas. Monthly sources and uses of funds are presented and discussed.

Experimental Procedures

Data on cash transactions, inventories, and production information for 18 feeder cattle operations were available from the Financial Plu sprogram of the Kansas Farm Management Association. A vast majority of the livestock fed on these farms was purchased rather than raised. To be included in the analysis, a farm had to have data for 1988 through 1992.

A monthly cash-flow statement was constructed to determine the amount of excess cash available for investment and debt repayment. The net cash-flow measure included on-farm sources and uses of cash as well as nonfarm cash flows. Cash operating income, defined as the amount of cash income from the farm business, was used to measure both profitability and liquidity. This cash is used for discretionary purposes such as meeting scheduled principal payments, on- and off-farm investment, and family living. Net loans are calculated as loans received minus loans repaid and reflect the level of debt repayment or lack thereof. A negative value for net loans indicates that producers were paying down debt.

Results and Discussion

Table 1 presents a 5-year, average, monthly, cash-flow statement for the 18 feeder cattle farms. These farms were relatively profitable during the period, averaging $50,921 of net farm income per year (accrual basis). Cash operating income was much lower, averaging $33,462 per year. Net

[1]Department of Agricultural Economics.

farm income includes the noncash items of inventory changes and depreciation expense, whereas cash operating income includes only the cash transactions. Net cash flow averaged -$238 per month or -$2,852 per year. When positive, this cash is available for new or unplanned investments. Using Table 1, we can analyze the seasonality of the various revenue and expense items as well as the summary variables in the lower portion of the Table. Cash operating income, on average, was positive in March through August. The largest positive, monthly, net, cash flows occurred in January and June. The largest monthly principal payment occurred in May. Feeder cattle farms took out the most loans in January, September, October, and December. Net loans were negative in April through August, corresponding to the positive cash operating incomes during that time. The data indicate that feeder cattle farms were accumulating about $21,912 of debt per year during this study. Family living expenses averaged $16,736 per year; thus, about one-half of cash operating income was used for family living expenses.

Financing of intermediate assets occurred predominately from the use of new or existing debt. The farms in this study increased current inventories of farm assets and non-farm assets. Cash investment in vehicles and equipment was steady during the period. Cash expenditures on buildings increased sharply, growing by nearly 170% over the period. The value of owned land increased by about 7%. Intermediate loan balances increased by $32,016 during the period.

Cash-flow management is an essential component of effective financial control. Cash planning alleviates last minute decisions that can be costly. Understanding the seasonality of cash sources and uses will allow producers to make better investment decisions.

Table 1. Monthly Cash Flow Statement for Feeder Cattle Farms, 1988-1992.

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Sources												
Livestock	94,178	74,120	92,773	95,761	121,049	106,011	97,907	109,777	90,117	79,036	93,781	85,372
Breeding stock	202	403	646	192	209	113	450	50	88	81	775	85
Crops	10,917	5,093	4,709	5,872	8,336	7,185	9,526	3,608	5,040	10,313	4,442	9,208
Miscellaneous	2,488	1,273	1,849	2,668	3,195	2,382	2,860	2,517	2,615	2,833	2,633	6,570
Asset Sales	61	219	111	288	172	213	30	146	1172	3058	376	237
Total Farm Sources	107,846	81,109	100,089	104,782	132,960	115,904	110,774	116,098	99,032	95,321	102,007	101,473
Non-farm	13,353	2,169	1,177	1,239	1,782	2,402	624	1,953	2,923	2,923	1,442	5,880
Total Sources	121,199	83,278	101,266	106,021	134,742	118,306	111,398	118,052	101,954	98,244	103,448	107,353
Uses												
Livestock purchases	78,507	62,382	69,354	48,304	44,658	35,343	41,011	65,113	86,726	85,443	82,451	55,360
Feed	12,971	10,264	11,614	15,251	17,782	16,286	17,232	15,153	18,216	15,959	16,301	37,460
Veterinary	803	902	1,085	1,092	667	416	508	625	968	1,689	1,649	2,405
Fert., Seed & Chem.	1,375	2,015	3,495	3,263	3,591	4,635	4,201	2,279	2,412	4,604	2,300	7,791
Machine Hire & Labor	3,186	2,463	2,728	3,101	2,993	3,397	4,047	4,038	3,611	3,290	3,734	6,992
Fuel and Repairs	1,900	2,158	2,935	2,809	3,226	3,530	4,152	3,842	3,568	3,856	3,535	4,780
Asset Purchases	2,641	2,596	3,808	2,189	4,025	2,960	3,189	3,762	4,727	4,520	1,273	1,925
Interest Paid	3,688	2,417	2,502	4,297	3,935	3,252	4,407	3,229	5,713	3,323	2,780	11,173
Miscellaneous	5,710	2,888	5,742	3,883	4,314	6,814	4,414	6,685	5,677	9,980	6,358	16,884
Total Farm Uses	110,780	88,085	103,264	84,189	85,190	76,634	83,162	104,726	131,617	132,663	120,382	144,770
Tot Non-farm Uses	23,053	6,952	3,115	3,472	2,931	3,868	2,073	2,071	4,709	4,181	2,557	5,582
Total Uses	133,833	95,037	106,379	87,661	88,121	80,502	85,235	106,796	136,326	136,845	122,939	150,352
Loans Received	122,110	107,702	86,253	90,983	74,456	59,843	71,708	92,022	114,324	128,156	99,391	125,854
Loan Payments	95,310	97,320	81,766	108,275	120,896	90,069	98,550	100,360	90,035	90,448	86,232	91,629
Net loans	26,800	10,382	4,487	(17,291)	(46,440)	(30,226)	(26,842)	(8,339)	24,289	37,708	13,159	34,225
Operating Income	(353)	(4,600)	522	22,493	51,623	42,018	30,772	14,987	(29,032)	(35,881)	(17,477)	(41,610)
Net Cash Flow	14,167	(1,376)	(626)	1,068	181	7,578	(679)	2,917	(10,082)	(893)	(6,332)	(8,775)

Cattlemen's Day 1995

KANSAS ENVIRONMENTAL REGULATIONS

J. P. Murphy [1], J. P. Harner [1], and L. Hess [2]

The Kansas Department of Health and Environment (KDHE) enforces two different regulations in the state of Kansas. One set of regulations is from the Federal Environmental Protection Agency (EPA) and applies to larger operations. The other is a set of Kansas regulations created by our state legislature for smaller operations.

EPA regulations pertain to confined feeding operations in excess of 1,000 animal units and require an EPA National Pollution Discharge Elimination System (NPDES) permit. Because an animal unit for the NPDES permit is defined as one beef animal, a feedlot with a capacity of 1,000 or more will need to apply to KDHE for a NPDES permit. The main criterion of the permit is to contain the runoff volume from a 24-hour, 25-year frequency rainfall event.

Operations below 1,000 animal units come under a regular KDHE permit. In cases where questions arise as to which type of permit is needed, KDHE can make the determination because they administer both types of permits.

The regular KDHE permit was modified by the Kansas legislature in Senate Bill (SB) 800, which took effect July 1, 1994. Its provisions modify Kansas water-pollution control statutes and regulations involving water-pollution control practices, but make no changes to the Federal EPA permits administered by KDHE.

The program modifications resulting from SB 800 center around operation size, separation distances from neighbors, waiver and exemption of provisions, and changes in the permit fee structure. The following information is a review of SB 800 contained in a KDHE document *New Legislation Impacts, Kansas Livestock Operations*, and is not intended to be a comprehensive summary of regulatory requirements that pertain to livestock waste management practices in Kansas.

Operation Size Required for Permit: SB 800 changed the size threshold of facilities required to register for a permit. Before SB 800, the required size was from 300 *head* to 999 *head*. After SB 800, size requirements were based on *animal units*, with the lower limit of the permit defined as 300 *animal units*.

How Is an Animal Unit Calculated? The total number of animal units is calculated by multiplying the number of confined animals by the following factors and adding the result for each livestock category:

---

[1]Department of Biological and Agricultural Engineering.
[2]Kansas Department of Health and Environment, Agricultural Permit Administer.

Livestock Category	Number of Head	X Factor	= Animal Unit
Beef cattle > 700 lbs.		1.0	
Beef cattle < 700 lbs.		0.5*	
Mature dairy cattle		1.4	
Swine > 55 lbs.		0.4	
Sheep or lambs		0.1	
Horses		2.0	
Turkeys		0.018	
Laying hens/broilers (facility with continuous overflow watering; nipple/cup watering)		0.01	
Laying hens/broilers (facility with liquid manure system)		0.033	
Ducks		0.2	
TOTAL ANIMAL UNITS			

*Note: When determining registration/permitting requirements in regard to Federal NPDES permits, only the 1.0 factor should be used when calculating facility capacity for beef cattle.

Pollution Potential: Both size of operation and pollution potential are now considered in determining permit necessity. As well as the size threshold of 300 animal units, a pollution potential must exist before facilities are required to have a permit.

Separation Distance Requirements: SB 800 identifies separation distance criteria that provide a buffer between livestock facilities and dwellings, public buildings, and certain types of commercial establishments. These separation distances apply to any new construction or expansion of an existing facility. A separation distance is measured as the shortest distance between a habitable structure and any confined building, pens, manure storage or compost area, or pollution control utilized at the confined feeding facility. Separation distance criteria do not apply to property boundaries or land application sites used for waste disposal.

The new separation distances are:
Facilities with a capacity of 300-999 animal units - 1,320 feet.
Facilities with a capacity of 1,000 animal units or more - 4,000 feet.

Separation Distance Reduction Waivers: SB 800 allows KDHE to reduce the above separation distances if:

1. A written agreement (waiver) is obtained from the owners of all habitable structures located within the separation distance and is filed with the Register of Deeds Office in the county where the habitable structure is located, or

2. No objection to separation distance is received from an owner of habitable

structure as a result of a public notice of the proposed permit, or

3. The board of county commissioners requests that the separation distance be reduced.

Separation Distance Exemptions: SB 800 allows existing facilities to be exempted from the above separation distance requirements in the following situations:

1. Facilities permitted or certified by KDHE prior to July 1, 1994.

2. Facilities in existence prior to July 1, 1994 and registered with KDHE prior to July 1, 1996.

3. Facilities with 1,000 animal unit capacities or more and in existence prior to July 1, 1994 may expand, regardless of the separation distance criterion, as long as the expansion does not encroach closer to any habitable structure located within the separation distance.

4. Facilities with fewer than 1,000 animal unit capacities and in existence prior to July 1, 1994 may expand, regardless of the separation distance criterion, as long as the expansion does not encroach closer to any habitable structure located within the separation distance, and the expansion does not exceed 2,000 animal units.

5. The waiver provisions, addressed above, are met.

Note: **Facilities that fail to register prior to July 1, 1996, will be considered new facilities in regard to the separation distance requirements of SB 800.**

Fee Structure: SB 800 establishes the following fees: Submission of a registration - $25.00

Annual Permit Fees

Less than 300 animal-unit capacity $ 25.00

300-999 animal-unit capacity   25.00
1,000-4,999 animal-unit capacity   100.00
5,000-9,999 animal-unit capacity   200.00
over 10,000 animal-unit capacity   400.00

Who Needs a Water Pollution Control Permit?

☐ Any facility, regardless of size, determined by KDHE to present a significant water pollution potential, including but not limited to the following:

1. All livestock operations that utilize wastewater control facilities i.e., manure pits, ponds, lagoons, or other devices.

2. Open lots located across or adjacent to creeks, streams, intermittent waterways, or other conveying channels or devices.

3. Any operation that cannot retain or control wastewater or waste solids upon the operators property.

4. Any operation observed to practice improper disposal of livestock wastes (liquid and solids) that has the potential to degrade or impair the quality of any waters of the State (surface and groundwater).

5. Any facility that generates wastewater and releases it on a daily or more frequent basis. (Dairy parlors, uncontrolled releases from watering systems, etc.)

☐ Any confined animal-feeding facility with a designed animal-unit capacity of 300 or more **and** a significant water-pollution potential.

☐ All facilities with designed animal-unit capacities of 1,000 or more, regardless of pollution potential.

☐ Sale barns and collection centers with an average capacity greater than 300 animal units or utilized more than once a week.

☐ All wash facilities for livestock trucks.

57

☐ Any other animal-feeding operation whose operator elects t ocome under these statutes and regulations.

Steps Required to Obtain a Permit or Modify a Facility:

1. Contact KDHE for information (telephone numbers below).

2. Request a site appraisal from KDHE.

3. Submit a registration application along with $25.00 to KDHE.

4. Obtain releases from adjacent residents, if required, or addres sseparation distance requirement s and submit information to KDHE.

5. Submit a general information and operational plan to KDHE.

6. Submit permit application, fees (if applicable), construction plans and waste management plan to KDHE for review and approval.

7. KDHE places draft permit on 30 day public notice (if applicable).

8. KDHE issues permit and ap proval to start construction.

9. Notify KDHE at start of construction.

10. Notify KDHE at the completion of construction for postconstruction inspection.

11. The facility is placed into service.

12. An annua l permit fee will be billed to the operator.

13. The permit is renewed every 5 years.

Who to Contact? For more information, please contact an agricultural environmental technician or the district engineer in the KDHE dis rtict offices in Hays at (913) 625-5664; Salina at (913) 827-9639; Lawrence at (913) 842-4600; Dodge City at (316) 255-0596; Wichita at (316) 337-6020; Chanute at (316) 431-2390; or the KDHE Bureau of Water central office in Topeka at (913) 296-5570 or (913) 296-5532.

Cattlemen's Day 1995

LOSSES FROM TOP SPOILAGE IN HORIZONTAL SILOS [1]

D. L. Holthaus [2], M. A. Young, B. E. Brent
L. Pfaff, and K. K. Bolsen

Summary

The top 3 ft of silage from 127 horizontal silos was sampled at three locations across the width of the silo during a 4-year period (1990 through 1993). Ninety-six percent of the silages were either corn or forage sorghum, and only 18 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 inches in 1991 and 1993 than 1990 and 1992. Sealing reduced spoilage losses of OM in the top 18 inches by 16, 37, 19, and 36 percentage units in 1990 through 1993, respectively, and in the second 18 inches by 4, 13, 3, and 7 percentage units.

Dry matter (DM) contents were lower for forage sorghum silages in the top 18 inches than for corn silages in the first 3 years, and in all 4 years, DM contents for sealed silages were lower than those for unsealed silages. Silage had higher pH values in the top 18 inches than in the second 18 inches.

(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, because of large surface areas, a high percentage of the silage is exposed to weathering. The conventional method of protecting these silages has been polyethylene sheeting weighted with tires. However, efficacy depends on sealing techniques and the physical properties of the sheeting, and labor is extensive.

Because only limited information is available regarding the DM or OM losses in horizontal silos under field conditions, our objectives were to estimate the amount of those losses from the top layer in farm-scale, horizontal silos and to compare losses in unsealed and sealed, corn and forage sorghum silages. Preliminary results from 1990 and 1991 were presented in KAES Reports of Progress 623 and 651.

Experimental Procedures

In January of 1990, March of 1991, November of 1992, and March of 1993, the top 3 ft of silage from 127 horizontal silos (bunkers, trenches and stacks) in the Colby, Dodge City, Leoti, Scott City, and Manhattan areas of Kansas was sampled at three locations across the width of the silos. Sampling depths were: 0 to 18 inches from the surface (depth 1) and 18

---

[2]Former graduate student. Current address: Texas Tech University, Lubbock, Texas.

to 36 inches from the surface (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. Sealed silos were covered with a single sheet of .4 or .6 mm, black polyethylene, held in place with either tires or soil.

Additional DM and OM losses (losses in addition to the losses from well-preserved silage) were estimated by comparing ash in the samples to that from a well-preserved reference sample. The relationship between ash changes and DM or OM changes was described in KAES Reports of Progress 623 and 651.

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 Tables 1 and 2. In the top 18 inches (depth 1), additional OM loss ranged from 7 to 61%, and as expected, losses were higher in silages that

were left unsealed. Applying a seal reduced OM loss in the top 18 inches by a range of 16 to 37 percentage units. Similarly, sealing reduced additional spoilage losses in the second 18 inches by 3 to 13 percentage units.

The effects of crop and sealing treatment on silage DM and pH at the three sampling depths are shown in Tables 3 and 4. The DM contents were lower for forage sorghum silages in the top 18 inches than for corn silages in the first 3 years, and DM contents for sealed silages were lower than those for unsealed silages in all 4 years. The high silage pH values near the exposed surface of the unsealed silages were typical of severely deteriorated silages. In the second 18 inches and at the face, sealing treatment did not appear to affect either DM content or pH. The relatively low pH values at these depths ranged from 3.78 to 4.04 for the 4 years, indicating satisfactory preservation.

Several of the sealed silages had OM losses and pH values in the top depth that were higher than expected, suggesting that some sealing methods were not effective, or that sealing material had been damaged.

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**

Crop and Treatment [1]	Depth 1 [2] 1990	1991	Depth 2 1990	1991	Depth 1 1990	1991	Depth 2 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
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
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
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.
[2]Depth 1 = 0 to 18 inches and depth 2 = 18 to 36 inches from the surface on the day of sampling.
[3]Expressed as percentage unit increase in spoilage loss of OM.
[4]Includes data from unsealed alfalfa, wheat, and oat silages in 1990.

Table 2. **Effects of Crop and Sealing Treatment on the Ash Content and Estimated Additional Spoilage Loss of OM at the Top Two Depths in Horizontal Silos in 1992 and 1993**

Crop and Treatment [1]	Depth 1 [2]		Depth 2		Depth 1		Depth 2	
	1992	1993	1992	1993	1992	1993	1992	1993
	———% Ash———				——Estimated OM [3] loss ———			
All crops (46, 21) [4]	13.6	16.6	8.1	10.1	38	41	11	10
Corn (25, 13)	14.4	17.7	7.9	9.7	40	46	11	11
Sorghum (19, 8)	12.1	14.9	8.0	10.8	33	32	9	9
Unsealed (37, 20)	16.9	17.0	7.7	10.1	41	43	12	10
Sealed (9, 1)	11.0	11.0	7.6	8.9	23	7	9	3
Unsealed (21, 13)	17.7	17.9	8.3	9.7	44	46	12	11
Sealed (4, 0)	15.2	—	6.5	—	17	—	6	—
Sorghum								
Unsealed (14, 7)	12.5	15.5	7.8	11.1	36	36	18	10
Sealed (5, 1)	11.1	11.0	8.5	8.9	27	7	12	3

[1] Number of silos per crop or treatment in parentheses for 1992 and 1993, respectively.
[2] Depth 1 = 0 to 18 inches and depth 2 = 18 to 36 inches from the surface on the day of sampling.
[3] Expressed as percentage unit increase in spoilage loss of OM.
[4] Includes data from two unsealed soybean silages in 1992.

Table 3. **Effects of Crop and Sealing Treatment on Silage DM and pH at the Three Sampling Depths 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.
[2] Depth 1 = 0 to 18 inches; depth 2 = 18 to 36 inches; and face = at least 6 to 7 ft from the surface on the day of sampling.
[3] Includes data from unsealed alfalfa, wheat, and oat silages in 1990.

Table 4. **Effects of Crop and Sealing Treatment on Silage DM and pH at the Three Sampling Depths in Horizontal Silos in 1992 and 1993**

	Depth 1		Depth 2		Face		Depth 1		Depth 2		Face	
Crop and Treatment[1]	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
	% DM						pH					
All crops (46, 21)[3]	30.2	30.9	32.2	33.4	33.9	33.6	6.25	5.94	4.03	4.03	3.84	4.03
Corn (25, 13)	31.6	32.8	32.8	31.6	33.8	34.9	6.21	5.94	4.04	4.01	3.82	4.03
Sorghum (19, 8)	27.9	36.2	31.4	34.3	34.2	35.2	6.13	5.95	4.03	4.06	3.87	4.02
Treatment												
Unsealed (37, 20)	30.6	30.3	32.9	32.8	33.8	31.9	6.42	5.99	4.05	4.03	3.63	4.00
Sealed (9, 1)	28.5	28.6	33.8	35.4	34.2	34.3	5.59	5.05	3.96	3.93	3.87	4.49
Corn												
Unsealed (21, 13)	32.7	33.6	33.0	30.3	34.2	31.7	6.43	5.94	4.09	4.01	3.82	4.03
Sealed (4, 0)	25.6	-	31.9	-	31.5	-	5.06	-	3.79	-	3.83	-
Sorghum												
Unsealed (14, 7)	26.9	34.9	30.1	31.9	33.5	32.6	6.17	6.08	4.01	4.07	3.86	3.95
Sealed (5, 1)	30.8	28.6	35.3	35.4	36.3	34.3	6.01	5.05	4.10	3.93	3.91	4.49

[1]Number of silos per crop or treatment in parentheses for 1992 and 1993, respectively.
[2]Depth 1 = 0 to 18 inches; depth 2 = 18 to 36 inches; and face = at least 6 to 7 ft from the surface on the day of sampling.
[3]Includes data from two unsealed soybean silages in 1992.

