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COMPARISON OF CORN AND GRAIN SORGHUM DRIED DISTILLERS GRAINS AS PROTEIN SUPPLEMENTS FOR GROWING BEEF HEIFERS

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Summary

An experiment was conducted to determine if corn and grain sorghum dried distillers grains could be effective protein supplements for growing beef replacement heifers. Crossbred heifers (n=77) were individually fed 6 lb/heifer daily (dry matter basis) of supplements containing 20% crude protein. The three supplements compared were: 1) 50% cracked corn, 25% soybean meal, and 25% ground grain sorghum; 2) 50% cracked corn and 50% corn distillers grains with solubles; and 3) 50% cracked corn, 31% sorghum distillers grains with solubles, and 19% ground grain sorghum. Heifers grazed a common native-grass pasture and had free-choice access to smooth broom hay in round bale feeders. During the last week of the trial, heifers (n=4) from each supplement were used to determine diet digestibility. Although there were no differences in weight gain or total diet digestibility, dry matter intake as a percentage of body weight was less for heifers receiving supplements containing dried distillers grains from either corn or grain sorghum. Our data indicate that producers can expect similar growth performance, regardless of the grain source of dried distillers grains used to formulate a 20% crude protein supplement fed at about 1% of body weight daily.

Introduction

With the expansion of ethanol production in Kansas, the availability of ethanol coproducts will continue to increase. There are many uses for these co-products as animal feed due to their high protein and energy content, but the physical characteristics and nutrient profiles suggest potential in diets for growing cattle. A majority of the research involving distillers grains has focused on their use as protein/energy supplements in confinement feeding. University of Nebraska research recently demonstrated that corn dried distillers grains can be a suitable supplement for high-protein forages because it contains little starch but much fermentable fiber. It is possible, based on differences in chemical composition, that dried distillers grains from corn or from grain sorghum could lead to differences in diet digestibility. Therefore, the objective of this study was to determine if dried distillers grains originating from either corn or grain sorghum could be used interchangeably in a 20% crude protein supplement used in a management system for growing cattle grazing on medium- to low-quality forage.

Experimental Procedures

Seventy-seven crossbred heifers (average starting weight=637 lb) were individually fed supplements for 71 days. Treatments (Table 1) consisted of feeding about 6 lb/heifer daily (dry matter basis) of 20% crude protein supplements made from: 1) 50% cracked corn, 25% soybean meal, and 25% ground grain sorghum; 2) 50% cracked corn and 50% corn distillers grains with solubles; or 3) 50% cracked corn, 31% sorghum distillers grains with solubles, and 19% ground grain sorghum. When not being fed supplements, heifers grazed a common Flint Hills, native-grass pasture near Manhattan, Kansas, with free access to brome hay (in round-bale feeders), fresh water, and a commercial pasture-type mineral supplement. The experiment was designed as a randomized complete-block design. Because the supplements were fed daily to individual animals, each heifer was considered as an experimental unit. The trial began on February 15, 2005. Heifers were weighed on March 10, April 5, and April 27. All heifers were weighed after being held off feed and water overnight. During the final 2 weeks of the trial, all heifers were placed in dry lot, with free access to brome hay fed in round-bale feeders.

A digestibility trial was conducted during the last week of the animal performance trial. Four heifers were randomly selected from each treatment and individually fed supplement and brome hay for 7 days. Daily forage and supplement intakes, as well as feed refusals, were measured. Fecal grab samples were collected twelve times over 4 days, and fecal output was estimated to calculate digestibilities by using acid detergent insoluble ash as an internal marker.

Results and Discussion

One heifer was removed from the trial (SBM treatment) due to refusal to readily consume her supplement, which was possibly due to her aversion to the confines of the feeding facilities. For the remaining heifers, once they became accustomed to the facilities and feeding routines, no feed refusals were noted for any of the supplements. Therefore, we believe that the palatability of the supplements had no effect on our results.

Previous research has indicated that, due to its high fat content, the maximum inclusion amount for corn dried distillers grains with solubles is between 3 and 3.5 lb/day for growing cattle weighing 500 to 700 lb. Producers typically feed growing cattle about 1% of body weight daily of a supplement (grain mix) containing 20% crude protein. In consideration of these two criteria, supplements were formulated to contain about 20% crude protein via the addition of cracked corn and ground grain sorghum and were fed at 6 lb/heifer daily (dry matter basis). Supplements differed in fat content (Table 1).

Body weights and gains are presented in Table 2. No differences in heifer weights and average daily gains were noted among treatments (P=0.13). Heifers receiving the corn dried distillers grains supplement exhibited a slight numerical advantage in gain early in the trial; this is interesting because the digestibility of the corn dried distillers was numerically less (Table 3). This difference can possibly be explained by the higher fat content of the corn distillers grains. Diet digestibility data are presented in Table 3. Total diet intake was similar among all treatments (P=0.42), but dry matter intake as a percentage of body weight was significantly greater for heifers receiving the soybean meal treatment (P=0.02). The difference in intake may possibly be due to the greater degradable intake protein content of the soybean meal, but the entire diet was formulated to be sufficient in degradable intake protein as analyzed by the National Research Council beef cattle model. The starch concentrations in the supplements were similar because cracked corn, the main source of starch, was present in equal amounts in all supplements. The total diet digestibilities were also similar among treatments (P=0.51).

The results of our study showed that co-products of ethanol production, of either corn or grain sorghum origin, can be used in a management system for growing cattle grazing on medium- to low-quality forage.

Table 1. Ingredient and nutrient composition of supplements and brome hay fed to heifers grazing native grass pastures

	Supplement			
Item	Soybean Meal	Corn DDGS[1]	Sorghum DDGS[1]	Brome Hay
Ingredient composition, %				
Soybean meal	25.0	–	–	
Corn dried distillers grains with solubles	–	50.0	–	
Sorghum dried distillers grains with solubles	–	–	31.3	
Ground grain sorghum	25.0	–	18.7	
Cracked corn	50.0	50.0	50.0	
Amount fed, lb/heifer daily[2]	6.2	6.0	6.0	Free-choice
Nutrient composition				
Moisture, %	6.3	9.2	9.7	7.7
Crude protein, %[2]	20.5	19.9	20.2	10.8
ADF, %[2]	4.8	12.5	13.4	40.5
NDF, %[2]	8.4	23.7	16.0	66.4
Estimated NEm, Mcal/lb[2]	0.91	0.88	0.86	0.56
Estimated NEg, Mcal/lb[2]	0.58	0.55	0.54	0.23
Estimated TDN, %[2]	79.1	76.5	75.5	52.6
Ether extract (fat), %[2]	3.7	7.3	5.3	2.8

[1]DDGS=Dried distillers grains with solubles.
[2]Dry matter basis.

Table 2. Performance of heifers fed supplements while grazing native grass pastures and having access to brome hay

	Supplement			
Item	Soybean Meal	Corn DDGS[1]	Sorghum DDGS[1]	SEM
No. heifers	25	26	26	
Initial wt (Feb. 15), lb	635	637	637	9.6
Wt gains, lb				
Feb. 15 to March 10	39	43	36	2.3
March 10 to April 5	36	44	42	4.6
April 5 to April 27	11	9	8	4.7
End Wt (April 27), lb	722	732	722	4.1
Daily gain, lb				
Feb. 15 to April 27	1.21	1.35	1.21	0.06

[1]DDGS=Dried distillers grains with solubles.

Table 3. Intakes and total tract digestibilities

Item	Supplement			SEM
	Soybean Meal	Corn DDGS[1]	Sorghum DDGS[1]	
No. heifers	4	4	4	
Average wt, lb	724	727	762	23
Daily dry matter intake, lb	20.7	19.6	20.8	0.29
Daily dry matter intake, % of body weight	2.86[a]	2.70[b]	2.72[b]	0.04
Dry matter digestibility, %	61.2	57.2	62.5	3.2

[1]DDGS=Dried distillers grains with solubles.
[a,b]Means having different superscript letters differ significantly ($P<0.05$).

EFFECTS OF SPRING PASTURE BURNING, PASTURE DEWORMING, AND GRAIN SUPPLEMENTATION ON PERFORMANCE OF STOCKER STEERS GRAZING NATIVE FLINTHILLS PASTURE

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Summary

A grazing study was conducted using 445 crossbred beef steers (496 lb) to determine the benefits of feeding a grain-based supplement on burned and unburned native pasture, with and without a Safe-Guard[2] (fenbendazole) treatment while on pasture. Treatments consisted of mineral only, mineral with Safe-Guard treatment at day 29, and a supplement based on dry-rolled corn with a Safe-Guard treatment on day 29. All three treatments provided GainPro[3] to the steers. Twelve pastures were used, six that were burned and six that were not burned during the month before the start of the trial. The control pastures were stocked at 272 lb per acre; the pastures with cattle receiving supplements were stocked at 312 lb per acre, 15% more than controls. Cattle grazing burned pastures had greater daily gains (1.81 vs. 1.65 lb/day; P=0.05) and gained 9 lb more per acre (85 vs. 76 lb/acre; P=0.03) than those grazing unburned pastures. Supplementation with grain mix improved the pounds of gain per acre, compared with cattle not receiving supplement (95 vs. 76 lb/acre; P<0.01). Steers treated with Safe-Guard while on pasture tended to have greater daily gains (1.73 vs. 1.61; P=0.17) and gained slightly more weight per acre, but this increase was not significant (P=0.24). Analysis of fecal samples indicated that deworming while on pasture did not reduce the average number of eggs shed per animal, but did increase the percentage of steers shedding no eggs.

Introduction

Providing supplemental energy to grazing steers is an effective way to increase animal performance while also increasing stocking density. Grain supplements also provide a means to include growth promotants into the diet. GainPro (bambermycins) is a growth promotant that is a non-ionophore antibiotic. GainPro can improve efficiency of ruminal fermentation of forage, as well as enhance amino acid digestibility and increase nutrient uptake in the small intestine. This product is commonly fed to range and backgrounding cattle to improve performance. One of the goals of this study was to compare daily gain of steers receiving mineral that contained GainPro with that of steers receiving a grain mix supplement that contained GainPro.