Ash and Organic Matter Loss

During spoilage of silage, microbes use up organic nutrients such as proteins and carbohydrates. However, the absolute amount of minerals (ash) remains the same. Assume 100 g of well-preserved silage contains (dry matter basis) 5% ash and 95% organic matter. Assume that after spoilage, the silage contains 10% ash. Because the absolute amount of ash stays the same, the dry weight of the silage has been reduced to 50 g. The original silage sample contained 95 g organic matter (100-5). The spoiled sample contains only 45 g organic matter (50-5). Therefore, 45/95=47.4% of the organic matter remains and 52.6% has been lost to spoilage.

Cattlemen's Day 1995

TOP SPOILAGE LOSSES FOR CORN AND FORAGE SORGHUM SILAGES STORED IN BUNKER SILOS [1]

D. L. Holthaus [2], M. A. Young, B. S. Dalke [3],
L. Pfaff, J. E. Boyer [4], and K. K. Bolsen

Summary

Corn and forage sorghum silages were stored in small bunker silos for 180 days. Dry matter (DM) and organic matter (OM) losses, fermentation characteristics, *in-situ* DM digestibility, and temperatures were measured at 10, 20, and 30 inches from the original silage surface. Sealing the exposed surface increased DM and OM recoveries and improved fermentation quality and nutritive value in both crops, regardless of depth. The unsealed corn silages were much hotter within the top 3 ft than sealed silages, indicating aerobic losses. As expected, the unsealed silages from both crops deteriorated severely in the top 20 inches. Placing a roof over the unsealed silos increased the silage DM content at all three depths, but did not consistently improve the storage efficiency or silage quality of either crop.

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

Introduction

Large horizontal silos (i.e., bunkers, trenches, and stacks) store large quantities of ensiled feeds economically, but by design, much of the silage is exposed to the environment. In 1,000 ton silos (100 ft long × 40 ft wide × 12 ft deep), up to 25% of the original silage mass is within 3 feet of the surface. In earlier studies, we found that DM losses in unsealed bunkers were 80.4 and 29.4% at depths of 10 and 20

inches, respectively, for corn silage after 6 months of storage and 77.0 and 53.2% for forage sorghum silage at the same depths (KAES Report of Progress 651, page 131). However, sealing with polyethylene sheeting significantly reduced the DM losses for both crops at both depths. Our objectives were: 1) to measure the rate and extent of top spoilage losses in unsealed and sealed silages and 2) to determine the effect of placing a roof over the silage mass on preservation efficiency and nutritive value. To our knowledge, the feasibility of using a roof to protect unsealed corn or sorghum silage from rain and snowfall has not been studied in controlled experiments.

Experimental Procedures

Experiment 1: Whole-Plant Corn. On August 25 and 26, 1992, whole-plant corn (2/3 milk line maturity and 34.2% DM) was chopped and packed into four, 16 ft long × 13.5 ft wide × 4 ft deep, bunker silos. Alternate loads were used to fill the bottom half of each silo on the first day and the top half of each silo on the second day. During filling, nylon net bags, each containing 4.5 lb of fresh material, were placed 10, 20, and 30 inches from the surface of the original ensiled mass (three 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 single-tired tractors to equal densities (13.8 lb of DM/cubic ft). Treatments were: 1) silo left

---

[2] Former graduate student. Current address: Texas Tech University, Lubbock, Texas.
[3] Former graduate student. Current address: Grant County Feeders, Ulysses, Kansas.
[4] Department of Statistics.

unsealed, no roof, 2) sealed, no roof; 3) left unsealed, with a roof; and 4) sealed, with a roof. Both sealed silos were covered with a single sheet of .4 mm polyethylene, weighted with tires. A galvanized tin roof was used for treatments 3 and 4. Bunkers were emptied 180 days postfilling. The nylon net bags were recovered, and the silage was weighed; mixed; sampled; and analyzed for DM, ash, pH, and fermentation end products.

Experiment 2: Forage Sorghum. On October 20 and 21, 1992, whole-plant, Northrup King 300, forage sorghum (late-dough maturity and 37.1% DM) was chopped and packed to equal densities (10.2 lb of DM/cubic ft) into four bunker silos. All experimental procedures were the same as in Experiment 1.

***In-Situ* Digestibility**. Ruminal DM disappearance was determined for the silages from the nylon net bags recovered from the bunker silos in Experiments 1 and 2. Three ruminally cannulated steers were used. Approximately 1 g of dried, ground silage was placed in a 5 cm × 10 cm dacron bag with a 53 micrometer pore size. Silages were digested for 72 hours. Once removed from the rumen, the bags were rinsed with cold water until the water was clear. Bags and undigested material were dried in a forced-air oven at 55°C for 72 h and then weighed; DM disappearance was calculated.

Results and Discussion

Experiment 1: Whole-Plant Corn. Results are presented in Table 1. The two silages from the unsealed silos had dramatically lower DM and OM recoveries at the 10- and 20-inch depths than the two sealed silos. Sealed silages were well preserved at all three depths, but in the unsealed silos, only the silage at the 30-inch depth was acceptable. The silage in the unsealed, roofed silo had the highest DM content at all depths, whereas the unsealed, no-roof silage had the lowest. Temperatures in the two sealed silos and the unsealed, no-roof silo peaked within the first 4 to 12 days postfilling, but temperatures in the unsealed, roofed silo did not reach maximum until 40 to 44 days. Few fermentation differences were observed among the sealed silages. The poor fermentation at the 10-inch depth in the sealed, roofed silage was caused by rodent damage to the polyethylene. The two unsealed silages were of dramatically lower quality, as indicated by increased pH values, lower lactic acid content, and decreased lactic:acetic ratios (data not shown), especially at the 10- and 20-inch depths. Silages were of acceptable quality at the 30-inch depth in both unsealed silos. The silages in the two sealed silos and the unsealed, roofed silo had higher ruminal *in-situ* DM digestibilities at all three depths than the silage in the unsealed, no-roof silo. In both unsealed silos, silage at the 10-inch depth had a lower *in-situ* DM digestibility than silages at the 20- and 30-inch depths, indicating that much of the digestible organic matter had been removed by weathering and(or) spoilage.

Experiment 2: Forage Sorghum. Results are presented in Table 2. The unsealed, no-roof silage had the lowest DM content at all three depths, whereas the unsealed, roofed silage had the highest. Unsealed silages had dramatically lower DM and OM recoveries at the 10-inch depth than the two sealed silages. The unsealed, roofed silage had the lowest recoveries at the 20-inch depth. The two unsealed silages had deteriorated severely at the 10-inch depth, as evidenced by high pH values and almost no fermentation end products. The silages at all three depths in the two sealed silos and the unsealed, roofed silo had higher ruminal *in-situ* DM digestibilities than that in the unsealed, no-roof silo.

Conclusions. During the 180 days of storage, water from rain and snow percolated through the unsealed, no-roof silage for both crops, and the silages at all three depths were much wetter than the pre-ensiled forages. In contrast, the silages at the 10- and 20-inch depths in the unsealed, roofed silos were much drier than the pre-ensiled forages, because considerable dehydration/evaporation took place in the absence of a seal.

These data document that sealing corn or forage sorghum silages in bunker, trench, or stack silos greatly increases preservation efficiency and nutritive value in the original top 2 to 3 ft of ensiled material.

Table 1. Effects of Sealing Treatment and Depth from the Original Surface on the DM Content, DM and OM Recoveries (rec.), Temperature (temp.), Fermentation Characteristics, and DM Digestibility (DMD) of Corn Silages Stored in Bunker Silos in Experiment 1

Sealing Treatment	Depth	DM	DM Rec.[1]	OM Rec.[2]	Maximum Temp.[3]	In-Situ DMD	pH	Lactic Acid	Acetic Acid	Ethanol
	inches	%			°F	%		- % of the silage DM -		
Unsealed, no roof	10	15.6	24.9	24.4	113(10)	37.1[d,y]	7.11	.07	.13	.08
	20	23.2	75.0	76.9	105(12)	63.1[b,x]	3.84	.97	3.21	.41
	30	24.4	76.7	77.6	97 (4)	65.7[b,x]	3.86	5.21	4.22	1.43
no roof	20	33.6	92.4	92.7	95 (6)	71.2[a]	3.79	4.23	1.48	1.40
	30	32.8	93.6	93.3	95 (4)	71.9[a]	3.88	4.31	1.60	1.67
roof	20	37.3	82.8	83.2	127(40)	70.4[a,x]	5.11	.89	.96	.15
	30	34.9	93.8	93.7	114(44)	72.7[a,x]	4.01	4.55	1.42	.58
roof	20	35.1	94.5	94.5	96 (8)	68.6[a]	3.85	4.48	1.71	1.06
	30	33.1	94.1	93.0	96 (4)	71.7[a]	3.87	4.61	1.63	1.59

[1]Expressed as a % of th eoriginal DM ensiled . [2]Expressed as a % of the original OM ensiled . [3]The day postfilling when the maximum temperature occurred is shown in parentheses . [4]ND=not detected. [a,b,c,d]Means within a depth across sealing treatment with different superscripts differ (P<.05). [x,y]Means within a sealing treatment across depth with different superscripts differ (P<.05).

Table 2. Effects of Sealing Treatment and Depth from the Original Surface on the DM Content, DM and DM Recoveries (rec.), Fermentation Characteristics, and DM Digestibility (DMD) of the Forage Sorghum Silages Stored in the Bunker Silos in Experiment 2

Sealing Treatment	Depth	DM	DM Rec.[1]	OM Rec.[2]	In-Situ DMD	pH	Lactic Acid	Acetic Acid	NH₃-N
	inches	%			%		- % of the silage DM -		
Unsealed, no roof	10	14.0	52.3	52.5	35.8[c,y]	6.68	ND[3]	.13	.04
	20	26.1	95.0	95.1	57.7[b,x]	5.08	3.37	2.45	.14
	30	25.6	91.5	91.5	55.1[b,x]	4.94	3.13	2.27	.13
no roof	20	37.6	97.8	97.6	60.8[a]	4.59	4.08	3.48	.13
	30	36.5	97.6	97.7	58.9[b]	4.38	5.63	2.39	.10
roof	20	66.2	73.2	71.8	62.2[a,x]	7.73	.08	.08	.12
	30	38.8	96.1	97.7	62.9[a,x]	4.06	2.18	1.13	.12
roof	20	36.5	97.9	98.2	61.5[a,x]	4.63	4.99	2.74	.16
	30	36.0	94.5	93.9	58.4[b,x,y]	4.47	6.23	4.45	.17

[1]Expresse d as a % of the original DM ensiled . [2]Expressed as a % of the original OM ensiled. [3]ND=no t detected . [a,b,c]Means within a depth across sealing treatment with different superscripts differ (P<.05). [x,y]Means within a sealing treatment across depth with different superscripts differ (P<.05).

Cattlemen's Day 1995

EFFECT OF BACTERIAL INOCULANTS ON THE PRESERVATION AND NUTRITIVE VALUE OF WHOLE-PLANT CORN SILAGES [1]

K. K. Bolsen, M. A. Young, D. W. Rice [2],
M. A. Hinds [2], and C. Zimmermann [2]

Summary

Inoculated and control corn silages were compared using pilot-scale silos. Inoculated silages (Pioneer inoculant 1174 and 1132) had significantly higher lactic to acetic acid ratios, and numerically lower values for DM loss, acetic acid, ethanol, and ammonia-nitrogen than the control silage—evidence that both inoculants produced a more efficient fermentation. Although the inoculated silage rations had higher DM intakes than the control, nutrient digestibilities were similar for the three silages. These results are consistent with numerous studies that compared untreated and inoculant-treated silages over a wide range of crops and ensiling conditions in our research during the past several years.

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

Introduction

Adding selected strains of lactic acid bacteria (LAB) has become common practice in silage-making. These are intended to dominate the fermentation phase of the ensiling process. However, numerous characteristics of the forage to be ensiled—species, DM content, water-soluble carbohydrate content, and buffering capacity—interact with epiphytic (naturally occurring) and inoculant microbes to determine the outcome of the fermentation. The objective of this study was to continue to document the effect of commercial bacterial inoculants on preservation and nutritive value of whole-plant corn silages.

Experimental Procedures

In August of 1992, irrigated whole-plant corn (Pioneer 3377) was chopped at the 90% milk line stage of kernel development with a FieldQueen forage harvester and ensiled in 12 pilot-scale silos.

Four silos received each of the following treatments: 1) control (no additive); 2) Pioneer® brand 1174 silage inoculant; and 3) Pioneer® brand 1132 corn silage inoculant. The inoculants were applied in liquid form and supplied 1.0×10^5 colony-forming units (cfu) of LAB per g of fresh crop. Because of the limited amount of silage, sheep were used as model animals. After 90 days of storage, each silage was fed to eight wether lambs in a 20-day voluntary intake (VI) and digestion trial. Rations contained 90% silage and 10% supplement (DM basis). The pre-ensiled forage contained 1.2×10^6 cfu of epiphytic *Lactobacillus* per g and 1.3×10^6 yeasts per g on a fresh basis.

Results and Discussion

The results are shown in Table 1. The data are consistent with several of our previous inoculant studies using laboratory-scale, pilot-scale, and farm-scale silos. The 1174- and 1132-treated silages had significantly higher lactic to acetic acid ratios and numerically lower values for acetic acid, ethanol, ammonia-

nitrogen, and DM loss than the control silage—evidence th at the inoculants produced a more efficient fermentation and improved preservatio n efficiency. Although DM intake were higher for the inoculated silage rations than for the c ontrol, nutrient digestibilities were similar for the three silages.

Based upon results from several earlier studies (KAES Report of Progress 651, page 101), we would expect the better preserved, inoculated sila ges in this study to produce more weight gain in beef cattle or milk in dairy cattle per ton of crop ensiled than untreated (control) silage.

Table 1. **Effect of Pioneer Brand 1174 and 1132 Silage Inoculants on the Preservation Efficiency and Nutritive Value of Whole-plant Corn Silage**

	Treatment		
Item	Control	1174	1132
Silage Preservation and Chemical Analyses			
Silage DM, %	37.0	36.6	36.8
DM recovery, % of the DM ensiled	95.3	95.9	96.0
pH	3.83	3.82	3.82
Aerobic stability, hours	>120	>120	>120
————% of the silage DM ————			
CP	7.31	7.37	7.50
NDF	41.8	41.9	43.3
ADF	26.1	25.5	26.3
Lactic acid	5.95	6.49	6.85
Acetic acid	2.31	2.09	2.01
Ethanol	.46	.41	.40
Ammonia-nitrogen	.10	.08	.08
Sheep Metabolism Trial			
Voluntary intake, g/metabolic			
————Digestibility, % of the ration ————			
DM	69.7	69.2	70.0
CP	66.2	67.4	66.5
NDF	55.1	56.2	57.2
ADF	54.1	52.5	54.7

[a,b]Means on the same line with different superscripts differ (P<.10).

Cattlemen's Day 1995

AGRONOMIC PERFORMANCE AND SILAGE QUALITY TRAITS OF FORAGE SORGHUM HYBRIDS IN 1994

M. A. Young, M. S. Mitchem, L. Pfaff, and K. K. Bolsen

Summary

The 1994 growing season was c haracterized by near norm al rainfall and temperatures. Both whole-plant DM and gra in yields were excellent for all hybrid s The middle-season Pioneer 947 hybrid had the highest grain yield. The two dual-purpos e hybrids had the highest whole-plant DM yields, and the male sterile (Golden Harvest H-1) and the grain sorghum (DeKalb 42Y) had the lowest. Strong winds in the first week in September caused substantial lodging in three of the four tall middle- and late-season hybrids (DeKalb FS-5 and Golden Harvest H-2 and H-68). Two of the short height, dual-purpose hybrids (Northrup King 300 and Golden Harvest H-45) were not affected. The 10 sorghu m hybrids differed significantly in the three important silage quality traits -- whole-plant DM, crude protein, and acid detergent fiber.

(Key Words: Forage Sorghum, Hybrid, Silage, Yield.)

Introduction

In Kansas, 80,000 acres of sorghum were harvested for silage in 1992, producing nearly 1,300,000 tons with a value o f over $21 million.

Growing season and hybrid have a tremendous effect on ag ronomic and silage quality traits, as shown in ear lier studies (KAES Report of Progress 678, page 13). Our objective was to continue documenting the effects of hybrid and growing season on the agronomic performance and sil age quality traits of a wide variety of forage sorghums.

Experimental Procedures

Nine forage sorghum hybrids and one grain sorghum were selected to represent a range of phenotypic characteristics and season lengths. All were grown under dryland conditions near the Kansas State University campus. The forage and grain sorg hum plots were planted on May 26, 1994, and each hybrid was assigned randomly to three rep lcations. The 6-row plots were in a Reading silt loam soil. Anhydrous ammonia was applied at 100 lb of nitrogen per acre, Furadan 1 5 G was applied in the furrows at planting, and Ramrod-atrazine was applied the day after planting as a preemergent herbicide. Rows were 30 ft long with a 30-inch spacing, and plots were thinned to uniform stand s of 34,800 plants per acre. Because our earlier work (KAES Report of Progress 623, page 65) showed that harvesting at the late-dough stage of kernel maturi ty maximizes silage yield, all hybrids were harvested at that stage. The two outside rows in each plot were protecti ve borders. Whole-plant DM yield was measure d by harvesting the 2nd and 3rd rows with a one-ro w precision chopper. All heads in the 4th and 5th rows were hand clipped and dried for grain yield determinat ion. A sample of whole-plan t material from each plot was analyze d for DM, crude protein (CP), and acid detergent fiber (ADF).

Results and Discussion

Agronomi c performance of the 10 hybrids is presented in Table 1. Days to half bloom for the nine forage sorghums ranged from 61 for Golden Harvest EX-218 to 88 for Golden Harves t H-68. Plant heights were near normal. The two late-season forage sorghums (Golden Harvest H-2 and H-68) and DeKalb FS-5 were the tallest, whereas the three dual-purpose

hybrids (Northrup King 300, G olden Harvest H-45, and EX-218) were the shortest among the forage sorghums. As expected, the grain sor-ghum (DeKalb 42Y) was the shortest overall. Eight of the nine forage sorghums contained at least 32% whole-plant DM. This is essential, because hybrids with less than 30% DM are preserved less efficiently as silage and can produce la rge amounts of effluent during initial fermentation. Whole-plant DM yield was highest for two of the dual-purpose forage sorghums (Northrup King 300 and Golden Harvest H-45), whereas the male sterile (Golden Harvest H-1) and the grain sorghum had the lowest silage yields. Grai nyields were excellent for all hybrids and ranged from 9.5 to 146.3 bu per acre. High wind during the first week in September caused sever elodging in three of the four tall middle- and late-season hybrids (DeKalb FS-5, Golde nHarvest H-2, and H-68). The earl ier hybrids had already been harvested, and two of the dual-purpose hybrids were not affected by the strong winds.

As expected, the grain sorghum had the highest CP (8.5%) and the lowest ADF (30.7%). Among the forage sorghums, CP values ranged fro m6.5 to 8.4%, and ADF from 33.0 to 40.2%. No significant correlations occurre d between th e three silage quality traits (whole-plan t DM, CP, and ADF) and days to half bloom, plant height, or whole-plant DM and grain yields.

Selecting a silage hybrid that has acceptable yield and nutritive value traits is an important management decision. Fo rage sorghums can be grown under a wide range of moisture and temperatur e environments, have drought tolerance, and have the ability to recover from drought and still produce satisf actory yields with relatively low inputs. Results from earlier studies have indicated that several forage sor-ghum hybrids compared favorably to corn and grain sorghum hybrids for both agronomic and nutritive value silage traits (KAES Reports of Progress 539, pages 167 and 1 72; 568, page 12; and 678, page 16). Most importantly, choose silage hybrids that fit the cropping and cattle-feeding programs of your operation.

Table 1. **Agronomic Performance and Quality Traits of Nine Forage Sorghum Hybrids and the Grain Sorghum**

Hybrid[1]	Days to Half Bloom[2]	Plant Height, inches[3]	Harvest Date	Days from 1/2 Bloom to Harvest	Whole-Plant[4] DM, %	CP, %	ADF, %	DM Yield, tons/acre	Grain Yield, bu/acre[5]
Grain sorghum									
DeKalb 42Y	62	44 (0)	8-25	32	33.6	8.5	30.7	5.6	119.3
NK 300	79	89 (0)	9-13	34	35.8	7.6	33.4	8.9	128.4
DeKalb FS-5	66	99 (85)	9-06	39	32.3	6.5	32.8	8.1	97.6
Pioneer 947	68	92 (0)	9-06	38	38.1	7.8	35.6	8.0	146.3
Golden Harvest									
H-1	---	91 (0)	8-25	---	26.2	6.9	35.3	5.5	---
H-2	84	97 (90)	9-15	31	33.6	6.5	40.1	8.1	116.5
H-45	79	78 (0)	9-09	30	34.7	7.4	34.2	8.5	114.4
H-68	88	99 (100)	9-15	27	34.3	6.7	35.2	8.3	97.8
EX-217	81	84 (0)	9-06	25	33.5	7.5	36.5	8.1	97.5
EX-218	61	77 (0)	8-22	30	32.9	8.4	33.0	6.4	115.1
Mean[6]	76	89.5 (31)	9-02	32	33.5	7.25	35.1	7.75	114.2
LSD (P<.05)[7]	1.7	13.7 (39.2)	---	1.7	5.7	.9	4.1	1.8	14.7

[1]NK is Northrup King and EX is experimenta l. [2]Golden Harvest H-1 is a male sterile. Paper bags were placed over the emerging heads to prevent grain development in the two harvested rows. [3]Percent lodging on the day of harvest is shown in parentheses. [4]Crude protein (CP) and acid detergent fiber (ADF) are expressed on a DM basis. [5]Adjusted to 14.5% moisture. [6]Mean values include only the nine forage sorghum hybrids. [7]The LSD (least significant difference) is valid only within a column.

Cattlemen's Day 1995

RELATING QUALITY CHANGES TO STORAGE TIME FOR BALED ALFALFA [1]

W. K. Coblentz [2], J. O. Fritz [2],
K. K. Bolsen, and R. C. Cochran

Summary

The relationships between storage time and several chemical indices for forage quality were established for alfalfa hay baled at two moisture levels (29.9 and 19.7%) in conventional and laboratory bales made at 1.0, 1.5, and 2.0 times the density of parent, conventional bales. Bales were sampled after 0, 4, 11, 22, and 60 days. For the high-moisture bales, most quality indices indicated substantial nutrient loss early in the storage period, particularly between days 4 and 11, with little change after 22 days. A nonlinear mathematical model was constructed to describe how neutral detergent fiber and several other quality indices changed with storage time. Acid detergent fiber was related poorly to storage time. Little change occurred in the low (19.7%) moisture bales.

(Key Words: Alfalfa, Bale Density, Hay, Laboratory Bales, Storage.)

Introduction

Hay quality degrades during storage when moisture levels at baling exceed about 20.0 percent. These changes, facilitated by microbial activity and the subsequent heat generation, include oxidation of carbohydrates, dry matter (DM) loss, mold growth, and increased concentrations of fiber components and artifact (unavailable) nitrogen. These changes decrease the relative feed value and decrease animal performance.

Previous research designed to study changes in forage quality during bale storage has relied on sampling at a single time, normally after microbial activity has ceased. By that time, internal bale temperature has returned to near ambient, following an initial rise. The quality changes that occur early in storage, i.e., when bales are actively generating heat, has largely been ignored. Such information is important to the mechanisms that cause deterioration in hay quality.

Our objective was to establish how quality of alfalfa hay in laboratory-scale and conventional bales changed during storage.

Experimental Procedures

A 3-year-old stand of `Kansas Common' alfalfa was harvested (fourth cutting) at 10% bloom with a mower-conditioner on September 9, 1992 near Keats, Kansas. The forage was allowed to dry undisturbed, until the desired high- and low-moisture levels were reached on September 11. Actual moisture levels averaged out to 29.9 and 19.7%. Densities of conventional bales were 19.4 and 11.7 lb/ft^{3} (as-is basis) for the high- and low-moisture alfalfa, respectively. Laboratory-scale bales were subsequently made from the same alfalfa at 1.0, 1.5, and 2.0 times the density of the conventional bales using a method described previously (KAES Report of Progress 678, page 31). Specific bale characteristics for each treatment appear in Table 1. All bales were stored in small haystacks.

Hay was sampled prebaling and a t 4, 11, 22, and 60 days postbaling. Sampling dates were chosen prior the study to approximately coincide with specific points on typical temperature vs. time curves for alfalfa hay during storage. These curves are characterized by two prominent temperature maxima. The first is short duration (1 to 4 days) and occurs immediately after baling. The second maximum is normally a broad peak or group of peaks, which occurs after the internal bale temperatures has decreased after the first maximum (i.e., about 5 to 20 days post-baling). Bales were sampled on day 4 to separate effects of the first and second temperature maxima. Additional sampling at 11 and 22 days was targeted at the second temperature maximum. By day 60, we considered nutritional quality to be stable.

Samples were analyzed for nitrogen (N), NDF, ADF, and acid detergent insoluble N (ADIN). Acid detergent-insoluble N concentrations were calculated and reported based on a total DM (ADIN-DM), total N (ADIN-N), and total ADF (N-ADF).

Results and Discussion

Each of these quality indices was regressed against storage time within each moisture level. Various linear and nonlinear models were used to determine the best relationship. For all indices, quality changes over time were best fit by the nonlinear function;

$$Y = A - Be^{-kt^2}$$

where A = asymptotic maximum of the response variable, B and k are constants computed by fitting the model, and t = time (days). Comparisons of prestorage alfalfa quality traits at both moisture levels indicated no significant differences between bale types within a given moisture level (Table 2). This establishes that the laboratory-scale baling process did not affect forage quality, and all treatments of the same moisture content had a common starting point before entering storage.

During the storage period, low-moisture (19.7%) bales exhibited relatively minor changes in alfalfa quality indices (data not shown). This was expected, because 20% moisture has been suggested as the threshold for negative quality changes during storage. At the high (29.9%) moisture level (Table 3), quality changes for all baling treatments were much more pronounced.

All high-moisture treatments exhibited significant increases in NDF during storage, but none of these increases occurred between 22 and 60 days, suggesting that the changes occurred within the first month of storage. NDF increases ranged from 3.4 to 4.8 percentage units in the high-moisture bales over the first 4 days of storage, suggesting that they might be associated with the first temperature maximum.

Increases in ADF with time were less dramatic than those in NDF. Among high moisture treatments, only conventional and laboratory-scale bales (density factor = 2.0) exhibited statistically significant ADF increases.

Acid detergent insoluble N responses were relatively consistent across the three methods of expressing artifact N. Particularly large ADIN increases occurred between 4 and 11 days of storage, a window of time when all bales were intensely generating heat. Artifact N levels usually changed little from 22 to 60 days. This suggests that degradation of nitrogen availability is essentially complete within the first month of storage.

It is unclear why NDF values increased with storage so much more than ADF. However, changes in both are thought to be due to losses of soluble or nonstructural components and not to changes in fiber components themselves.

71

Table 1. **Description of Baling Treatments for High- and Low-Moisture Alfalfa Preserved in Laboratory-Scale (LAB) and Conventional (CONV) Bales**

Moisture, %	Bale Type	Density Factor[a]	Bale Volume[b], ft³	Fresh bale Weight[c], lb	Estimated Density, lb/ft³
29.7	CONV	—	5.22	101.4	19.4
30.1	LAB	1.0	.0526	1.02	19.4
	LAB	1.5		1.53	29.1
	LAB	2.0		2.04	38.8
20.2	CONV	—	5.22	60.8	11.7
19.1	LAB	1.0	.0526	0.61	11.6
	LAB	1.5		0.92	17.5
	LAB	2.0		1.22	23.2

[a]Theoretical quotient of laboratory-scale bale density divided by conventional bale density.
[b]Laboratory-scale volume based on a predetermined average of .0526 ft³.
[c]Excludes bale-wire weights for all laboratory-scale baling treatments.

Table 2. **Comparison of Prestorage Alfalfa Quality Traits for Conventional (CONV) and Laboratory-Scale (LAB) Alfalfa Hay Baled at Two Moisture Levels**

Bale Type	DM, %	ADIN-N, % of N	ADIN-DM %	N-ADF, % of ADF	NDF, %	ADF, %
High moisture						
CONV	70.3	3.12	.117	.419	32.6	27.8
LAB	69.9	3.10	.115	.403	34.2	28.5
Low moisture						
CONV	79.8	3.06	.109	.384	34.6	28.3
LAB	80.9	3.25	.113	.376	36.5	29.9
SE[1]	0.9	0.08	.005	.016	.6	.7

[1]Standard error of moisture × bale type interaction means.

Table 3. **Mean Comparisons for Quality Responses over Time in Conventional (CONV) and Laboratory-Scale (LAB) High-Moisture Alfalfa Hay Bales**

Bale Type	Density Factor[1]	Time, Days	NDF, %	ADF, %	ADIN-DM, %	ADIN-N, % of N	N-ADF, % of ADF
CONV	—	4	37.4	30.4	.125	3.32	.413
		11	44.5	32.2	.206	5.36	.635
		22	47.0	33.3	.225	5.60	.675
		60	48.4	35.6	.238	6.50	.666
LAB	1.0	4	37.6	27.9	.124	3.28	.444
		11	45.4	31.0	.167	4.43	.539
		22	44.0	29.2	.164	4.00	.560
		60	44.4	30.3	.171	4.75	.564
LAB	1.5	4	38.1	30.1	.136	3.56	.451
		11	44.6	31.4	.171	4.65	.545
		22	50.2	33.3	.203	5.49	.609
		60	47.3	32.3	.197	5.53	.610
LAB	2.0	4	38.6	29.0	.135	3.54	.468
		11	43.9	30.7	.185	4.97	.604
		22	47.8	32.4	.211	5.58	.652
		60	48.6	32.5	.217	6.07	.666
LSD[2]			3.6	3.3	.023	.61	.047

[1]Theoretical quotient of laboratory-scale bale density divided by conventional bale density.
[2]LSD (P<.05) for comparison of any two means, regardless of bale type or storage time.

Cattlemen's Day 1995

CHANGES IN NUTRIENT CONTENT OF RYE, TRITICALE, AND WHEAT WHOLE-PLANT FORAGES WITH MATURITY

K. L. Hanson, R. S. Schalles,
L. H. Harbers, and C. Thompson

Summary

We compared upland and bottomland cereals seeded during 1991 at the KSU Agricultural Research Center -Hays. The five crops (three varieties of triticale, a winter wheat, and a winter rye) were harvested as whole plants during the latter part of the growing season. Crude protein (CP), acid detergent fiber (ADF), and neutral detergent fiber (NDF) were estimated using near infrared spectroscopy. Computer models were developed to describe nutrient changes. Crude protein content decreased whereas the two fiber components increased with maturity. Rye and wheat tended to have lower CP values when day 125 was used as the arbitrary harvest date. We observed only slight differences in nutritional components between upland and bottomland plantings.

(Key Words: Nutrient Content, Triticale, Wheat, Rye, Hay)

Introduction

Cereal crops have been used successfully for grazing and for preservation as hay or silage. Several previous studies conducted at different sites in Kansas have shown that nutritional components (i.e., CP, ADF, and NDF) vary greatly among both cereal species and the stages of maturity.

Experimental Procedures

Samples from both upland and bottomland plots were taken for Larned winter wheat and Bonel winter rye, as well as Trital 2700 (spring triticale) and Presto and Pika winter triticales. Dried samples were ground with an impact mill, and CP, ADF, and NDF were estimated using a tilting-filter near infrared spectrophotometer (NIRS).

Data were analyzed using a general linear model constructed with unequal subclass numbers. The model for each nutrient was : m + land + b_1 (date) + b_2 (date^2), where m= mean, land was upland or bottomland, and b_1 and b_2 were regression coefficients. The model allowed an accurate comparison to be made between species and variety within species.

Results and Discussion

All varieties on each land type showed the expected decrease in CP and increases in ADF and NDF with maturity (Figure 1). The analyses showed only slight variation between upland and bottomland growth. At the arbitrary harvest date (day 125 is May 6), triticale cultivars were higher in CP than Larned wheat or Bonel rye, and Pike triticale was unique because of its low NDF.

73
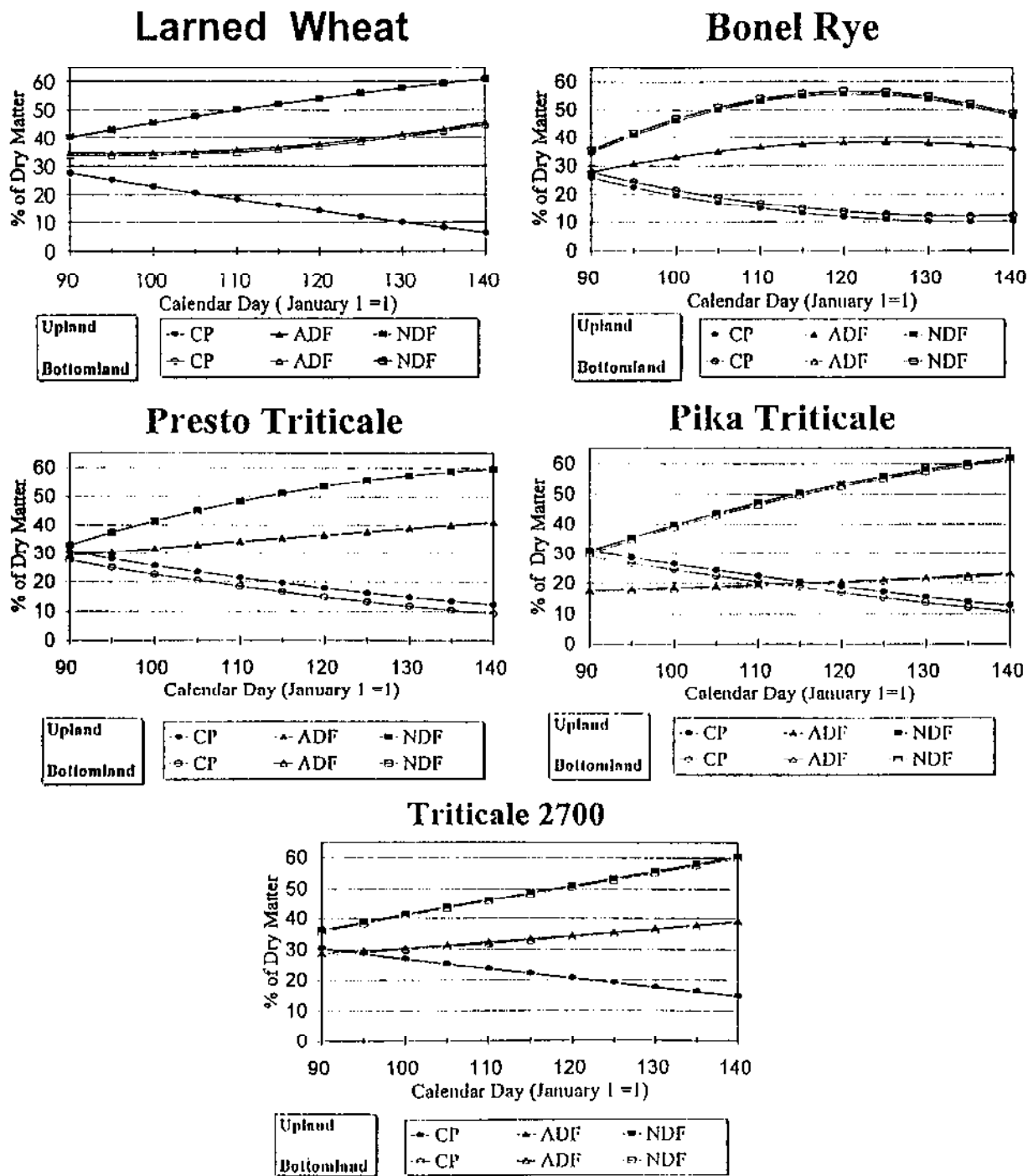
Figure 1. The Analyses Showed Only Slight Variation between Upland and Bottomland Growth. At the Arbitrary Harvest Date (Day 125 is May 6), Triticale Cultivars Were Higher in CP than Larned Wheat or Bonel Rye and Pike Triticale Was Unique Because of Its Low NDF

Cattlemen's Day 1995

PROCESS INTERVENTION TO ASSURE SANITATION OF BEEF CARCASSES AND CUTS

R. K. Prasai, C. L. Kastner, P. B. Kenney,
C. M. García Zepeda, L. E. Mease, L. R. Vogt,
B. L Willard, D. H. Kropf, R. K. Phebus,
R. E. Campbell, D.Y.C. Fung, and E.A.E. Boyle

Summary

The meat industry and Food Safety and Inspection Service (FSIS) strive to minimize carcass contamination during slaughter and subsequent processing. Because microbial contamination during slaughter cannot be avoided completely, decontamination methods must be addressed. This overview emphasizes process intervention studies conducted at Kansas State University to determine the most effective intervention points and technologies to control microbiological hazards in meat and meat products.

Our research shows that trimming of gross contamination followed by washing is a reasonable approach to minimizing microbial contamination on beef carcasses. We also found that sanitation of subprimal cuts may be just as effective as treating the carcass.

Decontamination

Carcasses:

Most bacterial contamination of carcass surfaces occurs during slaughter-dressing procedures and comes from a variety of sources, but mainly from hides and intestinal contents. In addition to good sanitary practices, spraying of carcasses with organic acids, particularly lactic and acetic, can limit bacterial contamination.

Our initial studies considered the fact that the industry and FSIS were evaluating pre-evisceration organic-acid rinsing; therefore, we chose to evaluate other control points. Other reports showed that carcass rinsing, although effective in decreasing microbial counts on the carcass, did not carry through to subprimal and retail cuts. Consequently, we also evaluated treating subprimal cuts with chlorine (200 ppm) or microwave (15 sec per side of each subprimal cut) as process-intervention treatments before vacuum storage.

Our carcass rinse study involved spraying beef carcass sides with water, 200 ppm chlorine, or 3% lactic acid immediately after rail inspection and(or) at the end of an 8 hour spray-chill cycle. All treatment combinations involving either chlorine and(or) lactic acid reduced carcass contamination from .4 to 1.8 logs (1 log equals 90% reduction, 2 logs equals 99% reduction). Lactic acid treatment at both spray times resulted in greater bacterial reduction (P<.05) than water and chlorine. However, carcass treatments did not carry through to the subprimal level. Additionally, treating subprimal cuts with chlorine or microwaves had no effect (P>.05) on microbial reduction during extended storage.

Subprimals:

We tested the efficacy of spraying 1.5% lactic acid onto subprimal cuts and followed the results of that treatment through to the display of retail cuts. Lactic acid solutions were sprayed on beef strip loins before and(or) after vacuum storage to yield five treatment combinations: i) vacuum packaged control, ii) no treatment prestorage but acid spray poststorage, iii) acid spray prestorage, iv) acid spray prestorage, and water spray poststorage, and v) acid spray pre- and poststorage. After prestorage treatment, all loins were vacuum packaged and stored for 14, 28, 56, 84, or 126 days at either 30 °F or 36 °F.

Acid spray prestorage was more effective than other treatments in reducing bacterial

contamination. Most loins stored at 30 °F had numerically lower microbial counts than those stored at 36 °F, and loins stored at 30 °F following acid treatment had lower microbial counts than control loins.