Deworming of grazing cattle is an important management practice that improves animal health and appetite, and can increase performance. Ivomec® pour-on is used externally to protect cattle from internal as well as external parasites, and Safe-Guard (fenbendazole)

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[1]Land O'Lakes Purina Feed, Longview Animal Nutrition Center, Gray Summit, MO.
[2]Safe-Guard is a registered trademark of Hoechst Celanese Corporation.
[3]GainPro is a registered trademark of Intervet International.

is an oral dewormer used strictly for internal parasite control. Another goal of this study was to measure the effects on performance of grazing steers when dewormed with Safe-Guard 29 days after treating them with Ivomec® pour-on, to determine the frequency of deworming that might be advantageous for stocker cattle in this area.

Burning native range in the spring of the year is a management tool that increases grass quality and controls brush. Due to inclement weather in April of 2004, only the south half of the Kansas State University research pastures could be burned in a safe and controlled manner, which left the north half unburned. This provided an opportunity to compare animal performance on burned and unburned pastures.

Experimental Procedures

Four hundred forty-five crossbred beef steers of Oklahoma origin were used in this experiment (496 lb initial body weight). Upon arrival the steers were identified, weighed, randomized, and assigned to treatment according to weight and breed. Ivomec® pour-on, Vision 7® (clostridial vaccine), Revalor®-G (growth promoting implant), and Titanium® 5 (5-way viral vaccine) booster were given to all steers.

The grazing season began on May 17 and ended on August 4. The steers were assigned to three treatments, with four replicates per treatment. Treatments were divided across burned and unburned pastures. The first treatment consisted of free-choice mineral containing GainPro and white salt blocks (control). The second treatment consisted of free-choice mineral containing GainPro and white salt blocks, as well as a Safe-Guard treatment on day 29 of the grazing period (June 15) (SG). The third treatment was a grain-based protein/energy/mineral supplement containing GainPro, with a Safe-Guard treatment at day 29 (SGGRAIN). The grain mix consisted of a protein supplement blended with dry-rolled corn. As the trial progressed, the percentage of protein supplement in the grain mix was increased relative to the rolled corn to offset the declining protein content of the grass. Protein content of the grain mix ranged from 12% at the beginning to 22% at the end of the study. The steers were allowed access to the grain mix through a self-feeder. Grain-mix consumption was controlled with a proprietary intake regulator, along with feeder gate adjustment. Separate free-choice mineral (containing 8% phosphorus) and free-choice white salt blocks were available in each pasture receiving the grain mix.

Salt blocks and the contents of the mineral feeders were weighed weekly to measure intake. Target intake rates of GainPro were between 10 mg and 20 mg per steer daily across all treatments. For treatments receiving mineral only, we moved the mineral feeders relative to the water source, and added or removed white salt blocks as necessary to achieve appropriate intake of GainPro.

On day 27 and 28, all steers received a blend of rolled corn, molasses, and CTC-50 to combat a widespread outbreak of pinkeye. On days 29 and 30, steers receiving the SG and SGGRAIN treatments received a blend of Safe-Guard mineral and rolled corn. This mixture was blended at a ratio of 0.5 lb of Safe-Guard mineral to 2 lb of rolled corn, and was fed at a rate of 2.5 lb per steer to deliver 5 mg fenbendazole/kg of body weight. The steers were presented with the entire recommended amount of dewormer blend on day 29, and any of the feed that was not consumed on the first day was saved, mixed with dry molasses, and presented again on day 30, at which time it was consumed. Control cattle received an equal amount of corn on day 29 to equalize energy across treatments.

Fecal samples were collected from steers (control and SG treatments only) on day 29, before feeding Safe-Guard, to determine if internal parasite eggs were present after the Ivomec® treatment on day 0. Fecal samples were also collected on day 51 to determine the effect of the Safe-Guard treatment on days 29 and 30.

At the end of the grazing period, steers were gathered according to the treatment block of burned and unburned pastures. On the evening of day 80, steers from all of the unburned pastures were gathered, penned overnight without feed and water, and weighed individually on the next morning. On the evening of day 81, steers from the burned pastures were gathered and handled in the same manner.

Results and Discussion

There were no significant treatment by pasture burning interactions for gain per acre or for daily gains. Steers grazing burned pastures had greater average daily gains, total weight gain, and gain per acre than did those grazing unburned pastures, when compared across treatments (Table 1).

Although grain supplementation did not increase daily gain statistically (Table 2; P=0.19), the numeric increase was 0.12 lb/day, indicating a marginal advantage in average daily gain to grain-based supplementation within either pasture condition. Because steers receiving SGGRAIN consumed 1.86 lb/day of the grain mix, conversion of the grain mix to gain was 15.5:1. Because stocking rate was greater for SGGRAIN than for SG or control pastures, gain per acre was 19 lb/acre greater for SGGRAIN than for SG (P<0.01).