Upon storage and treatment of the subprimals, 1-inch-thick steaks were fabricated from each loin. Steaks were packaged in oxygen-permeable film and displayed at 36.0±4 °F under 100-foot-candle intensity Deluxe Warm White lighting for 3 and 5 days or tested before display.

Total bacterial counts, presence/absence of *Listeria monocytogenes* and *Salmonella* spp., and instrumental and visual color evaluations were used to determine the microbiological and display quality of steaks. Spraying lactic acid on strip loins both pre- and poststorage, and lactic acid applied prestorage combined with water sprays after storage at 30 °F yielded about a 2 log reduction in bacterial counts of steaks not displayed or displayed for 3 days, and >1.0 log reductions at 5 days of display, compared to controls. Lactic acid treatment pre- and poststorage (30 °F) lengthened the lag phase of microbial growth on steaks. Storage at 30 °F reduced microbial growth compared to 36 °F. *L. monocytogenes* and *Salmonella* spp. were absent from all steaks.

On the basis of color, subprimal storage life and(or) steak display life were slightly shorter for lactic-acid-treated cuts than for controls. However, lactic acid sprays resulted in longer storage life and(or) steak display life when based on bacterial spoilage. A similar result was observed in a companion study involving vacuum-packaged retail cuts that were displayed up to 14 days.

Lactic acid treatment of subprimal cuts carried through to displayed retail cuts and may be more effective than treating carcasses. This is particularly true for aerobically packaged cuts. Good temperature control enhances the carry-through effectiveness of lactic-acid-treatment at the subprimal level.

Hot-Fat Trimming

Because the subcutaneous fat layer comprises the major outer surface of the carcass and is most likely to be contaminated during slaughter/dressing practices, trimming of this layer may provide an additional means to remove bacterial contamination on the carcass surfaces. Removal of fat prior to chilling also reduces refrigeration costs and time required for subprimal fabrication. Consequently, we examined the efficacy of hot fat trimming to reduce microbial contamination on beef carcasses and subsequent subprimals.

Immediately after washing, beef carcass sides were either trimmed to .25 inch external fat or left as controls. Trimmed and non-trimmed sides were analyzed for bacterial counts before and after 72 h of chilling. We found no reduction in bacterial counts (P>.05) from trimming.

Sides were trimmed with a Whizard knife, which may have smeared microorganisms from one location to another. By 72 hours, hot trimmed sides had numerically lower counts than control sides, indicating that microbial reduction by chilling was greater on trimmed than nontrimmed carcasses.

Subprimals from trimmed and control sides were microbiologically analyzed before (0 day) and after 14 days of vacuum storage. The average bacterial count was higher for trimmed-side than for nontrimmed-side subprimals at both times, indicating that subprimals from trimmed sides may have picked up additional microorganisms during fabrication.

Thus, hot-fat trimming may not be an effective way to improve the microbial quality of meat.

Trimming and(or) Washing

In another study, carcass trimming (fat trimming to remove visible contamination) and washing were studied separately or in combination. Beef carcass sides selected randomly in a commercial processing facility were assigned to one of four groups: i) no trim and no wash (NTNW), ii) trim but no wash (TNW), iii) trim

and wash (TW), and iv) no trim but wash (NTW). Samples were taken at the appropriate point in the normal slaughter process to achieve all treatment combinations.

The greatest reduction (P<.05) in bacterial counts was observed in TNW followed by TW and NTW, with the corresponding mean bacterial reductions relative to NTNW being 3.0, .9, and .3 logs, respectively (Figure 1). Because TW carcasses had bacterial counts that were almost 2 log$_{10}$

higher than those of TNW samples, recontamination by washing may have been extensive. *Escherichia coli* and coliform counts in NTNW samples were higher (P<.05) than for other treatments.

Because washing probably will be a part of all future decontamination protocols, and because trimming of the entire carcass surface is not commercially practical, trimming of obvious contamination in combination with washing likely would be the most reason able approach to minimize microbial contamination in commercial beef plants.
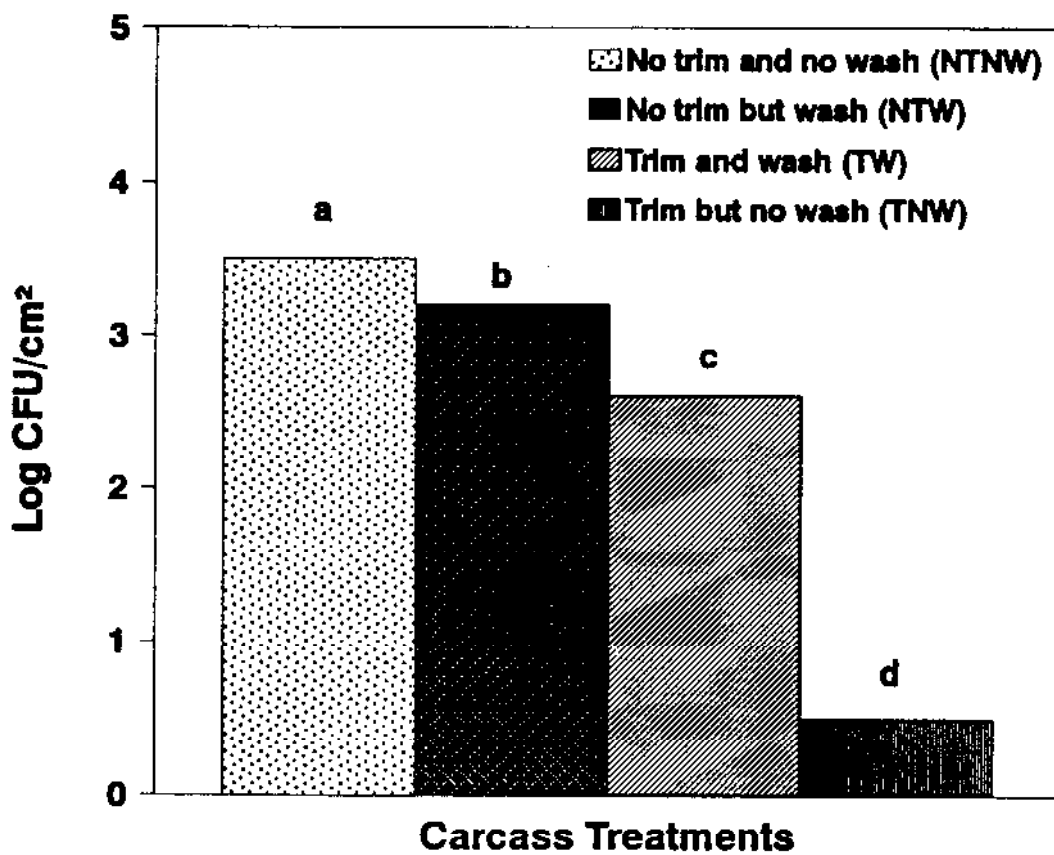
Figure 1.   Effect of Trimming and/or Washing on Total Bacterial Populations (Mean log$_{10}$ Bacterial Colony Forming Units/cm^2) of Beef Carcasses Sampled Immediately before Being Moved to a Cooler

Cattlemen's Day 1995

EFFECTS OF HOT-FAT TRIMMING ON RETAIL DISPLAY COLOR OF THREE BEEF MUSCLES

S. R. Stuewe, D. H. Kropf, M. C. Hunt,
R. E. Campbell, and C. L. Kastner

Summary

Steaks from subprimal cuts from carcass sides that were either hot-fat-trimmed to .25 inch or not hot-fat-trimmed (control) were used to determine trimming effects on retail display color. After 14 days storage in vacuum bags at 30°F, subprimals were cut into 1-inch-thick steaks for evaluation. Specific muscles that were evaluated were the loin strip (longissimus lumborum), inside round (semimembranosus only), and the chuck clod (triceps brachii only). The steaks were packaged in polyvinylchloride (PVC) film and displayed. The loin strip steaks from hot-fat-trimmed sides were more discolored (P<.05) than from nontrimmed controls at 0, 3, and 4 days display, but both had acceptable color through 4 days of display. Treatments were not different for inside round steaks (P>.05); the deep location was less red (P<.05) than the location closer to the muscle surface. Chuck clod steaks were not affected by trimming (P>.05). The location closest to the muscle surface was brightest red, and the deep location was darkest (P<.05). All inside round and chuck clod steaks were unacceptable in appearance by day 3 of display. Hot-fat trimming did not degrade the display color of these two muscles and overall effect of hot-fat trimming on beef steak display life was minimal.

(Key Words: Beef, Color, Hot Fat Trim.)

Introduction

Hot-fat trimming of beef carcasses is increasing, because it allows faster chilling of carcass meat and faster fabrication of chilled carcasses, but its effect on display-color life of retail cuts needs to be determined.

Our objectives were to determine display color of several locations of each of three different beef muscles that were prepared as retail cuts from vacuum packaged subprimal cuts that had been stored at 30°F for 14 days. The study compared hot-fat trimming to .25 inch with control sides that were not trimmed prior to chilling.

Experimental Procedures

Nine steer carcasses ranging in hot, untrimmed, carcass weight from 700 to 800 lb and in fat thickness from .40 to .60 inch were selected. The hot-fat trimming treatment was assigned randomly to right and left sides. Those sides were trimmed to approximately .25 inch external fat. After spray chilling at 34°F for 8 hours and storage at 34°F until 72 hours postmortem, sides were fabricated into primal and subprimal cuts, according to National Association of Meat Purveyors (NAMP) specifications. The strip loins (NAMP 180), inside rounds (NAMP 168), and chuck clods (NAMP 114) were vacuum packaged and stored at 30°F for 14 days before 1-inch steaks were cut from each. The first steak was a "facing" steak, and the second was used for display. The loin strip steaks were removed from the anterior end; inside round steaks were removed from the proximal (aitch bone) end; and chuck clod steaks were cut from the long head, perpendicular to the grain. Steaks were placed on styrofoam trays with a soaker pad, wrapped with polyvinylchloride film (high oxygen permeability) and displayed at 34°F with one daily defrost cycle. After

the initial (0 time) color evaluation, steaks were displayed continuously under 150-foot candle Deluxe Warm White fluorescent lighting. Visual appraisal by a seven-member experienced panel was used to evaluate color on day 0, 1, 2, and 3 for all muscles . The loin strip also was evaluated on day 4. The loin strip evaluation was an average of the entire muscle. The deep and superficial (close to muscle surface) locations of the inside round (semimembranosus) were evaluated separately. The chuck clod (triceps brachii) was evaluated separately at three locations -- the lateral head, the deep longitudinal (long), and close-to-surface longitudinal (long) head. Visual scores were estimated to the nearest .5 on a 5 point scale where 1 = bright red, 2 = dull red, 3 = slightly dark red or brown, 4 = dark red or brown, and 5 = very dark red or brown.

Results and Discussion

Consumers likely would discriminate against steaks with visual scores greater than 3.0 (Table 1). Loin strip hot-fat-trimmed steaks were darker than controls (P<.05)

on days 0, 3, and 4 ,but both treatments were of acceptable appearance, even at 4 days of display.

No difference was noted between hot-fat-trimmed and control steaks for inside round; however, there was a location within muscle effect. The deep location was more discolored (P<.05) than the superficial (close to surface) location on days 1, 2, and 3. Steaks from both treatments were unacceptable in appearance by day 3.

The chuck clod (triceps brachii) was a more complex muscle with three locations to evaluate. The only difference between hot-fat-trimmed and control steaks (P<.05) was on day 2 in the lateral location where the hot-fat-trimmed steaks were more discolored than the control. From day 1, location within the muscle differed (P<.05). The superficial long location was the brightest red throughout, the deep long location was the most discolored, and the lateral was intermediate. Color of steaks from both treatments was unacceptable by day 3 of display.

Table 1.   Visual Scores of Muscle Display Color [a]

Muscle, Treatment	Display Day				
	0	1	2	3	4
Loin strip					
Hot fat trimmed (HFT)	1.31[b]	1.66	2.18	2.51[b]	2.84[b]
Control	1.19[c]	1.57	2.29	2.32[c]	2.57[c]
Inside round (semimembranosus)					
Deep HFT	1.51	2.36[c]	3.01[c]	3.49[c]	
Deep control	1.48	2.39[c]	3.10[c]	3.36[c]	
Close to surface HFT	1.75	2.10[b]	2.62[b]	3.18[b]	
Close to surface control	1.62	2.19[b]	2.75[b]	3.06[b]	
Chuck clod (tricepsbrachii)					
Lateral HFT	1.77	2.73[c]	3.26[d]	3.66[c]	
Lateral control	1.66	2.59[c]	3.09[c]	3.49[c]	
Deep long HFT	1.75	2.97[d]	3.30[d]	3.73[c]	
Deep long control	1.73	2.91[d]	3.37[d]	3.69[c]	
Close to surface (superficial)					
Long HFT	1.76	2.51[b]	2.77[b]	3.24[b]	
Long control	1.73	2.39[b]	2.82[b]	3.17[b]	

[a]Visual scores were 1 = bright red, 2 = dull red, 3 = slightly dark red or brown, 4 = dark red or brown, and 5 = very dark red or brown.
[bcd]Means of the same muscle and column with different superscripts differ (P<.05).

Cattlemen's Day 1995

DISPLAY LIFE AND INTERNAL COOKED COLOR OF GROUND BEEF FROM VITAMIN E-SUPPLEMENTED CATTLE [1]

C. L. Lavelle, M. C. Hunt, and D. H. Kropf

Summary

Retail display life of ground beef and internal color of patties cooked to four endpoint temperatures (131, 149, 160, and 171°F) were determined for ground beef (9% fat) from vitamin E-supplemented (500 and 2000 IU per day) steers. Visual scores indicated that the display time required for the 500 and 2000 vitamin E samples to reach an objectionable reddish-brown/brown color was increased by 12 and 32 hours, respectively, as compared with the 0 vitamin E samples. Patties did not differ in internal cooked color regardless of vitamin E level. Vitamin E was effective in increasing retail display color stability and did not affect cooked color.

(Key Words: Visual Display, Cooked Color, Vitamin E, Ground Beef, Color.)

Introduction

Displaying meat cuts under high intensity lights, such as those found in retail cases, accelerates the formation of an undesirable brown, metmyoglobin color. Every year, retailers lose an estimated $1.1 billion from discoloration of meat cuts prior to microbiological spoilage. Cuts from vitamin E-supplemented cattle have a longer retail display life than cuts from nonsupplemented cattle. The effect of vitamin E supplementation on the internal cooked color of beef is not known. Our objectives in this research were to determine the effects of vitamin E supplementation on ground beef retail color stability and on cooked color development.

Experimental Procedures

Knuckles representing two replications of 18 Holstein steers each were obtained from the University of Wisconsin-Madison. For each replication, six steers received no supplemental vitamin E, six received 500 IU, and six received 2000 IU daily for approximately 120 days prior to slaughter. The meat was fabricated, vacuum packaged, shipped fresh to Kansas State University by Packerland (Green Bay, WI), and stored at 35°F until 17 days postslaughter. Coarsely ground lean was mixed with trimmed fat to achieve 9% fat and re ground through a 1/8-inch plate. Samples for visual appraisal were removed, and the remainder of the meat was formed into patties, frozen, vacuum packaged, and stored at -4°F until used.

For visual display, 3/4-lb packages were wrapped with oxygen-permeable film and arranged in a 32-36°F commercial, open topped, display cabinet programmed for one daily defrost cycle. Samples were displayed continuously under 150 footcandles of Phillips 40 watt DLX warm white fluorescent lights. Average CIE a* values were measured at 0, 16, 23, 44, 68 and 92 hours, and samples also were scored by six trained panelists using a 5-point scale (1=bright red, 2=red, 3=reddish-brown, 4=moderately brown, 5=very brown).

For cooked color, frozen patties were thawed and cooked on an electric griddle (325°F) to internal temperatures of 131, 149, 160, or 171°F. After cooking, average internal CIE Lab values were measured, and the internal

color was ranked subjectively to the nearest .5 on a 5-point color scale by one panelist.

Raw patties were analyzed for pH and fat oxidation (TBA) . Whole muscle samples taken prior to grinding were measured fo r α-tocopherol content. Data were analyzed as split-plots with differences among means being determined using least square means.

Results and Discussion

Vitamin E level did not consistently affect pH (Table 1). Increasing the level of vitamin E decreased TBA valu es (Table 1), and vitamin E levels reflected vitamin E intakes. Vitamin E level had no effect (P>.05) on the internal cooked color of patties (results not shown).

Vitamin E affected (P<.05) visual scores for display color stability, with differences between levels being detected by 16 hours (Figure 1). Thos edifferences persisted through 92 hours (P<.05). At each time interval, lower scores (i.e., more redness) were recorded for the 2000 E samples followed by the 500 E and 0 E samples. Considering a visual score of 3.5 as unsalable, the 0 E samples were salable for 48 hours, the 500 E samples fo r 60 hours, and the 2000 E samples for 80 hours. Instrumental a* values were similar (P>.05) for all three levels of v itamin E at 0 and 16 hours (Table 1). By 23 hours, the 500 and 2000 E samples had higher (P<.05) a* values than the 0 E samples, and the differences persisted (P >.05) throughout display (Table 1). The retail display life extension seen for the vitam in E samples in this study is less than that previously reported. Differences could be attributed to the amount of vitamin E in the muscle, re tail case temperature, defrost cycles, or light intensity. These data indicate that beef from vitamin E-supplemented cattle retained a redder color longer than that from cattle without supplemental vitamin E.

Table 1.   Characteristics [d] of Ground Beef with and without Vitamin E

Trait	Vitamin E Supplementation, IU		
	0	500	2000
Raw patty pH	5.63[a,b]	5.65[a]	5.62[b]
TBA value , μg TBA reactive/g sample	1.3[a]	.8[b]	.5[c]
α-tocopherol , μg/g fresh meat	1.22[a]	2.43[b]	5.31[c]
a* value (redness)			
0 hour	37.6	39.8	39.0
16 hour	29.5	32.5	31.7
23 hour	26.4[a]	30.9[b]	30.5[b]
44 hour	20.5[a]	25.6[b]	26.1[b]
68 hour	14.4[a]	19.7[b]	20.7[b]
92 hour	10.9[a]	15.1[b]	17.4[b]

[a,b,c]Means within a row with the same superscript letter are not different (P>.05).
[d]Data were pooled for replication.
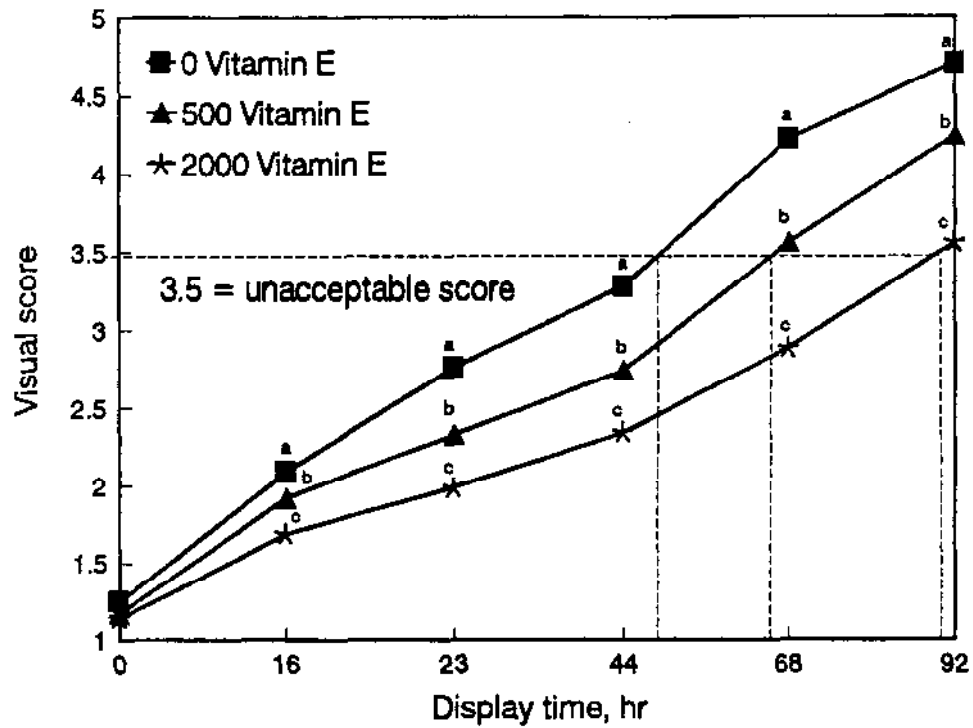
Figure 1. Effect of Vitamin E on Visual Color Score of Ground Beef during Lighted Display at 32°F. Visual score: l=bright red, 2=red 3=reddish-brown, 4= moderately brown, 5=very brown. Data points within each hour with a different letter are different (P<.05)

82

Cattlemen's Day 1995

FACTORS AFFECTING PREMATURE BROWNING IN COOKED GROUND BEEF

M. C. Hunt, K. E. Warren[1], D. H. Kropf, M. A. Hague[2], C. L. Waldner[3], S. L. Stroda, and C. L. Kastner

Summary

Some ground beef patties developed an internal, brown cooked color and looked well-done at temperatures as low as 13 1°F, whereas normal patties were re dto pink. The premature brown color was not relate dto percent fat; patty compaction; animal source and maturity; pH (5.5 to 5.8); or concentrations of raw patty heme and nonheme iron, myoglobin, and total pigment. Because oxidat ion-reduction potential and total reducing activitie swere higher (P<.05) and TBA numbers were lower (P<.05) in normal than prematurely brown patties, the brown color is apparently related to greater patty oxidation.

(Key Words: Ground Beef, Cooked Color, Oxidation, Reducing Activity, Food Safety.)

Introduction

Internal color of cooked meat normally changes from red to pink to tan as endpoint temperature s increase. These colors often are used to assess degree o fdoneness. However, in some of our earlier studies, a well-done appearance has developed in ground beef at lower than expected temperat ures. Because this premature brown color could result in consumer s eating undercooked ground beef, concern s for food safety were raised. This research examined the chemical properties of ground beef that turned brown prematurely during cooking.

Experimental Procedures

Samples exhibiting normal and premature brown cooked color were obtained from the quadriceps muscle of A- and E-maturity, British-beef and dairy breeds and from frozen beef trimmings. All raw materials had pHs of 5.5 to 5.8 and fat contents from 3 to 18%. Quarter pound patties were forme dcrust frozen (-40°F), vacuum packaged, and stored at - 4F for 2 to 11 months.

Oxidation-reductio n potential of raw sample s was measured usin ga platinum redox and a silver/silver chloride reference electrode. TBA values (a measure of oxidation) were determine d on raw patties using the perchloric acid extraction method . Total reducing activity, total pigment ,and heme and nonheme iron also were determined.

Prior to coo king, external and internal patty colors were assessed visuall yto the nearest half-point using a 5-point descriptiv escale (1=purple red, 2=dark reddish purple, 3=bright red, 4=brownish red, 5=very brown). Patties were cooked to 131, 149, or 16 7°F on an electric griddle (325°F). Internal temperature was monitored by intermittently inserting a needle thermo-prob e into the patty. Patties were cooled for 5 minutes and sliced for internal color evaluation to th enearest half-point using a 5-point descriptive scale (1=very dark red to purple, 2=bright red, 3=very pink, 4=slightly pink, 5=tan, no evidence of pink). A Hunter Labscan

[1]Tyson Foods, Springdale, Arkansas.
[2]Cryovac, Simpsonville, South Carolina.
[3]University of Kentucky, Lexington, Kentucky.

6000 was used to instrumentally evaluate color. Saturation index (color intensity) was calculated.

Data were analyzed as a completely randomized design where treatments were a 2 × 3 factorial of cooked color group and endpoint temperature. SAS General Linear Models procedures and least square means separation techniques were used.

Results and Discussion

An interaction (P<.05) was found for virtually all cooked color traits. As expected, patties from the normal group exhibited a typical color change during cooking from red to more tan as endpoint temperature increased. At all three end point temperatures, patties that had premature browning were described as slightly pink to tan. Visually, the normal group at 131°F was the most red (P<.05), followed by normal at 149°F (Table 1). Normal patties at 167°F and prematurely brown patties at 131 and 149°F were similar (P>.05) in cooked color. Patties that were prematurely brown were visually similar at 131, 149, or 167°F (P>.05). Instrumental measurements (Table 1) supported visual scores, because normal

patties at 131°F were the reddest (highest a*) and most intense in color (saturation index). For most instrumental color traits, the normal patties at 149°F were intermediate in redness (P<.05), whereas normal at 167°F and prematurely brown at 131°F were less red and not different (P>.05). For most instrumental traits, patties that were prematurely brown at 149 and 167°F did not differ (P>.05), and both exhibited the least (P<.05) redness.

Patties that had premature brown cooked color had higher (P<.05) TBA values (Table 2) than patties with normal color. They also had lower (P<.05) total reducing activity and oxidative-reductive potentials. No differences (P>.05) for heme, nonheme, or total pigment occurred in raw patties from the two cooked color groups (Table 2). After cooking, patties with normal color at 131°F retained higher concentrations of extractable pigment and heme iron compared to patties with premature brown color at this temperature. Nonheme iron increased more in patties with premature brown than normal color upon heating to 131°F. Overall, patties with premature brown cooked color were more oxidized and exhibited less reducing ability than patties with normal color.

Table 1. **Means for Cooked Internal Appearance Traits of Normal (NRM) and Prematurely Brown (PMB) Ground Beef Patties Cooked to 131, 149, and 167°F**

Trait	131°F		149°F		167°F	
	NRM	PMB	NRM	PMB	NRM	PMB
Visual color[1]	2.3^d	4.6^b	3.6^c	4.9^{ab}	4.6^b	5.0^a
a* Value (redness)	25.3^a	15.2^c	22.9^b	12.8^d	16.0^c	11.6^d
Saturation index	31.4^a	22.7^c	29.1^b	19.8^d	22.5^c	18.8^d

[1]Visual color scores for internal cooked color: 1=very dark red to purple, uncooked appearance; 2=bright red; 3=very pink; 4=slightly pink; 5=tan, no evidence of pink.
[a,b,c,d]Means within a trait without a common superscript letter differ (P<.05).

Table 2.   Means for Chemical Traits of Ground Beef Patties with Normal (NRM) and Prematurely Brown (PMB) Cooked Color Raw and Cooked to 131°F

Trait	NRM	PMB
Thiobarbituric acid (TBA) reactive substance (raw), µg/g (fat free)	.50[b]	1.11[a]
Total reducing activity (raw)	5 3[a]	.36[b]
Oxidative-reducing potential (raw), mv	-128[a]	-91[b]
Heme iron, (raw), µg/g patty(fat free)	15.29	14.14
Heme iron (131EF), µg/g patty (fat free)	5.81	4.76
Nonheme iron (raw), µg/g patty (fat free)	6.57	6.33
Nonheme iron (131EF), µg/g patty (fat free)	9.57	10.15
Total pigment (raw), µg/g patty (fat free)	9.92	9.62
Total pigment (131EF), µg/g patty (fat free)	3.73	2.94

[a,b]Means for a trait with different superscript letters differ (P<.05).

Meat Color and Myoglobin

Myoglobin is the pigment that makes meat red. It's similar in structure to hemoglobin found in blood. When a carcass is ribbed, the ribeye surface changes from dark red to bright red because myoglobin at the surface binds oxygen from the atmosphere. Each myoglobin molecule contains an atom of iron. Normally, that iron is in the ferrous (Fe+2) state and is said to be "reduced." However, during retail display, part of the iron converts to the ferric (Fe+3) form and is said to be oxidized. The myoglobin is now brown in color and is called metmyoglobin.

The iron in myoglobin is important nutritionally and is called "heme iron." It's the most biologically available form of iron known.

Cattlemen's Day 1995

PREMATURE BROWNING IN COOKED GROUND BEEF AFTER MODIFYING MYOGLOBIN

M. C. Hunt, K .E. Warren [1], D. H. Kropf, M. A. Hague [2],
C. L. Waldner [3], S. L. Stroda, and C. L. Kastner

Summary

Some ground beef patties develop an internal, brown cooked color and the patty looks well-done at temperatures as low as 131°F. This study determined if treatment of ground beef to oxidize or reduce meat pigments could influence cooked color. When the myoglobin pigment was chemically oxidized, premature browning occurred, whereas chemically reduced pigment produced normal cooked color. We conclude that biological factors affecting muscle reducing ability must be controlled to retain reducing capacity sufficient to develop normal cooked color of ground beef.

(Key Words: Ground Beef, Cooked Color, Oxidation, Reduction, Food Safety.)

Introduction

Internal color of cooked meat typically changes from red to pink to tan as endpoint temperatures increase, and these colors are often used to assess doneness. This assessment is not reliable for ground beef that develops a well-done appearance at final internal temperatures lower than expected. This premature brown color could result in consumption of undercooked ground beef, causing serious concerns for food safety.

In an earlier study we found that heme and nonheme iron, total pigment, percentage fat, patty compaction, animal source or maturity, and pH (5.5 to 5.8) were not different between patties that developed a normal or premature brown cooked color. The present study was done to determine if chemically oxidizing or reducing treatments of normal patties or those that turn brown at low temperatures could influence cooked color when heated to only 131°F.

Experimental Procedures

Patties exhibiting normal and premature brown cooked color were obtained from the quadriceps muscle of A- and E-maturity, British-beef and dairy breeds and from frozen beef trimmings. Patty pH was 5.5 to 5.8, and fat was 3 to 18%. Quarter pound patties were formed, crust frozen (-40°F), vacuum packaged, and stored at -4°F for 2 to 11 month.

Patties exhibiting normal and premature brown cooked color received one of three chemical modifications: 1) no chemical modification (NO); 2) reduced (RD; 10 mL of .05 mM sodium hydrosulfite); or 3) oxidized (OX; 10 mL of .04 mM potassium ferricyanide) for a total of six treatment combinations.

Prior to cooking, external and internal patty colors were assessed visually to the nearest half-point using a 5-point descriptive scale (1=purple red, 2=dark reddish purple, 3=bright red, 4=brownish red, 5=very brown). Patties were cooked to 131°F on an electric griddle (325°F). Internal temperature was monitored by intermittently inserting a needle thermo-probe into the patty. Patties were cooled for 5 minutes and sliced for internal color evaluation to the nearest half-point using a 5-point descriptive scale

---

[1]Tyson Foods, Springdale, Arkansas.

[2]Cryovac, Simpsonville, South Carolina.

[3]University of Kentucky, Lexington, Kentucky.

(1=very dark red to purple, 2=bright red, 3=very pink, 4=slightly pink, 5 =tan, no evidence of pink). A Hunter Labscan 600 0was used to instrumentally evaluate color. Saturation index was calculated. Expressible juice was squeezed from patties and its color was evaluated to the nearest half-point using a five-point scale (1=dark, dull red; 2=red; 3=pink; 4=pinkish tan; 5=yellow, no pink).

Data were analyzed as a completely randomized design where treatments were a 2 × 3 factorial with cooked color group and chemical modification as variables. SAS General Linear Models procedures and least square means separation techniques were used.

Results and Discussion

Because patties from the normal group had higher total reducing activity than those in the prematurely brown group, we examined the effects of modifying the myoglobin state before cooking. Patties with NO and RD modifications did not differ in total reducing activity (P>.05) and both were considerably higher (P<.05) in reducing activity than patties with OX modification (Table 1). The potassium ferricyanide in OX patties may have confounded determination of total reducing activity, because it is the compound monitored for reducing activity. Thus, the extremely low total reducing abilities of OX patties were unexpected.

Raw patty external and internal appearances were altered by chemical modification (Table 1). Visually, patties from normal-RD, prematurely brown-RD, and normal-NO groups were the most (P<.05) purplish red. Patties from normal-OX, prematurely brown-OX, and prematurely brown-NO groups were the most oxidized and brown in appearance. OX modification resulted in patties with a brown external and internal appearance, typical of a metmyoglobin. RD resulted in

a purple-red external surface and purple-red internal surface typical of deoxymyoglobin. Instrumental color (not all data shown in Table 1) followed a pattern similar to visual evaluations, with normal patties having higher (P<.05) a* values (more red) than prematurely brown patties. RD patties had the highest (P<.05) a* values and saturation indices, NO was intermediate, and those with OX had instrumental values indicative of being brown.

Patties with normal-RD treatment had the most (P<.05) red internal visual cooked color (Table 1). NO-normal and RD-prematurely brown patties were intermediate and were scored very pink. Prematurely brown-NO and -OX modifications yielded patties that were the least red. Instrumentally (not all data shown), patties from normal-RD and prematurely brown-RD groups had the highest (P<.05) a* values and saturation indices (Table 1).

Although differences occurred in the internal patty appearance between cooked color groups and from the chemical modification, no differences in color of expressible juice were found. The juice from patties from all treatment groups was very red in color. The reason for the disparity in patty color (red vs. brown) and juice color is unknown, but we had found previously that expressible juice color and internal patty color were not highly related. Endpoint temperature was more related to expressible juice color than to internal patty color, especially at low endpoint temperatures.

The relationship between pigment oxidative state and internal cooked color indicates the need for rapid and conscientious handling of raw materials to ensure sufficient reductive capacity in meat that will lead to normal cooked color. Because oxidiation of ground beef leads to the development of prematurely brown internal color, factors influencing metmyoglobin formation also may influence premature browning. Higher storage temperatures promote greater oxygen uptake and more rapid reduction of reducing enzyme

activity. Increasing length of time postmortem and mechanical manipulation, such as grinding, drastically decrease a muscle's reducing ability. Rapid pH decline during

chilling while carcass temperature is still high might promote premature browning by decreasing myoglobin stability.

Table 1.   Characteristics of Ground Beef with Normal and Prematurely Brown Cooked Internal Color at 131 °F

Trait	Meat Color Group	Pigment Chemical Modification		
		None	Reduced	Oxidized
Total reducing activity, raw	Summed over both	.55[a]	.52[a]	-10.0[b]
External visual color, raw [1]	Normal	2.8[b]	2.1[c]	4.5[a]
	Premature brown	4.3[a]	3.0[b]	4.0[a]
External a* values, raw	Summed over both	12.9[b]	24.0[a]	9.9[c]
Internal visual color, raw [1]	Normal	1.9[c]	1.5[c]	4.7[ab]
	Premature brown	4.2[b]	2.0[c]	5.0[a]
Internal a* values, raw [2]	Summed over both	15.1[b]	25.9[a]	10.2[c]
Internal visual color, cooked [3]	Normal	2.4[b]	1.7[c]	4.8[a]
	Premature brown	4.7[a]	2.1[b]	5.0[a]
Internal a* values, cooked	Normal	24.9[b]	30.8[a]	15.7[c]
	Premature brown	15.1[c]	29.7[a]	10.8[d]
Expressible juice visual color [4]	Normal	2.2[a]	2.0[a]	2.2[a]
	Premature brown	2.0[a]	2.0[a]	2.3[a]

[1]Visual color scores for raw external and internal color: 1 =purple red, 2=dark reddish purple, 3=bright red, 4=brownish red, 5=very brown.

[2]An instrumental measure of redness.

[3]Visual color scores for internal cooked color: 1=very dark red to purple, uncooked appearance; 2=bright red; 3=very pink; 4=slightly pink; 5=tan, no evidence of pink.

[4]Expressible juice color: 1=dark, dull red; 2=red; 3=pink; 4=pinkish tan; 5=yellow, no pink).

[a,b,c]Means within a trait without a common superscript letter differ (P<.05).

Cattlemen's Day 1995

RELATIONSHIPS BETWEEN WEANING WEIGHT, MATERNAL WEANING WEIGHT, AND MILK PRODUCTION IN POLLED HEREFORD CATTLE

J. B. Glaze, Jr. and R. R. Schalles

Summary

Performanc e data from a Polled Hereford herd selected for improved feed conversion were used to calculate a variety of genetic parameters. Heritabilities were .14 for weaning wt, .18 for maternal weaning wt., and .19 for milk productio n The genetic correlations were –.10 between weaning weight and maternal weaning weight and 0 between weaning weight and milk production. However, the genetic correlatio n between maternal weaning weight and milk was . 99, indicating they are essentially the same trait. Milk EPDs published by most breed associations are calculate d as the maternal weanin g weight. Our study strongly supports this method of estimating an animal's genotype for milk production.

(Key Words: Weaning Weight, Maternal Weaning Weight, Milk Production, Heritabilities, Genetic Correlations.)

Introduction

Today, beef pr oducers have a wide array of informatio n to assist them in making sound selection decisions. Heritabilities provide informatio n regarding the variation in traits due to inheritance, as well as information about expecte d response from selection. Genetic correlation s indicate how traits are genetically related o r how the same genes affect more than one trait. Our purpose was to estimate the heritabilities and genetic cor relations of weaning weight, maternal weaning weight, and milk production.

Experimental Procedures

Performanc e data were collected on 1459 animals from a Polled Hereford herd at Kansas State University, from 1967 through 1979. Foundatio n animals were donated by breeders from several states and were a representative sampl e of the Polled Hereford breed. Animals from the original herd were use d to establish a selectio n herd. Following establishment of the selectio n herd, the original herd then was used as an unselected control. Replacements were selected from within each he rd. Two bulls were selected based on individual feed conversion and used fo r 2 consecutive years in the selected herd. In each year, the first bul l born, sired by the oldest herd sire in the control herd, was selec ted to replace his sire. These bulls were used in the control herd for approximately 6 years. Cows in both herds were maintained on native pasture throughout the year and were supplemented in the win ter. Cows were bred to calve in Marc h and April. Calves were weaned in the fall at an average age of 196 days. Bull cal ves were individually fed for 140 days postweaning , which allowed selection for feed conversion (feed/g ain). Heifers were group-fed and, thus, were not selecte d on individual feed conversion. C ows were culled according to the follow ing: (1) open at the end of the breeding season, (2) severe structural problems, and (3) horned. Milk produce d by a sample of 59 cows at the end of the study (weigh-suckle-weigh technique) was measured each month prewe aning, during a 3 year period. The numbers of observations,

89

means, and standard deviations for weaning weight and milk production are presented in Table 1. A multiple-trait derivative-free, restricted maximum likelihood (MTDFREML) procedure, incorporating a full numerator relationship matrix, was used to analyze the data. The mixed linear animal model included age of dam (2, 3, 4, 5-10, and >10 yr) and contemporary group (sex an dyear of birth) as fixed effects for weaning weight. Yea rof milking and age at milking (2, 3, 4, 5-10, and >10 yr) were included as fixed effects in the milk production model. We aning weights were regressed to the average weaning age. Individual animal effect was included as a random effect for weaning weight and milk production, with maternal effect and permanent environment al effect being included for weaning weight.

Results and Discussion

Heritabilities and genetic correlations for weaning weight, maternal weaning weight, and milk production are presented in Table 2. The heritability for weaning weight (.14) is lower than estimates previously reported, whereas the heritabilities for maternal weaning weight (.18) and milk production (.19) are similar to others. The strong positive genetic correlation of .99 between maternal weaning weight and milk indicates that the same genes affect both traits. Maternal weaning weight commonly is used as an indication of milk production by breed associations publishing milk EPDs. This study agrees with others, by indicating that maternal weaning weight is a good predictor of milk production.

Table 1.   Number of Observations (n), Means, and Standard Deviations (SD) for Each Trait Analyzed

Trait	n	Mean	SD
Weaning wt, lb	1284	383.82	68.24
Milk, lb/lactation	115[a]	2498.63	859.93

[a]Number of milk records produced by 59 cows.

Table 2.   Heritabilities and Genetic Correlations [a] for Each Trait Analyzed

Trait[b]	WWT	MWWT	MILK
WWT	**.14**		
MWWT	-.10	**.18**	
MILK	.00	.99	**.19**

[a]Heritabilities are on the diagonal; genetic correlations are below the diagonal.
[b]WWT = weaning weight; MWWT = maternal weaning weight; MILK = milk production.

Cattlemen's Day 1995

SELECTION RESPONSE AND GENETIC PARAMETER ESTIMATION FOR FEED INTAKE, GAIN, AND FEED CONVERSION

J. B. Glaze, Jr. and R. R. Schalles

Summary

Performance records of 1459 Polled Hereford cattle born from 1967 through 1979 were analyzed to estimate genetic parameters and the direct and correlated responses that were due to selection for feed conversion. Heritabilities were .24 for intake, .25 for gain, and .14 for feed conversion. The genetic correlation between average daily gain and feed conversion was -.82; correlation between average daily gain and feed intake was .42. Faster-gaining cattle have greater feed intakes and are more efficient. Feed conversion was improved by direct selection. However, it is more economically feasible for breeders to improve feed conversion by selecting for faster rates of gain, rather than selecting for the trait directly.