Steers treated with Safe-Guard while on pasture tended to have greater average daily gain than those not receiving Safe-guard (1.73 vs. 1.61 lb/day for SG vs. control; P=0.17). Fecal egg counts showed no differences between the control steers and those that received Safe-Guard, either before or after the Safe-Guard treatment (Table 3). More of the steers receiving Safe-Guard, however, had zero eggs present on day 51 (P=0.04), indicating a response to the Safe-Guard. In light of the difficulty in achieving consumption of the Safe-Guard mix by the steers, it is likely that consumption of the grain mix containing Safe-Guard was variable among animals, and this may have prevented thorough deworming of steers that did not consume adequate amounts of the product.

Table 1. Grazing performance of steers on burned and unburned pastures

	Burned Pastures	Unburned Pastures	SEM
Number of steers	181	261	-
Number of pastures	6	6	-
Stocking rate, lb/acre	291	288	-
Starting weight, lb	497	495	0.58
Final shrunk weight, lb	643	627	3.45
Average daily gain, lb	1.81	1.65	0.05
Gain per acre, lb	85	76	2.19

Table 2. Grazing performance of steers receiving a mineral supplement, without (control) or with Safe-Guard treatment on day 29 (SG), or a grain-based supplement with Safe-Guard treatment on day 29 (SGGRAIN)

	Mineral Supplement		Grain Supplement	
Item	Control	SG	SGGRAIN	SEM
Number of steers	133	122	187	-
Number of pastures	4	4	4	-
Stocking rate, lb/acre	273	271	315	-
Starting weight, lb	497	496	496	0.71
Final shrunk weight, lb	626	635	644	4.23
Average daily gain, lb	1.61	1.73	1.85	0.06
GainPro intake, mg/steer daily	17.3	13.7	22.2	1.80
Grain-mix intake, lb/steer daily	-	-	1.86	0.030
Grain-mix conversion	-	-	15.5	-
Gain per acre, lb	71	76	95	2.7

Table 3. Egg counts from fecal samples collected before and after Safe-Guard treatment

	Treatment			
Item	Control	SG[1]	SEM	P-value
Fecal egg counts, eggs/3 grams				
Pre-treatment (day 29)	64	69	10.9	0.75
Post-treatment (day 51)	38	36	7.0	0.77
% with zero eggs	10	29	4.4	0.04

[1]SG = Safe-Guard treatment on day 29.

THE EFFECTS OF FLAXLIC[1] BLOCK SUPPLEMENTATION ON FINISHING FEEDLOT HEIFERS

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Summary

An experiment was conducted to determine the effects of FlaxLic supplement blocks, fed free-choice during feedlot finishing, on heifer performance, carcass quality, and fatty acid profiles of loin steaks. Heifers (n=302, 1059±7 lb initial bodyweight) were fed diets based on steam-flaked corn. Cattle were assigned to dirt surfaced pens (12 to 13 heifers/pen, 12 pens/treatment). Treatments consisted of control (no block) or FlaxLic free-choice block supplements. Loins were obtained from three animals randomly selected from each pen for measurement of fatty acid profiles. Average daily gain and feed:gain were not different over the 75-day feeding trial. Dry matter intake was less for heifers supplemented with FlaxLic blocks. There were no differences between treatments for carcass characteristics. Heifers supplemented with FlaxLic blocks had greater concentrations of 18:3n3 (alpha-linolenic acid) fatty acids in loin steaks, compared with controls. The ratio of omega-6:omega-3 fatty acids was also reduced by supplementation with FlaxLic blocks.

Introduction

Flaxseed contains high concentrations of alpha-linolenic acid, an important omega-3 fatty acid. American diets historically have been largely deficient in omega-3 fatty acids. Consumption of omega-3 fatty acids has been linked to reductions in coronary heart disease, chronic inflammatory conditions, and tumor malignancy. Compounds such as fish oil, which are rich in omega-3 fatty acids, have been recommended as sources of omega-3 fatty acids for human diets. Past studies have demonstrated that the fatty acid composition of beef tissues may be altered by the incorporation of flaxseed into the diets of finishing beef cattle. Addition of flaxseed to diets of beef steers resulted in greater concentrations of alpha-linolenic acid in the longissimus muscle (ribeye), indicating that a proportion of dietary omega-3 fatty acids escape rumen biohydrogenation and subsequently are deposited into tissues, thus creating a product enriched with alpha-linolenic acid.

Availability of processed flax for use as cattle feed has been a limitation to its use by cattle producers with small to moderate size operations. An alternative mechanism to incorporate these omega-3 fatty acids into diets is to supply FlaxLic, a low-moisture block supplement containing ground flaxseed and flaxseed oil. The objective of our experiment was to determine if FlaxLic, when administered as a free-choice supplement to finishing beef heifers, results in higher concentrations of omega-3 fatty acids in tissues.

[1]FlaxLic is a trademark of New Generation Feeds, Belle Fourche, SD.

Experimental Procedures

Crossbred heifers (n=302) were purchased from salebarns and transported to Kansas State University Beef Cattle Research Center in Manhattan, Kansas. All cattle were offered *ad libitum* access to hay and water before processing. Within 24 hours after arrival, cattle were processed through the working facility. Heifers were weighed and treated with internal/external parasiticides. Cattle that were lame or sick at initial processing were not included in the experiment. Cattle were implanted with Revalor®-H, gradually adapted to a diet composed of 94% concentrate and 6% alfalfa hay (Table 1), blocked by initial weight into three weight blocks, and allotted to dirt-surfaced feeding pens containing 12 to 13 animals each. Within each weight block, four pens received FlaxLic and four pens did not receive FlaxLic block supplementation (control). Pens of cattle were weighed by using a platform scale on day 0 and immediately before being transported to a commercial abattoir for slaughter.