(Key Words: Selection, Genetic Parameters, Feed Intake, Average Daily Gain, Feed Conversion.)

Introduction

In beef cattle production, both growth rate and feed efficiency are economically important. Even though beef producers have traditionally emphasized improving growth traits, many are unaware of how that influences feed efficiency. Our purpose was to estimate the genetic parameters for feed intake, average daily gain, and feed conversion, and to provide basic information about the direct and correlated responses caused by selection for feed conversion.

Experimental Procedures

Performance data were collected on 486 bull calves produced in a Polled Hereford herd at Kansas State University, from 1967 through 1979. Animals were donated by breeders from several states and were representative of the Polled Hereford breed. Animals from the original herd were used to establish a selection herd. Following establishment of the selection herd, the original animals were used as unselected controls. Replacements were selected from within each herd. Two bulls were selected based on individual feed conversion and used for 2 consecutive years in the selected herd. The first bull born, sired by the oldest herd sire in the control herd, was selected to replace his sire each year. These bulls were used in the control herd for approximately 6 years. Cows representing the selected and control herds were maintained on native pasture throughout the year and were supplemented in the winter. Cows were bred to calve in March and April, with calves being weaned in the fall at an average age of 196 days. Bull calves were fed individually for 140 days postweaning, which allowed selection for feed conversion (feed/gain). The ration consisted of 25% prairie hay, 15% dehydrated alfalfa, 43% corn, 12.5% soybean meal, 4% molasses, and .5% salt. Heifers were group-fed and were not selected on the basis of feed conversion. Cows were culled according to the following: 1) open at the end of the breeding season, 2) severe structural problems, and 3) horned. Average feed intake was 16.68 ± 2.36 (std dev) lb/day, average daily gain was $2.81 \pm .42$ lb, and average feed/gain was $5.92 \pm .83$ lb. A multiple-trait, derivative-free, restricted maximum likelihood (MTDFREML) procedure, with a full numerator relationship matrix, was used to analyze the data. The mixed linear animal model included the fixed effects of age of dam (2, 3, 4, 5-10, and >10 yr) and contemporary group (sex and year of birth), as well as calf age as a covariate. Average weight maintained over the 140-day

test period was used as a covariate for feed intake and feed conversion. Individual animal effect was included as a random effect. Best linear unbiased prediction (BLUP) procedures were used to calculate breeding values, for each animal, in each of the traits. Selection response was examined by regressing trait breeding values on year within the selection and control lines.

Results and Discussion

Heritabilities and genetic correlations for feed intake, average daily gain, and feed conversion are presented in Table 1 . The heritabilities for intake (.24) and gain (.25) are similar in magnitude to estimates found in the literature. The heritability for feed conversion (.14) is lower than most previously reported estimates. The genetic correlation

between feed intake and average daily gain (.42) indicates that as calves eat more, they in turn gain more . The genetic correlation between average daily gain and feed conversion (-.82) shows that faster-gaining cattle are more efficient. Direct response to selection for improved feed conversion is presented in Figure 1. Most of the progress from selecting for feed conversion was made in 1974, with slow but steady improvement made thereafter. On the average, a .0l lb improvement in fee d conversion occurred each year. Bulls from the selection herd consumed more feed and gained faster than those in the control herd. When the cost of measuring individual feed intake is considered, as well as the large negative genetic correlation between gain and feed conversion, selecting cattle based on feed conversion appears to be uneconomical. Rather, breeders can improve feed conversion by selecting for faster rates of gain.

Table 1.   Heritabilities and Genetic Correlations[a] for Each Trait Analyzed

Trait[b]	INT	ADG	FC
INT	.24		
ADG	.42	.25	
FC	.27	-.82	.14

[a]Heritabilities are on the diagonal; genetic correlations are below the diagonal.
[b]INT = feed intake; ADG = average daily gain; FC = feed conversion.
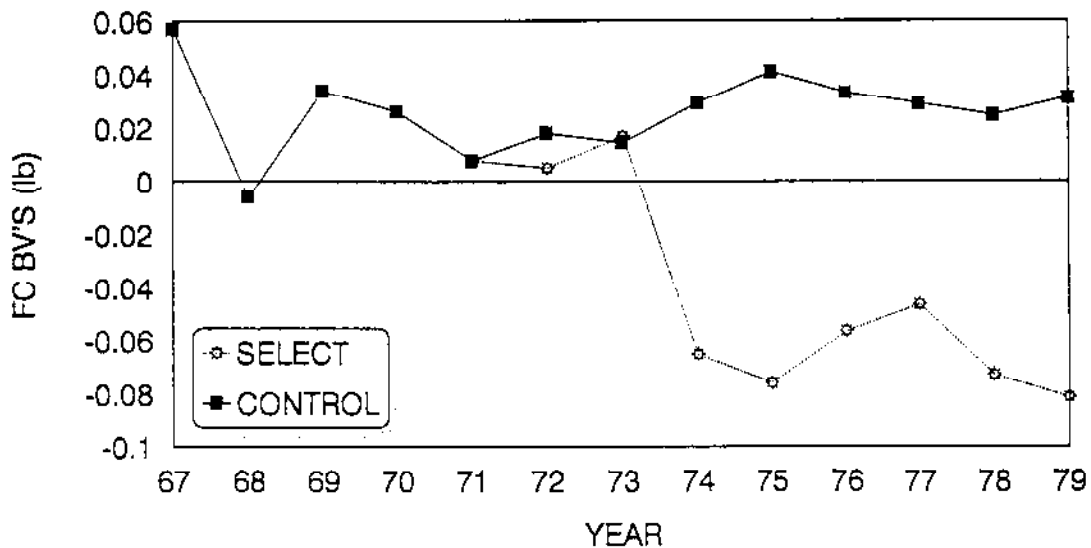
Figure 1.   Response to Selection for Feed Conversion. FCBV is Feed Conversion Breeding Value

Cattlemen's Day 1995

YEARLING SCROTAL CIRCUMFERENCE PREDICTION EQUATION AND AGE ADJUSTMENT FACTORS FOR VARIOUS BREEDS OF BEEF BULLS

J. M. Geske, R. R. Schalles, and K. O. Zoellner

Summary

Scrotal circumference measurements and other data were collected on 4,218 Angus, Red Angus, Brangus, Charolais ,Gelbvieh, Hereford, Polled Hereford, Limousine, Salers, and Simmental bulls born in the spring of 1991. All were participants in selected on-farm and central bull tests. Our objectives for the study were to develop 205-and 365-day age-adjustment factors for scrotal circumference and derive a 365-day scrotal circumference prediction equation based on adjusted 205-day scrotal circumference. We determined that a 205-day scrotal circumference of approximately 21 cm is necessary to reach 32 cm at 1 year. Age-of-dam adjustment factor for 205-day scrotal circumference is +.8 cm for 2- and 3-year-old dams. The factor for 365-day circumference is +.6 cm for 2-year-old dams.

(Key Words: Beef Cattle, Scrotal Circumference, Age Adjustment.)

Introduction

Previous research has indicated an important relationship between yearling scrotal circumference of beef bulls and the semen traits: sperm motility, percent normal sperm, percent primary abnormalities, percent secondary abnormalities, semen volume, sperm concentration, and total sperm. Yearling scrotal circumference also has been found useful in describing age at puberty.

The Society of Theriogenology recommends a minimum scrotal circumference of 30 cm for yearling bulls to ensure satisfactory reproductive performance. Many cattleman prefer bulls with yearling scrotal circumferences at least 32 cm. The limited information available indicates a high relationship between weaning and yearling scrotal circumference.

Yearling scrotal circumference has been reported as moderately to highly heritable. Yearling scrotal circumference in bulls also is correlated highly with age at puberty and with some performance traits of their female offspring.

Our objectives were to develop 205- and 365-day scrotal circumference age adjustment factors and derive a 365-day scrotal circumference prediction equation based on adjusted 205-day scrotal circumference.

Experimental Procedures

Scrotal circumferences and other data were collected on 4,218 bulls born in the spring of 1991. The breeds included Angus, Red Angus, Brangus, Charolais, Gelbvieh, Hereford, Polled Hereford, Limousin, Salers, and Simmental. All were participants in selected on-farm and central bull tests starting in the fall of 1991. Three scrotal circumference measurements were taken; at the start of the test, midway through, and at the end of the test. At each measurement, weight and date also were recorded. The measuring procedure is described in the Manual for Breeding Soundness Examination of Bulls (Journal of Theriogenology) . Other information collected included location of test, pedigree information, and age of dam.

The 205-day scrotal circumference adjustment factors were developed using least squares analysis by breed, while limiting the age range to 160 to 250 days. The model included contemporary group as a fixed effect and age as a regression. The adjustment factor the linear

93

regression of age on scrotal circumference. The procedure for the 365-day scrotal circumference adjustment factor was identical, except the age range was 320 to 410 days. A 365-day scrotal circumference prediction equation, based on adjusted 205-day scrotal circumference, was developed by regressing adjusted 365-day scrotal circumference on adjusted 205-day scrotal circumference for each breed.

Least squares procedures were used to determine an age-of-dam effect for both 205- and 365-day scrotal circumferences. The age range again was limited from 160 to 250 days for the 205-day measurement and 320 to 410 days for 365 days. The model included contemporary group, breed, age of dam, and age of calf. Ages of dams were grouped into five categories: 2, 3, 4, 5-8, and 9+ years.

Results and Discussion

Table 1 shows the adjustment factors for each breed that would enable breeders to adjust scrotal circumferences to 205 or 365 days of age. As indicated by the differences between weaning and yearling factors, scrotal circumference does not increase at the same rate between weaning and yearling ages. These 365-day scrotal circumference adjustments were slightly higher than some studies have indicated.

Other studies have found age of dam to have a significant effect on scrotal circumference. These adjustment factors should not be used within our prediction equations, but rather as a means of comparing individual bulls for selection purposes. For 205-day scrotal circumference, bull calves out of 2- and 3-yr-old dams should be adjusted by adding .8 cm. For 365-day scrotal circumference, calves out of 2-yr-old dams should be adjusted by adding .6 cm.

The "B" values from Table 2 were used to estimate adjusted 205-day scrotal circumference necessary to average 32 cm at 1 year. With the exception of Herefords, the breeds were fairly similar. In general, bulls needed about 21 cm scrotal circumference at weaning to reach 32 cm at 1 year.

Age adjustment factors for 205- and 365-day scrotal circumferences will allow more accurate comparisons between bulls. Adjusted scrotal circumferences will make selection more accurate, just as adjusted 205-day weights have made selection for weaning weight more accurate.

Because many bull buyers prefer yearling scrotal circumferences of at least 32 cm, seedstock producers could reduce costs by eliminating those bulls at weaning that would likely fail to reach 32 cm at a year. The 365-day scrotal circumference prediction equation and the table of minimum scrotal circumferences should serve as guidelines for producers to identify and cull those individuals. The age-of-dam adjustments can make comparisons involving calves out of younger dams more accurate.

As an example, assume that an Angus bull from a 2-year-old dam is 220 days old when his scrotal circumference was measured as 22 cm. His adjusted 205-day scrotal circumference would be $[22 + .0856 \times (205 - 220) + .8] = 21.5$ cm. The adjustment factor of .0856 came from Table 1, and the age-of-dam adjustment would be .8 cm. The predicted 365-day scrotal circumference would be $[1.54 \times 20.7] = 31.9$ cm. The regression coefficient (B) of 1.54 was taken from Table 2. When predicting the yearling scrotal circumference, the 205-day age-of-dam adjustment would not be used.

Another example might be two Simmental bulls in a yearling contemporary group. One bull had a 36 cm scrotal circumference measured at 352 days of age, and his dam was 2 years old. His adjusted 365-day scrotal circumference would be $[36 + .0543 \times (365 - 352)] = 36.7$ cm, plus .6 cm for age-of-dam adjustment = 37.3 cm. The second bull was from a mature dam and had a measured scrotal circumference of 35.5 cm at 370 days of age. His adjusted 365-day scrotal circumference would be $[35.5 + .0543 \times (365 - 370)] = 35.2$ cm, or 2.1 cm less than that of the first bull.

Table 1. **Adjustment Factors (cm/day) for 205- and 365-Day Scrotal Circumferences**

Breed	205 Adj	365 Adj
Angus	.0856	.0374
Red Angus	.0585	.0324
Brangus	.0861	.0708
Charolais	.0767	.0505
Gelbvieh	.0839	.0537
Hereford	.0416	.0425
Polled Herefor d	.0969	.0305
Limousin	.0465	.0590
Salers	.0594	.0574
Simmental	.0854	.0543

Table 2. **Regression Coefficients (B) to Predict Yearling Scrotal Circumference and the Weaning Scrotal Circumference Needed to Expect a Yearling Scrotal Circumference of 32 cm**

Breed	No. of Bulls[a]	B[b]	Standard Deviatio n	Weaning Scrotal[c] Circumference
Angus	623	1.54	.17	20.8
Red Angus	275	1.55	.14	20.6
Brangus	108	1.60	.17	20.0
Charolais	280	1.54	.16	20.8
Gelbvieh	181	1.48	.13	21.6
Hereford	90	1.41	.15	22.7
Polled Hereford	121	1.53	.15	20.9
Limousin	68	1.60	.19	20.0
Salers	88	1.59	.17	20.1
Simmental	393	1.59	.17	20.1

[a]Number of bulls used to estimate the regression coefficients

[b]Regression coefficients. The adjusted 205-day scrotal circumference multiplied by B gives the expected 365-day scrotal circumference.

[c]The 205-day scrotal circumference needed to produc e an average yearling scrotal circumference of 32 cm.

Cattlemen's Day 1995

BREED AND MANAGEMENT COMPARISONS AND GENETIC PARAMETERS FOR CARCASS TRAITS

K. M. Andries, R. R. Schalles,
M. E. Dikeman, and D. E. Franke [1]

Summary

Carcass data from 5 years of a long-term, rotational, crossbreeding project were used to calculate heritabilities, genetic and phenotypic correlations, and management effects and to compare breeds for marbling, ribeye area, and hot carcass weight. Angus, Brahman, Charolais, Hereford, Polled Hereford, Gelbvieh, and Simmental breeds were involved. Sixty percent of the steer calves were fed as calves and 40% as yearlings. Heritabilities were .40 for marbling, .46 for ribeye area, and .51 for carcass weight. Genetic and phenotypic correlations were high between carcass weight and ribeye area but low between marbling and the other traits. Steers fed as calves had more marbling and lighter carcasses than steers fed as yearlings. Higher percentages of Gelbvieh or Brahman breeding resulted in lower (P<.05) marbling. Increased percentage of Charolais and Simmental breeding increased (P<.05) ribeye area and tended to increase carcass weight without reducing marbling

(Key Words: Postweaning Management, Genetic Parameters, Carcass Traits, Breeds, Beef Cattle.)

Introduction

Marbling score, ribeye area, and carcass weight determine carcass value, but profit is determined by the difference between carcass value and the cost of production. One major factor effecting cost of production is length of time the cattle must be maintained before slaughter. Our objectives were to 1) determine the heritabilities and genetic correlations among marbling, ribeye area, and carcass weight; 2) determine the influence of postweaning management on these traits; and 3) compare additive genetic breed differences for these traits.

Experimental Procedures

Records from 445 steer carcasses were analyzed for marbling, ribeye area, and hot carcass weight. Steers were produced at Louisiana State University as the fifth generation of a rotational crossbreeding project carried out in cooperation with KSU. Breeds were Angus, Brahman, Charolais, and Hereford (both horned and polled). All F_1 and two-, three-, and four-breed rotational crosses were represented with the restriction that Brahman be included in each cross. Terminal cross sires were mated to F_1 dams and half of each rotational-cross dam group. Gelbvieh was used for the first 3 years and Simmental for the last 2 years as the terminal sire breeds. Angus × Hereford F_1 also were produced.

Calves were born between mid January and mid April. Bull calves were dehorned and castrated in July. Calves were weaned and vaccinated in the first week of September. Approximately 60% of the steers were randomly assigned to the calf management group and shipped to KSU during the first week of October at an average age of 8 months. The remaining 40% made up the yearling management group and were backgrounded on ryegrass pasture at LSU before being shipped to KSU in early May at an average age of 15 months. In 1993, only a calf management group was available because fewer steer calves were produced at LSU.

---

[1]Louisiana State University, Baton Rouge.

Upon arrival at KSU, steers were weighed, sorted into pens, and place don feed. The ration consisted of sorghum silage and cracked corn plus a soybean meal, urea, and mineral supplement. Silage was reduced from 75 to 1 5% of the diet dry matter over a 4-week starting period. Steers were slaughtered at IBP, Inc., Emporia, Kansas, when the ultrasound-measured fat thickness was between .3 and .5 inch. Carcass data (hot carcass weight, marbling score, ribeye area, and adjusted fat thickness) were collecte d by members of the KSU faculty. USDA yield grades were calculated, and marbling sc ores were converted to a numeric value for analysis.

The data were analyzed using a multiple-trait DFREML procedure in a full-animal model. The model included pedigree information from all five generations of the project and the fixed effects of year of birth and management group. Differences in heterosis were adjusted for using regression procedures. All data were adjusted to a constant adjusted fat thickness endpoint for analysis . Breeding values obtaine d from the animal model were used to compare breeds, and Least Squ ares Means were used to compare management groups.

Results and Discussion

The carcasses averaged 717 lb, small [07] marbling, and 13.1 in[2] ribeye area. The heritability estimates were .40 for marbling, .46 for ribeye area, and .51 for carcass weight (Table 1). These estimates for ribe ye area and marbling are lower than some estimates using REML procedures , probably because the between-breed variation was included in our analysis.

Genetic and phenotypic correlations between marbling and the other traits were low. The correlation between marbling and ribeye area was negative, whereas that between marbling and carcass weight was positive. The correlation s between ribeye area and caracas weight were high (.75 for genetic and .57 for phenotypic). These results agree with earlier reports that indicat ea high relationship between weight-relate d traits and ribeye area, but small correlation s between weight-related traits and marbling.

Marbling was higher (P=.03)in carcasses of steers fed as calves than in steers fed as yearlings (Table 2). Steers fed as yearlings had heavier (P<.01) carcasses and tended to have larger (P=.07) ribeye area sthan the steers fed as calves. These results indicate that steers fed as calves could have higher quality grades at lighter weights compared to steers placed on feed as yearlings.

All breeds were compared to a nAngus base (Table 3). As the percentage Gelbvieh and Brahman breeding increased, marbling decreased (P<.05) relative to Angus. Increasing the percentage of Simmental or Charolais breeding resulted i nlarger (P<.01) ribeye areas, whereas increased percentage of Hereford tended (P=.06) to decrease ribeye area relative to Angus. As the am ount of Charolais breeding increased, carcass weight incr eased (P<.01). As the percentage of Hereford breeding increased, carcass weight tended to decrease.

Our results indicate that carcas straits can be improved through selection. At a constant adjusted-fat thickness, feeding steers beginning at weaning will result in lighter carcasses with more marbling compared to steers that are grazed before being placed on feed.

Table 1. Heritability and Genetic and Phenotypic Correlations [a]

Trait[b]	MARB	REA	HCW
MARB	**.40**	-.001	.17
REA	-.19	**.46**	.57
HCW	.14	.75	**.51**

[a]Heritabilities are on the diagonal, genetic correlations below the diagonal, and phenotypic correlations above the diagonal.
[b]MARB = marbling score, REA = ribeye area, and HCW = hot carcass weight.

Table 2. Least Squares Means by Management Group [a]

Management	MARB	REA (in^2)	HCW (lb)
Calf	small^{08} [x]	12.7[z]	695[x]
Yearling	slight^{90} [z]	13.0[z]	752[z]

[a]MARB = marbling score, REA = ribeye area, and HCW = hot carcass weight.
[x,z]Means in the same column with different superscripts differ significantly (P<.05).