The daily ration was delivered at approximately 3 p.m. each day. Unconsumed feed was weighed and accounted for in calculations of feed consumption. Each of the FlaxLic blocks were weighed before supplementation and after removal from the pens. Samples were obtained from each supplement block, and moisture content was measured.

Slaughter data, including hot carcass weight, incidence and severity of liver abscess, and dressing yield were obtained on the day of slaughter. After a 24-hour chill period, carcasses were evaluated for subcutaneous fat thickness; kidney, pelvic, and heart fat; longissimus muscle area; marbling score; and USDA yield and quality grades. After fabrication, loins were obtained from three animals randomly selected from each pen. The loins were allowed to age for 14 days in Cryovac bags at 32 ± 2˚F. After aging, loin steaks were removed and vacuum packaged for sampling. Steaks were cooked, being turned at an internal temperature of 104˚F and removed from the oven at an internal temperature of 158˚F, and then were refrigerated at 38˚F for 24 hours. After refrigeration, six to eight half-inch cores were removed parallel to the fiber orientation of the steaks for fatty acid analysis by gas chromatography.

Table 1. Diet composition

Ingredient	% of Dry Matter
Steam-flaked corn	79.6
Ground alfalfa hay	6.0
Corn steep	6.2
Soybean meal	2.8
Limestone	1.6
Urea	1.0
KCl	0.3
Salt	0.3
Trace mineral premix[a]	0.04
Drug premix[b]	2.2
Nutrient	
Dry matter, % as is	80
Crude protein	14
Fat	3.7
Calcium	0.75
Phosphorus	0.39

[a]Supplement formulated to provide to final diet: 0.3 ppm selenium, 10 ppm copper, 60 ppm zinc, and 60 ppm manganese, 2.1 KIU/lb vitamin A, and 15 IU/lb vitamin E.
[b]Diets formulated to provide 300 mg monensin, 90 mg tylosin, and 0.5 mg melengesterol acetate per heifer daily.

Results and Discussion

Average daily gain was not affected by block supplementation (Table 2), but average daily dry matter intake for the FlaxLic-supplemented heifers was significantly less than for the control heifers ($P<0.05$). The heifers provided FlaxLic supplement were slightly more efficient than control animals, although the difference was not significant. Carcass weight, ribeye area, and fat thickness measured at the 12th rib were similar for the two treatments (Table 3). Yield grades and quality grades also were not different between treatments.

Cattle provided access to FlaxLic blocks yielded loin steaks with greater concentrations ($P<0.001$) of alpha-linolenic acid (18:3n3) (Table 4). The concentration of total fatty acids (a measure of total fat content) was similar between the two treatments. Proportions of alpha-linolenic acid, when calculated as percentage of total fatty acids, were higher for cattle in the FlaxLic treatment. Also, concentrations of total omega-3 fatty acids were significantly higher for cattle fed FlaxLic ($P<0.01$), and the ratio of total omega-6 fatty acids to omega-3 fatty acids was significantly less in heifers fed FlaxLic, compared with that in heifers receiving no block supplementation.

Feeding FlaxLic blocks to finishing heifers for 75 days before slaughter resulted in comparable rates of gain, but with less total feed consumption. FlaxLic blocks increased concentrations of omega-3 fatty acids in cooked ribeye steaks.

Table 2. Performance of finishing heifers

Item	Control	FlaxLic	SEM	*P*-value
Number of heifers	152	150	-	-
Number of pens	12	12	-	-
Days on feed	75	75	-	-
Initial weight, lb	855	853	3.2	0.78
Final weight, lb	1162	1161	7.3	0.97
Dry matter intake, lb/day	22.2	21.3	0.24	0.02
Average daily gain, lb	4.10	4.09	0.10	0.99
Gain:feed, lb:lb	0.184	0.192	0.004	0.18

Table 3. Carcass characteristics of finishing heifers

Characteristic	Control	FlaxLic	SEM	*P*-value
Carcass weight, lb	738	737	5	0.97
Ribeye area, square inches	13.60	13.45	0.20	0.61
Fat thickness (12th rib), inches	0.30	0.31	0.01	0.62
Kidney, pelvic, heart fat, %	2.25	2.22	0.03	0.55
Marbling score[1]	384	369	7	0.16
Average USDA yield grade	2.00	2.00	0.06	0.99
USDA Choice, %	41.8	35.1	5.1	0.37
USDA Select, %	54.9	58.9	5.4	0.61
USDA Standard, %	3.3	6.0	2.0	0.35
USDA Yield Grade 1, %	23.9	23.8	4.4	0.99
USDA Yield Grade 2, %	55.7	54.2	4.2	0.80
USDA Yield Grade 3, %	17.0	19.4	3.1	0.60
USDA Yield Grade 4, %	3.4	2.0	1.5	0.52

[1]Traces=200-299, slight=300-399, small=400-499, modest=500-599, moderate=600-699, slightly abundant=700-799, moderately abundant=800-899, and abundant=900-999.

Table 4. Fatty acid concentrations of cooked loin steaks from control and heifers provided FlaxLic supplement

Fatty Acid	Control	FlaxLic	SEM	*P*-value
	---------- % of sample ----------			
C16:0	1.096	1.069	0.045	0.67
C18:0	0.566	0.572	0.024	0.86
C18:2n6t	0.006	0.007	0.0003	0.22
C18:2n6c	0.200	0.198	0.006	0.80
C18:2cis9trans11	0.018	0.018	0.001	0.92
C18:2trans10cis11	0.002	0.002	0.0002	0.63
C18:2cis9cis11	0.0004	0.0005	0.0001	0.57
C18:2trans9trans11	0.003	0.003	0.0002	0.87
C18:3n6	0.005	0.006	0.0005	0.52
C18:3n3	0.020	0.023	0.0007	<0.001
Total fatty acids	4.49	4.40	0.171	0.72
Total omega-3 fatty acids	0.068	0.074	0.001	<0.01
Omega-6/Omega-3	3.84	3.53	0.090	0.02

AN INVESTIGATION INTO THE MECHANISMS OF ACTION OF REVALOR[1]-S AND OPTAFLEXX[2] IN GROWING STEERS

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Summary

An experiment was conducted to evaluate the interaction between steroidal implantation and feeding ractopamine on nitrogen retention, blood metabolites, and messenger RNA (mRNA) expression. Six Holstein steers (initially weighing 509 lb) were implanted or not with Revalor-S (120 mg trenbolone acetate plus 24 mg estradiol-17β), and all were fed no ractopamine for the initial 28 days and then 2 grams per steer daily of Optaflexx (200 mg/day ractopamine-HCl) on days 29 through 56. Implantation increased nitrogen retention. Optaflexx increased nitrogen retention in non-implanted steers, but did not significantly increase retained nitrogen in implanted steers. Implantation increased serum insulin-like growth factor (IGF)-I concentration. Optaflexx, however, numerically decreased serum IGF-I concentrations. Implantation numerically increased IGF-I mRNA in the longissimus muscle, but expression of IGF-I mRNA was significantly decreased when Optaflexx was fed. Both growth promotants increased nitrogen retention in steers, but, despite perceived differences in their mode of action, the combination yielded a less than additive response for nitrogen retention.

Introduction

In the feedlot industry, enhancing efficiency of growth of finishing cattle is a major objective. Improvements in growth have been achieved by use of steroidal implants. Steroidal implants such as Revalor-S that contain trenbolone acetate and estradiol-17β can improve daily gain and feed efficiency, which results, at least in part, from increased blood concentrations of IGF-I and local tissue production of IGF-I. Insulin-like growth factor-I affects postnatal muscle growth by increasing the number of satellite cells (which contain DNA), fusion of these satellite cells with existing muscle fibers, and muscle protein accretion.

Optaflexx is growth promotant that is new to the market in the United States. Optaflexx is the trade name for ractopamine-HCl, a β_1 adrenergic agonist. Addition of Optaflexx to the diet can repartition nutrients away from fat deposition and to muscle accretion, thus improving daily gain and feed efficiency. Little research has been conducted with steers that have been implanted with Revalor-S and fed Optaflexx.

Implants and β agonists may improve growth by potentially different mechanisms. Previous research has shown that implanting steers with Revalor-S increases serum concentrations of IGF-I, and this effect is maintained for up to 150 days. Similarly, mRNA expression of IGF-I in the longissimus and the liver of steers implanted with Revalor-S is significantly increased by implantation. As a result

[1]Revalor is a registered trademark of Intervet, Inc.
[2]Optaflexx is a registered trademark of Elanco Animal Heath, Indianapolis, IN.

of these increases in IGF-I, daily gain and feed efficiency are improved. Insulin-like growth factor-I improves muscle growth by increasing protein accretion and by increasing the DNA content in the muscle, which is needed to sustain the increased protein accretion. Optaflexx has been shown to improve daily gain and feed efficiency in feedlot cattle, but the mechanisms involved have not been completely elucidated. For example, the impact of Optaflexx on IGF-I measures has not been documented.

The aim of our study was to evaluate effects of feeding Optaflexx to steers implanted with Revalor-S and, thus, evaluate some mechanisms of action for these growth promotants in an effort to predict if they might yield additive or synergistic responses. For our study, growing Holstein steers were used as a research model to provide some insight into the mechanisms by which these two growth promotants function.

Experimental Procedures

Six Holstein steers (509 lb initial weight) were used in a split-plot design. Steers were housed in individual metabolism crates and were adapted to a corn-based diet for 1 week before the study. All steers had free access to water and received the same diet in equal proportions at 12-hour intervals during the experiment. The diet contained 62% dry rolled corn, 15% alfalfa hay, and 20% expeller soybean meal. Rumensin (30 mg/kg) and tylan (11 mg/kg) were added to the diet. The diet was formulated to supply excess metabolizable protein to the steers.