Table 3. Regression Coefficients and Standard Errors for Breed Comparisons [a]

Breeds	MARB (%)	REA (in^2)	HCW (lb)
Gelbvieh	-.182±.072	.002±.001	-.082±.094
Simmental	.075±.081	.006±.002	.200±.105
Brahman	-.589±.105	.002±.002	.020±.137
Charolais	.043±.072	.013±.002	.838±.103
Hereford[b]	-.088±.214	-.003±.001	-.280±.092
Angus	.000±.080	.000±.001	.000±.092

[a]For each one percentage change in the breed composition, the traits changed by this amount. MARB = percent of a marbling score, REA = ribeye area, and HCW = hot carcass weight.
[b]Hereford and Polled Hereford.

Cattlemen's Day 1995

AD LIBITUM SUCKLING BY A FOSTER CALF IN THE PRESENCE OR ABSENCE OF THE COW'S OWN CALF PROLONGS POSTPARTUM ANESTRUS TO FIRST OVARIAN CYCLE

G. C. Lamb, J. M. Smith, and J. S. Stevenson

Summary

Five treatments were initiated approximately 15 days after calving: 1) calf was weaned from its dam (CW); 2) calf was present continually with its own dam (CP-O); 3) calf was present continually with its own dam but contact with the udder was restricted (CR); 4) foster calf was present continually but the cow's own calf was absent (CP-F); and 5) foster calf was present continually, and the dam's own calf was present but restricted (CR+F). Cows weaned at 15 days (CW) cycled in about 2 weeks, whereas cows in the CR treatment cycled 1 week later, and cows in the CP-O treatment did not cycle for about 5 weeks. Cows fostering calves in the presence (CR+F) or absence (CP-F) of their own calves had extended anestrus periods similar to those in cows nursing their own calves (CP-O). If a cow bonds with a foster calf (as in the CP-F treatment), then the duration of anestrus is lengthened. We conclude that anestrus is prolonged only when milk is removed by a calf (her own or a foster calf) to which the cow is bonded.

(Key Words: Suckling, Anestrus, Cow, Postpartum.)

Introduction

The length of gestation in cows limits producers to one calf crop per year. Suckling lengthens the period from parturition to first estrus, which may lengthen the calving interval beyond the ideal 1 year. Reproductive efficiency of cows could be increased by reducing the interval to first estrus.

The cow-calf suckling interaction is a critical component in lengthening anestrus. Cows suckled continually have longer intervals to first estrus than cows whose calves have been weaned. Anestrus is longer in cows that are nursed more frequently. Presence of non-suckling (muzzled or nose-plated to prevent suckling) calves lengthens anestrus as much as when calves can suckle, because the perception of suckling or milk removal is maintained with continued calf presence.

When maintained with their own calves, udder-intact cows and cows with denervated udders had similar intervals to postpartum estrus. Mastectomized cows maintained with their calves remained anestrus longer than weaned mastectomized cows, suggesting that presence of the calf but not the mammary gland was essential for prolonging anestrus. Both mastectomized cows and udder-intact cows, whose calves were restricted so they could not suckle, cycled about a week later than cows whose calves were not present.

Cows that limit-nursed foster calves (limited to four suckling bouts per day for 10 minutes) had shorter intervals to first estrus than cows nursing their own calves. This suggests that the cow must recognize her own calf to be nursing in order to prolong anestrus. The present experiment was designed to determine whether nursing a foster calf in the presence or absence of the cow's own calf would alter the interval to the first ovulation.

Experimental Procedures

Thirty-one multiparous, crossbred (Angus × Hereford) cow-calf pairs were assigned randomly to five treatments at 15 days after birth: 1) calves were weaned permanently from their dams (calf weaned; CW); 2) calves were placed in a pen within the dam's individual pen, where the calf could make tactile contact to the

dam's head and neck but could have no contact with the mammary gland (calf restricted; CR); 3) cows had unrestricted access to their own calves (own calf present; CP-O); 4) cows had unrestricted contact from a foster calves (foster calf present; CP-F); 5) cows had restricted contact with their own calves (CR treatment) plus unrestricted contact from foster calves (CR+F).

Cows were fed individually to meet NRC recommendations, and intakes were adjusted weekly according to individual body weight and condition. The CW and CR cows were fed as dry second-trimester, pregnant, beef cows and the CP-O, CP-F and CR+F cows were fed as superior milk producers. Restricted calves in the CR+F and CR treatments were fed milk replacer twice daily.

Daily blood samples were taken from cows to determine the onset of the first progesterone rise after treatment initiation. Ovulation generally occurs 1 to 2 days before serum progesterone exceeds .5 ng/ml for at least 2 days.

Results and Discussion

The postpartum interval to first rise in progesterone (Table 1) was shorter (P<.05) in the CW (13.6 ±4.4 d) and CR (22.0 ± 4.4 d) treatments than in the CP-O (38.4 ± 4.4 d), CP-F (38.8 ± 4.4 d), or CR+F (35.7 ± 4.4 d) treatments. Although no significant difference occurred between the CW and CR treatments, there was an apparent delay in estrus of about 8 days. This supports an earlier report that maintained cow-calf recognition even in the absence of suckling prolongs anovulation (1994 Cattleman's Day; KAES Report of Progress 704:111). The current data suggest that cows in the CP-F treatment formed a new bond with their foster calves, and that bonding prolonged the postpartum interval to first estrus, because cows in the CR-F treatment had prolonged anestrus equal to CP-O. Apparently, both milk removal and a cow-calf bond (with own calf or with a foster calf) are essential for prolonged anestrus. Thus, we can conclude that a cow does not require her "own" calf to suckle to prolong anestrus, because the cow-calf suckling interaction can be newly formed with a foster calf.

Table 1. Average Intervals to First Postpartum Rise in Serum Concentration of Progesterone

Treatment	No. of Cows	Days to first P4[a] > .5 ng/mL
Calf weaned (CW)	6	13.6 ± 4.4^x
Calf restricted (CR)	6	22.0 ± 4.4^x
CR + foster calf (CR+F)	6	35.7 ± 4.4^y
Foster calf present (CP-F)	6	38.8 ± 4.4^y
Own calf present (CP-O)	7	38.4 ± 4.1^y

[a]Progesterone rise indicates ovulation occurred and the first postpartum estrous cycle was initiated.
[x,y]Means with uncommon superscript letters differ (P < .05).

Cattlemen's Day 1995

INFLUENCE OF TIMING AND RATE OF GAIN ON PUBERTY AND REPRODUCTIVE PERFORMANCE OF BEEF HEIFERS

J. M. Smith, G. C. Lamb, J.E. Minton,
R. T. Brandt, Jr., and R. C. Cochran

Summary

Seventy-seven crossbred heifers (573 lb initial body weight) were developed in drylot and limit-fed a corn, sorghum silage diet predicted to produce gains of either 1 lb/day for the entire developmental period (EVENGAIN) or .25 lb/day for the first two-thirds of the period followed by 2 lb/day during the last third (LATEGAIN). Treatments began on November 15, 1993 and continued until April 25, 1994, the onset of the breeding season. Actual daily gains averaged 1.31 lb/day for EVENGAIN heifers, whereas LATEGAIN heifers averaged .55 lb/day for the first two-thirds of the feeding period and 2.5 lb daily for the last third. Age and weight at puberty were not affected by feeding treatment, and body condition score, estimated fat thickness, frame score, and pelvic area were similar regardless of growth regimen. At the conclusion of the feeding period, estrus was synchronized using two injections of prostaglandin $F_{2\alpha}$, and heifers were inseminated artificially during a 45-day breeding season. Open heifers were mated naturally for an additional 15 days. First-service and overall pregnancy rates were similar between treatments. In summary, rate and time of gain did not affect puberty or breeding performance. However, LATEGAIN heifers were more efficient and developed on 12% less feed than the EVENGAIN heifers. These data suggest that replacement heifers can be developed more efficiently if most of the body weight gain required to enter the breeding season occurs late in development.

(Key Words: Beef Heifers, Puberty, Heifer Development.)

Introduction

Yearling beef heifers conceiving early in their first breeding season will have increased lifetime production and efficiency. It is critical that these heifers attain enough weight to initiate their first estrous cycle before the onset of the breeding season. Current management practices target heifers to reach 60 to 65% of their estimated mature body weight by the start of the breeding season. However, little is known regarding the importance of the timing of this weight gain.

Our primary objective was to evaluate when this weight should be acquired; specifically, whether uniform weight gain over the development period is necessary or whether restriction followed by rapid gain could provide cost efficient gain without compromising reproductive performance.

Experimental Procedures

Seventy-seven, spring-born, Angus × Hereford heifers (573 lb initial weight) were blocked by weight and assigned randomly within weight blocks to two treatments. Heifers were fed to gain 1 lb/day for the entire 159-day period of development (EVENGAIN) or to gain .25 lb/day for the first two-thirds of the development period followed by 2 lb/day for the last third (LATEGAIN). Heifers were housed in drylot with eight head per pen and five pens per treatment. Of 80 heifers that began the experiment, three were removed for health reasons or reproductive tract abnormalities. The feeding period began on November 15, 1993 and continued until April 25, 1994, the onset of the breeding season. LATEGAIN heifers were switched to the higher rate of gain on March 7, 1994. Diets were formulated according to NRC

(1984) recommendations. Based on previous research with restricted gain on a similar diet, dry matter intake was adjusted to compensate for increased efficiency at the predicted rate of gain. The diet (as fed) was 62% corn, 20% sorghum silage, 9% prairie hay, 7% of a vitamin-mineral supplement (which supplied Rumensin® at 150 mg/head/day), and 2% molasses. Soybean meal was topdressed to meet protein requirements for desired weight gains. Body weights were measured every 14 days.

Beginning on January 24, 1994, blood samples were collected every Monday, Wednesday, and Friday. Serum was harvested and frozen at -20°C until analyzed for progesterone. Four consecutive samples with progesterone greater than 1 ng/ml indicated first ovulation and luteal function. The day of puberty was estimated by subtracting two days from the first day when progesterone was greater than 1 ng/ml, followed by an estrous cycle of normal duration.

Body weight and body condition score (1=extremely thin, 9=extremely fat) were determined at day 0 (initial), day 112 (feed switch), and day 159 (onset of breeding season), when ribeye fat thickness, pelvic area, and frame score were estimated. Estrus was synchronized using two injections of Lutalyse®, given 14 days apart. Heifers were inseminated artificially at estrus according to the AM-PM rule for the first 45 days of the breeding season. Heifers then were exposed to bulls for 15 days to complete the 60-day breeding season. First-service pregnancy rates were determined by transrectal ultrasonography at approximately 30 days postbreeding.

Results and Discussion

The results for EVENGAIN and LATEGAIN treatments are summarized in Table 1. Age and weight at puberty were similar between treatments, and treatment had no effect on body condition score, ribeye fat thickness, frame score, or pelvic area. In addition, we found no differences in first-service or overall pregnancy rates in heifers.

Although dry matter intake was adjusted to compensate for increased efficiency at restricted rates of gain, both treatments exceeded NRC predicted daily gains. The higher than predicted gain tended to increase over time, suggesting that limit-fed animals became more efficient as they matured. LATEGAIN heifers were developed to the same end weight as the EVENGAIN heifers on approximately 12% less feed, resulting in a substantial decrease in feed expense.

Our data suggest that rate and time of gain did not affect the onset of puberty or breeding performance. Therefore, the primary objective of replacement heifer development should be to reach a target weight prior to the onset of the breeding season that facilitates reproductive performance, in a cost-efficient manner. Delaying the majority of the necessary weight gain until the last third of development should require less feed, because a smaller heifer can be maintained more economically for a longer period of time.

Table 1. Performance and Reproductive Characteristi cs of Heifers Developed at Different Rates and Times of Gain

Item	Dietary Treatments [a]		
	EVENGAIN	LATEGAIN	SE
No. of heifers	39	38	
Initial weight, lb	573.5	572.9	21.94
Pre-breeding weight, lb	781.9	752.4	20.27
Daily gain, lb/head	1.31	.55; 2.5 [b]	
Age at puberty, day	388.0	384.4	10.25
Weight at puberty, lb	726.4	694.0	17.33
Body condition score [c,d]	5.65	5.60	.054
Ribeye fat thicknes s[d],cm	.485	.476	.029
Pelvic are a[d], cm^2	195.7	192.5	5.56
Frame score[d]	4.53	4.41	.118
First service conception, %	55.3	55.5	
Overall pregnancy rate, %	87.2	86.8	

[a]EVENGAI N heifers were fed to gain 1 lb/day (November 15, 1993 to April 25, 1994) and LATEGAIN heifers were fed to gain .25 lb/day from November 15, 199 3 until March 7, 1994, when predicted rate of gain was increased to 2 lb/day until April 25, 1994.

[b]Daily ga in for LATEGAIN heifers represents the gains during the first two-thirds and last third of the breeding period, respectively.

[c]BCS: 1 = extremely thin, 9 = extremely fat.

[d]Determined at the onset of the breeding season, April 25, 1995.

Cattlemen's Day 1995

PREGNANCY RATES IN VIRGIN HEIFERS AND SUCKLED BEEF COWS AFTER SYNCHRONIZED OVULATION USING PGF₂α, NORGESTOMET, AND GnRH

PREGNANCY RATES IN VIRGIN HEIFERS AND SUCKLED BEEF COWS AFTER SYNCHRONIZED OVULATION USING $PGF_{2\alpha}$, NORGESTOMET, AND GnRH

D. P. Hoffman, J. S. Stevenson, C. L. Krehbiel,
D. A. Nichols, and R. M. McKee

Summary

One disadvantage of most estrous synchronization programs is their inability to induce cycling in prepubertal heifers and anestrous suckled beef cows. Suckled cows and virgin heifers were treated with $PGF_{2\alpha}$, norgestomet, and GnRH to induce ovarian cyclicity in prepubertal heifers and anestrous suckled cows as well as to synchronize estrus in cycling females. The treatment consisted of two injections of $PGF_{2\alpha}$ (day –14 and 0) plus 100 µg of GnRH and a 6 mg norgestomet implant on day –7. The implants were removed 24 h after the second injection of $PGF_{2\alpha}$ (day 0). An injection of 100 µg of GnRH was given 30 hours after implant removal. The treatment group was inseminated at estrus or 18 hours after the second injection of GnRH. Pregnancy rate in the treated females was higher than in the controls that had received $PGF_{2\alpha}$ injections 14 days apart and were bred at estrus (65.1 vs 48.1%). The treatment also successfully induced a fertile ovulation in previously prepubertal heifers and anestrous cows (treatment vs. control; 67.7 vs 20.0%). We conclude that treating beef cattle with $PGF_{2\alpha}$, norgestomet, and GnRH induced ovarian cyclicity and increased pregnancy rates in prepubertal heifers, anestrus cows, and cycling females.

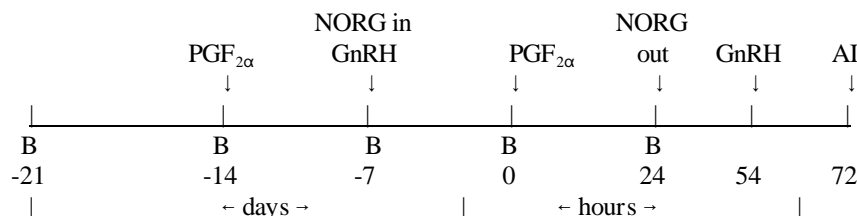(Key Words: Prepubertal Status, Anestrus, Heifer, Cow, Estrous Synchronization.)

Introduction

Estrous synchronization improves reproductive efficiency by reducing the length of the breeding and calving season and increasing calf weaning weights, because cows calve earlier. However, most estrous synchronization programs do not induce cycling in prepubertal heifers and anestrous suckled beef cows. Treatments that involve single or multiple injec-

tions of gonadotropin-releasing hormone (GnRH) given at 10- to 12-day intervals and(or) implants of norgestomet have been used to "jump-start" these acyclic females. The effect of GnRH is to induce LH and FSH release and ovulation of follicles that are of preovulatory size and function. The effect of the norgestomet is to prime the hypothalamic-pituitary axis for the release of endogenous GnRH, LH, and FSH necessary for follicular growth. In both prepubertal heifers and anestrous suckled cows, the norgestomet implant prevents the short luteal phase that follows the first pubertal or postpartum ovulation. That short luteal phase prevents the continuation of pregnancy, even if fertilization occurs.

Therefore, our objective was to determine the effect of a treatment consisting of $PGF_{2\alpha}$, norgestomet, and GnRH on inducing ovarian cyclicity in prepubertal heifers and suckled cows, as well to synchronize estrus in cycling females before one fixed-time insemination.

Experimental Procedures

Purebred Angus, Hereford, and Simmental heifers and suckled cows were assigned to two treatments: 1) two injections of $PGF_{2\alpha}$ 14 days apart (control); or 2) two injections of $PGF_{2\alpha}$ (days 0 and 14) plus 100 µg of GnRH and a 6 mg norgestomet implanted on day –7 (Figure 1). The implants were removed 24 h after the second injection of $PGF_{2\alpha}$ (day 0). A second injection of 100 µg of GnRH was given 30 h after implant removal. Three blood samples were collected (–21, –14, and –7 days) before the second $PGF_{2\alpha}$ injection to determine cycling status. Control females were inseminated 12 to 16 h (AM-PM rule) after first detected estrus until 80 h after the second $PGF_{2\alpha}$ injection, when all remaining females were inseminated. The females in the treatment group were inseminated either at estrus or at 18 h after the

second injection of GnRH (48 h after implant removal or 72 h after the second $PGF_{2\alpha}$ injection). Pregnancy status was determined at day 34 to 35 postservice by intrarectal ultrasonography.

Results and Discussion

Pregnancy rate was greater (P<.05) in the treated females than in the controls (65.1 vs 48.1%). No differences in pregnancy rates were detected among breeds or parity groups (heifers, primiparous, and multiparous cows). An interaction (P<.01) occurred between treatment and insemination type. Control and treated females inseminated at estrus had similar pregnancy rates (61.5 vs 62.8%), whereas control and treated females inseminated at a fixed time were markedly different (7.7 vs 66.7%, respectively). An interaction also occurre dbetween treatment and cycling status (P<.05). The treatment successfully induced a fertile ovulation in previously prepubertal heifers and anestrous cows (Table 1). Furthermore, the treatment numerically increased pregnancy rates in all cycling females in each of the parity groups. We conclude that treating beef cattle with $PGF_{2\alpha}$, norgestomet, and GnRH induced ovarian cyclicity and increased pregnancy rates in prepubertal heifers, anestrus cows, and cycling females.

		NORG in			NORG		
$PGF_{2\alpha}$		GnRH		$PGF_{2\alpha}$	out	GnRH	AI
↓		↓		↓	↓	↓	↓
B	B	B		B	B		
-21	-14	-7		0	24	54	72
	← days →				← hours →		

Figure 1. Treatment Protocol and Blood Sampling (B)

Table 1. Pregnancy Rate: Interactions of Treatment and Cycling Status

| | Treatments [1] | | | | |
| | Control-$PGF_{2\alpha}$ | | $PGF_{2\alpha}$/GnRH/NORG/GnRH | | |
Cycling status [2]	No.	% Pregnant [3]	No.	% Pregnant [3]
Noncycling	25	20.0	31	67.7
Heifers	4	0.0	5	100.0
Primiparous	4	0.0	8	37.5
Multiparous	17	29.4	18	72.2
Cycling	79	57.0	75	64.0
Heifers	32	56.2	32	59.4
Primiparous	17	58.8	14	64.3
Multiparous	30	56.7	29	69.0

[1]Cows in the control-$PGF_{2\alpha}$ treatment received two injections of $PGF_{2\alpha}$ 14 d apart. Cows in the $PGF_{2\alpha}$/GnRH/NORG/GnRH treatment received two $PGF_{2\alpha}$ injections as controls plus 100 µg of GnRH 7 d before the second injection of $PGF_{2\alpha}$ when 6 mg of norgestomet was implanted. Implants were removed 24 h after the second injection of $PGF_{2\alpha}$. An injection of 100 µg of GnRH was administered 30 h after implant removal. [2]When concentration of progesterone in serum on days -21, -14, and/or –7 (second injection of $PGF_{2\alpha}$) exceeded 1 ng/mL, estrous cycles were assumed to have been established; otherwise, heifers were defined to be prepubertal and cows to be anestrous. [3]Based on ultrasonically determined presence of uterine fluid and embryo on day 34 or 35 postservice.