The main plot treatments were implantation with Revalor-S (120 mg trenbolone acetate plus 24 mg estradiol-17β; Intervet, Millsboro, DE) or no implant. Three of the six steers were implanted on day 0. The subplot treatment was feeding of 0 or 2 grams per steer daily of Optaflexx (providing 0 or 200 mg/day ractopamine-HCl; Elanco Animal Health, Greenfield, IN). None of the steers received Optaflexx during the initial 28 days of the trial, and then all steers were fed 2 grams per steer daily of Optaflexx, beginning on day 29 and continuing through the end of the trial.

Representative samples of the diet, orts, feces, and urine were collected over 4-day periods for measuring nitrogen balance (a measure of lean-tissue deposition). Jugular blood samples were collected 2 hours after the morning feeding on days 0, 14, 28, 42, and 56 for analysis of glucose, urea, insulin, and IGF-I. Biopsy samples were collected from the longissimus muscle of each steer on days 0, 14, 28, 42, and 56. Semimembranous muscle and liver samples were collected from each steer after they were euthanized on day 56. Total RNA was isolated from muscle and liver samples for use in real-time, quantitative polymerase chain reaction (PCR) to measure the expression of IGF-I mRNA.

Results and Discussion

Optaflexx significantly increased diet digestibility and significantly decreased nitrogen intake, fecal nitrogen excretion, and urinary urea nitrogen excretion (Table 1). Decreases in N intake were a result of slightly lower dietary N concentrations during the second half of the experiment. An increase in digestibility would lead to less fecal nitrogen loss. Total urinary nitrogen excretion was significantly decreased by Revalor-S and by feeding Optaflexx to control steers; it was not, however, affected by feeding Optaflexx to steers implanted with Revalor-S. Increases in diet digestibility and decreases in nitrogen excretion led to significant increases in nitrogen retention in response to Revalor-S as well as in response to Optaflexx in non-implanted steers, but not in response to Optaflexx in implanted steers (Figure 1).

Plasma urea and glucose concentrations were not significantly affected by treatment (Table 2). Plasma insulin concentrations were not significantly affected by Revalor-S or Optaflexx, but numerically concentration decreased 66% in implanted steers when Optaflexx was fed, in contrast to an 8% decrease in non-implanted steers in response to Optaflexx. Implantation with Revalor-S significantly increased serum IGF-I concentrations. In contrast, Optaflexx led to numerical decreases in serum IGF-I concentrations in both control and implanted steers. During the final 28 days, when Optaflexx was fed, implanted steers maintained greater serum IGF-I concentrations than control steers did.

Messenger RNA is the product of gene expression and is the first of many steps in producing a protein. Measuring mRNA expression of a gene is not a direct measure of the protein produced, but it typically is related to production of the protein. Insulin-like growth factor-I mRNA expression in the longissimus muscle followed the same pattern as serum concentrations of IGF-I (Table 2). Implantation with Revalor-S led to numerical increases in IGF-I mRNA expression, but IGF-I mRNA expression in longissimus muscle was significantly decreased by Optaflexx. During the final 28 days, when Optaflexx was fed, implanted steers maintained greater IGF-I mRNA expression than control steers did. Implantation with Revalor-S resulted in numerical increases in IGF-I mRNA expression in semimembranosus muscle tissue on day 56 (Table 3). Revalor-S also led to numerical increases in IGF-I mRNA in the liver on day 56 (Table 3), which agrees with the higher serum IGF-I concentrations that implanted steers maintained throughout the study. Because the liver is the primary source of blood IGF-I, the relationship between liver mRNA expression and serum concentrations of IGF-I was expected.

The results gathered from this experiment show that Revalor-S or Optaflexx can improve growth in lightweight, growing Holstein steers, as shown by improvements in nitrogen retention. Administering a combination of the two, however, did not enhance nitrogen retention beyond that observed for the implant alone. The two growth promotants demonstrated different modes of action; Revalor-S increased serum concentrations and mRNA expression of IGF-I, whereas Optaflexx led to decreases in these parameters. Although our steers were not typical of finishing cattle that would receive Optaflexx (they were much smaller and more recently implanted), the use of these animals allowed an evaluation of the mechanisms of action of the two growth promotants.