Cattlemen's Day 1995

PREGNANCY RATES IN MGA-PROSTAGLANDIN-SYNCHRONIZED HEIFERS BRED AT ESTRUS OR INSEMINATED AT FIXED TIMES

J. M. Smith, L. R. Corah,
G. C. Lamb, and A. R. Spell

Summary

The objective of this project was to study the effects on pregnancy rates of inseminating estrus-synchronized heifers either at observed estrus or at a fixed time. In April, 1994, 574 yearling crossbred heifers, located on six Kansas ranches, were inseminated to achieve this objective. Herd size ranged from 38 to 293 head. The heifers were synchronized with the MGA-prostaglandin (PGF) system. Heifers were either inseminated 12 hr after the onset of estrus or, if not showing estrus, 72 hr after PGF. Pregnancy rates of 491 heifers bred on estrus averaged 56.6% (39.2 to 80.4%). Pregnancy rates for the 83 fixed-time-inseminated heifers averaged 39.8% (15.6 to 56.5%) . Heifers that responded to the MGA-PGF synchronization system with a standing heat had higher pregnancy rates than those that were inseminated at a fixed time. However, fixed-time inseminations used in conjunction with inseminations made at estrus increased the total number of heifers bred to proven AI sires.

(Key Words: Heifer, Synchronization of Estrus, Fixed-Time Insemination.)

Introduction

Proper management of replacement heifers is essential, because they represent the future profitability of the herd. Utilizing estrus synchronization and artificial insemination (AI) can increase the proportion of heifers bred early in their first breeding season and, consequently, increase their lifetime productivity. Although several synchronization programs and insemination regimens are available, a common practice utilizes estrus detection, with inseminations based on the AM-PM rule (i.e., a female first showing estrus in the morning is inseminated that evening). However, fixed-time inseminations also can be used, when all females are inseminated at a specific time in a synchronization program, whether or not estrus has been detected. This method reduces labor, but pregnancy rates are often variable. Our objective was to evaluate the effects of inseminating estrus-synchronized heifers at observed estrus plus a fixed-time insemination for those not detected in estrus, in order to maximize the total number of pregnancies achieved with AI.

Experimental Procedures

In April, 1994, yearling crossbred heifers on six Kansas ranches were used in an estrous synchronization and artificial insemination program. Herd size ranged from 38 to 293 head and averaged 96 head. Each herd was assigned two or three experienced AI technicians before the breeding season. Heifers were synchronized with an MGA-prostaglandin (PGF) system in which animals were fed MGA at .5 mg/head/day for 14 days, then given a PGF injection 17 days after MGA withdrawal. Heifers were observed for signs of estrus and were inseminated artificially 12 hr after the first detected standing heat. Animals showing no signs of estrus were inseminated 72 hr after PGF. All females were pregnancy tested 30 days after insemination by real-time ultrasonography, with a 7.5 MHz intrarectal probe.

At location A (Table 1), 293 heifers were assigned randomly to receive the prostaglandin injection on either day 16 (PM) or day 17 (AM) after MGA withdrawal. Heifers then were evaluated for response to synchronization, onset of estrus, first-service pregnancy rate, and total pregnancy rate.

Results and Discussion

Table 1 shows the rates of detected estrus and first-service pregnancy rates at each location. Based upon detection of estrus, 85.5% of the 491 heifers responded to synchronization. The first-service pregnancy rates of those heifers ranged from 39.2 to 80.4%, with an average of 56.6%. The remaining 83 heifers, either not responding to the estrous synchronization program or not detected in heat, were inseminated at 72 hr after PGF. Pregnancy rates ranged from 15.6 to 56.5%, with an average of 39.8%. These data suggest that heifers responding to the MGA-PGF synchronization system with a standing heat have higher pregnancy rates than those that are inseminated at a fixed-time. However, fixed-time AI used in conjunction with inseminations made after detection of estrus can increase overall pregnancy rates. A primary goal of a synchronization-AI program for replacement heifers is to maximize the number of pregnancies to proven AI sires in the first 21 days of the breeding season. This allows heifers to

calve earlier in the calving season, breedback earlier in the following breeding season, and wean heavier calves in the fall.

Figure 1 illustrates the percentage of heifers detected in estrus at location A after receiving injections of PGF on either day 16 or 17 after MGA withdrawal Of the 131 heifers receiving a day-16 injection, 81.7% were detected in heat before 72 hr, and first-service pregnancy rate was 62.6%, whereas that of the 24 remaining time-inseminated heifers was 12.5%. Of the 137 heifers receiving a day-17 injection, 95.6% were detected in heat by 72 hr, and first-service pregnancy rate was 56.5%, whereas that of the 6 time-inseminated heifers was 33%. At the completion of a 60-day breeding season with clean-up bulls, overall pregnancy rates were 96.2 and 94.2% for day-16 and -17 prostaglandin injections, respectively. These data suggest that heifers may respond better to estrous synchronization when injected with PGF 17 days following MGA withdrawal. However, overall first-service pregnancy rate (estrus and time-inseminated heifers) and total pregnancy rate were similar between injection times.

Table 1. Variability among Ranches in Detected Estrus and First-Service Conception of Beef Heifers Synchronized with MGA and Prostaglandin (PGF)

Item	Ranches					
	A	B	C	D	E	F
No. of heifers	293	38	51	56	90	73
No. and % detected in estrus						
by 72 hr after PGF	261 (89.1)	35 (92.1)	51 (100)	33 (58.9)	65 (72.2)	46 (63.0)
No. and % pregnant						
AI at estrus	157 (60.2)	15 (42.9)	20 (39.2)	18 (54.5)	31 (47.7)	37 (80.4)
AI at 72 h	5 (15.6)	1 (33.3)	—	13 (56.5)	14 (56.0)	—
Total first-service						
pregnancy rate (%)	55.3	42.1	39.2	55.4	50.0	80.4
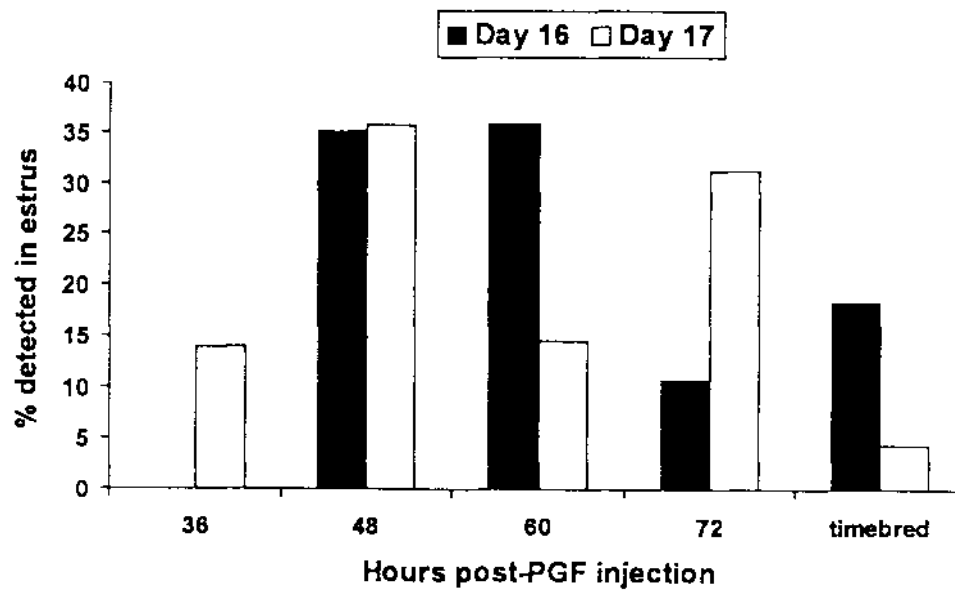
Figure 1. **Onset of Estrus in Heifers Given Prostaglandin F $_{2\alpha}$ on Either Day 16 or 17 Post-MGA Withdrawal**

Cattlemen's Day 1995

THE EFFECT OF DIETARY ZINC LEVEL AND SOURCE ON YEARLING BULL GROWTH AND FERTILITY [1]

J. D. Arthington, K. R. Johnson [2], L. R. Corah,
C. L. Willms [3], and D. A. Hill [4]

Summary

To study the effect of dietary zinc level and source on bull growth and fertility, 325 yearling Angus bulls were allotted by weight into six pens (three pens of heavy and three pens of lightweight bulls). The three supplemental zinc (Zn) treatments were 1) 40 ppm inorganic Zn all supplied by Zn sulfate (ZnI); 2) 40 ppm Zn with 1/3 supplied by Zn proteinate and 2/3 supplied by Zn sulfate (ZnPI); and 3) 60 ppm ZnI all supplied by Zn sulfate (ZnHi). Initial and final liver biopsies (10 per pen) were collected and analyzed for zinc concentration. Individual weights and scrotal circumferences also were recorded at the start and conclusion of the trial. Bulls intended for public sale (n=167) had their semen collected and evaluated for motility and morphological abnormalities. Bulls with percent normal sperm cell counts of less than 70% or with motility scores less than fair (motility scores = poor, fair, good, very good) were considered classification deferred (CD). Following 126 days of treatment, ZnHi bulls had a greater (P=.058) percent change in liver Zn concentration than ZnI, but similar increases to ZnPI. No differences in bull ADG or percent change in scrotal circumference were detected. ZnPI and ZnHi bulls had a higher (P<.05) percent of normal sperm cells than ZnI bulls. ZnPI and ZnHi treatments had fewer (P<.05) CD bulls than ZnI. In all fertility measures observed, bulls receiving the Zn proteinate/Zn sulfate combination at 40 ppm had improved semen quality when compared to bulls supplemented with 40 ppm Zn sulfate.

(Key Words: Zinc, Bull, Growth, Fertility.)

Introduction

The important role of Zn in male fertility has been realized for some time. Recently, however, the use of "minerals" in livestock nutrition has gained considerable interest from commercial and purebred producers alike. The generic term "organic mineral" is used to describe any of the three forms of protected minerals available in the feed industry: chelates, proteinates, and complexes. The support for their use stems from research studies and field experience that suggesting that organic minerals are more biologically available than inorganic forms. Nevertheless, controlled experiments continue to produce conflicting results. Our study investigated the potential use of organic Zn as Zn proteinate in growing bull diets. Growth, sexual maturation, and fertility were compared when bulls were supplemented with either inorganic (Zn sulfate) or organic Zn sources. Additionally, a third treatment, consisting of inorganic Zn at an increased level, was included to answer the important question: will increased levels of the less expensive inorganic Zn achieve the same benefits as organic Zn?

[2]University of Nebraska, Clay Center.
[3]Harvest States Cooperatives, Sioux Falls, South Dakota.
[4]Nutribasics Company, Willmar, Minnesota.

Experimental Procedures

Yearling Angus bulls (n=325) were allotted by weight into six pens of similar size resulting in three pens of heavy- and three pens of lightweight bulls. One of three supplemental zinc treatments consisting of 1) 40 ppm, all supplied by Zn sulfate (ZnI); 2) 40 ppm Zn with 1/3 supplied by Zn proteinate and 2/3 supplied by Zn sulfate (ZnPI); or 3) 60 ppm, all supplied by Zn sulfate (ZnHi). Each Zn treatment was given to cattle in two pens, one heavy- and one lightweight, for 126 days. Initial and final liver biopsies (10 per pen) were collected and analyzed for Zn concentration via inductively coupled plasma spectroscopy. Individual bull weights and scrotal measures also were recorded at the start and conclusion of the trial. One person measured all scrotal circumferences at each time period. Semen from bulls intended for public sale (n=167) was collected by electro-ejaculation and evaluated for motility and morphological abnormalities prior to the conclusion of the study. Bulls with fewer than 70% normal sperm cells or with motility scores of poor (motility scores = poor, fair, good, very good) were considered classification deferred (CD).

Results and Discussion

Following 126 days, ZnHi bulls had greater (P=.058) increases in liver Zn concentration than ZnI, but were similar to ZnPI treatments (-9.8, 1.2, and 20.6 ppm for ZnI, ZnPI, and ZnHi, respectively). No differences in ADG or change in scrotal circumference were detected (Table 1). ZnPI and ZnHi treatments had a higher (P<.05) percent of normal sperm cells and, consequently, fewer CD bulls than the ZnI treatment. In all fertility measures we studied, bulls receiving the Zn proteinate/Zn sulfate combination at 40 ppm rated highest, followed by those receiving Zn sulfate at 60 ppm, and lastly by those receiving Zn sulfate at 40 ppm.

These data support the importance of dietary Zn in male fertility. The use of organic Zn in growing bull diets may improve subsequent fertility measures. However, inorganic Zn at an increased level also improved fertility. For growing bulls, the NRC-recommended level of 30 ppm in the diet may be too low. Further studies that investigate higher levels of Zn both in the organic and inorganic forms are merited.

Table 1. **Effect of Zinc Level and Source on Yearling Bull Growth, Sexual Maturation, and Fertility**

Item	ZnI[c]	ZnPI[c]	ZnHi[c]
ADG, lb	2.9	3.3	3.3
Change in scrotal circumference, cm	8.6	9.3	9.1
Normal sperm cells in the ejaculate, %	55.8[a]	68.9[b]	62.5[b]
Bulls classification deferred, %	77.6[a]	51.5[b]	58.8[b]

[a,b]Means with unlike superscripts within a row differ (P < .05).
[c]ZnI = 40 ppm Zn as Zn sulfate; ZnPI = 40 ppm Zn, 2/3 as Zn sulfate and 1/3 as Zn proteinate; and ZnHi = 60 ppm Zn as Zn sulfate.

INDEX OF KEY WORDS

Indexer's note: The pages identified here are the first pages of each article which uses the listed key word.

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 change— 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, 1993-1994

On the following page are graphs of the 1993 and 1994 Manhattan weather. They were produced by the Kansas State University 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 since 1985.
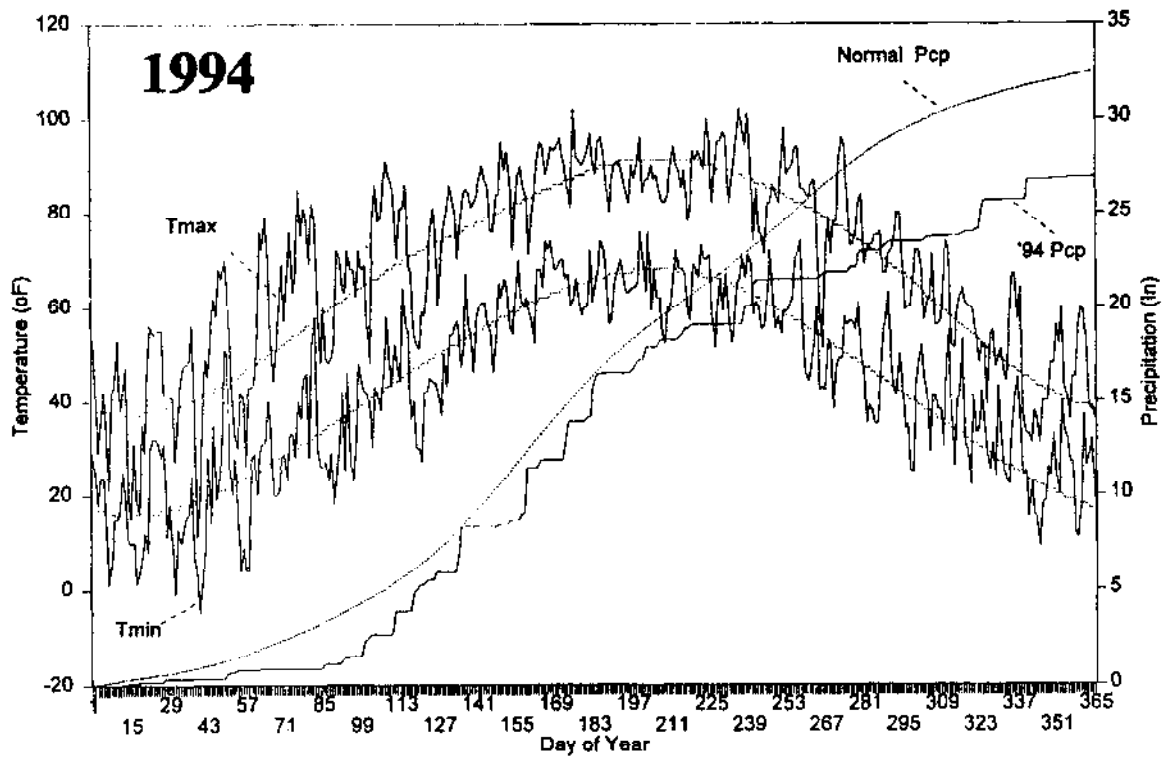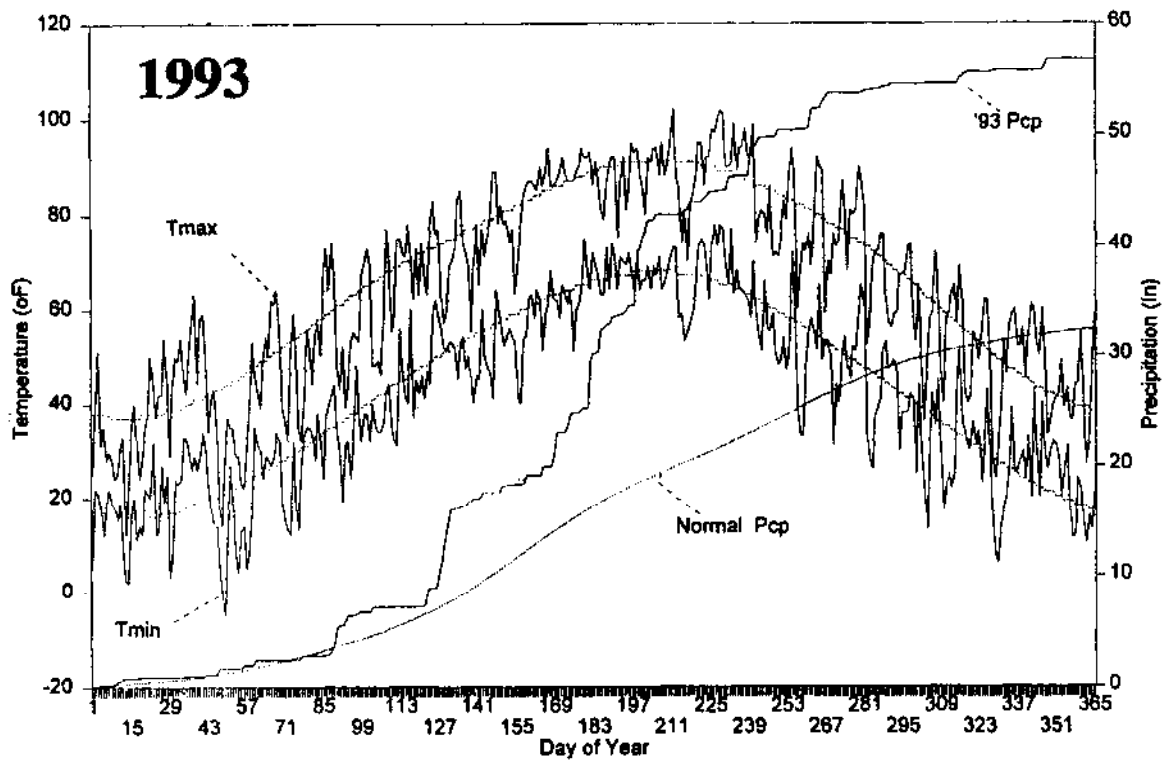
Summaries of Weather in Manhattan, KS, 1993 and 1994

ACKNOWLEDGEMENTS

Listed below are individuals, organizations, and firms that have contributed to this year's beef research program through financial support, product donations, or services. We appreciate your help!

Notice

Kansas State University makes no endorsements, expressed or implied, of any commercial product. Trade names are used in this publication only to assure clarity of communication.

Some of the research reported here was carried out under special FDA clearances that apply only to investigational uses at approved research institutions. Materials that require FDA clearances may be used in the field only at levels and for the uses specified in that clearance.