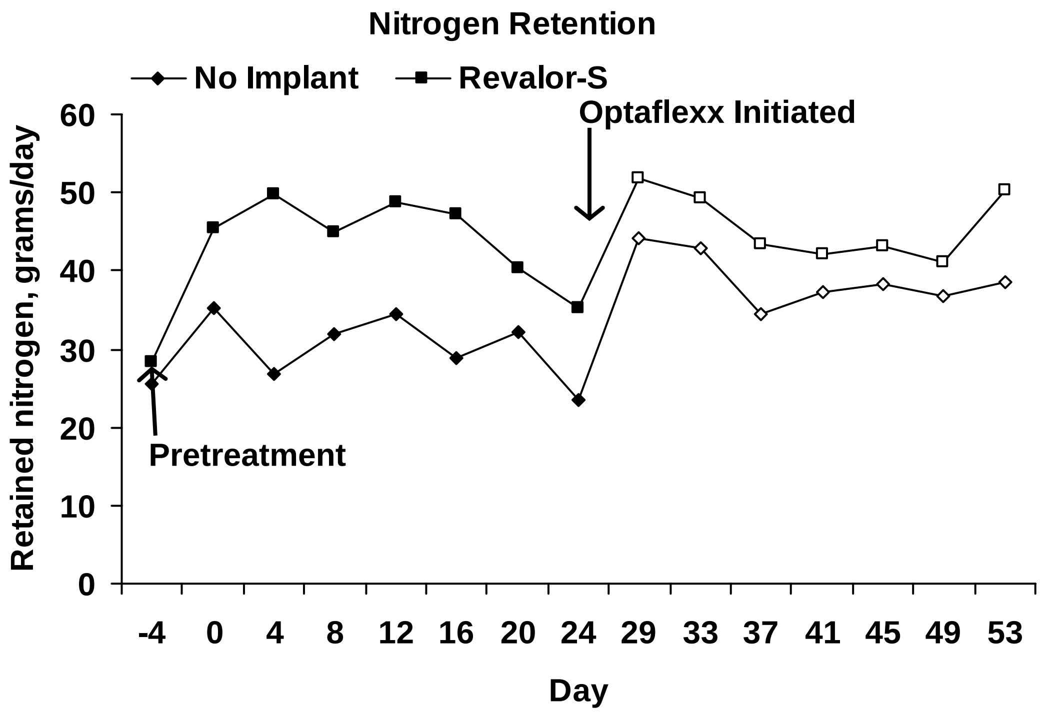

Figure 1. Effects of Revalor-S and Optaflexx on nitrogen retention over time in Holstein steers. Filled symbols represent times when Optaflexx was not fed, whereas the open symbols represent times when Optaflexx was fed. Each value represents an average of nitrogen retained over four days. SEM = 1.4.

Table 1. Effects of Revalor-S and Optaflexx on nitrogen balance and diet digestibility in growing steers

	Days 0 to 28 No Optaflexx		Days 29 to 56 2 g/d Optaflexx		
Nitrogen, grams/day	No Implant	Revalor-S	No Implant	Revalor-S	SEM
Dietary intake[a]	143.2	140.4	139.6	135.6	3.9
Fecal[a]	35.2	35.4	29.1	29.9	2.9
Urinary[b]	77.2[z]	60.8[x]	71.2[y]	60.2[x]	4.0
Retained[b]	30.4[x]	44.6[z]	39.0[y]	45.9[z]	1.4
Dry matter digestibility, %[a]	76.9	77.7	79.0	80.2	1.9

[a]Effect of Optaflexx, $P<0.05$.
[b]Effect of Revalor-S × Optaflexx interaction, $P<0.05$.
[x,y,z]Means having different superscript letters within a row differ, $P<0.05$.

Table 2. Effects of Revalor-S and Optaflexx on blood metabolites and IGF-I mRNA expression in Holstein steers

	Days 14 and 28 No Optaflexx		Days 42 and 56 2 g/d Optaflexx		
Item	No Implant	Revalor-S	No Implant	Revalor-S	SEM
Plasma glucose, mM	4.81	4.64	4.72	4.36	0.2
Plasma urea, mM	4.60	4.24	4.30	4.02	0.3
Serum insulin, ng/mL	0.50	0.40	0.46	0.14	0.1
Serum IGF-I, ng/mL[a]	443	593	359	545	93
Longissimus mRNA					
IGF-I, arbitrary units[b]	516	838	218	453	181

[a]Effect of Revalor-S, $P<0.05$.
[b]Effect of Optaflexx, $P<0.05$.

Table 3. Effects of Revalor-S on mRNA expression in semimembranosus muscle and liver

Tissue	No Implant	Revalor-S	SEM
	--- IGF-I mRNA, arbitrary units ---		
Semimembranosus muscle	956	3,288	792
Liver	37,252	78,554	19,536

EFFECT OF OPTAFLEXX[1] AND DAYS ON FEED ON FEEDLOT PERFORMANCE, CARCASS CHARACTERISTICS, AND SKELETAL MUSCLE GENE EXPRESSION IN YEARLING STEERS

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Summary

Two-thousand two-hundred fifty-two yearling steers (690 lb) were used to evaluate the effects of Optaflexx and days on feed on finishing steer performance and carcass characteristics. Treatment groups included serial harvest dates of 150, 171, or 192 days. Within each harvest date, steers either received Optaflexx (200 mg/steer daily of ractopamine-HCl) for the final 28 days, or did not receive Optaflexx. All steers were initially implanted with Revalor[4]-IS and were re-implanted with Revalor-S after 75 days on feed. At harvest, muscle samples from the inside round were obtained for mRNA analysis of the β-adrenergic receptors (AR). Optaflexx increased daily gains, hot carcass weight, and ribeye area, and improved feed efficiency. Optaflexx did not affect dressing percentage, USDA yield grade, or quality grade. Optaflexx did not change overall feed intake across the entire feeding period, but feed intake was increased during the 28-day period that steers received Optaflexx. As expected, greater days on feed decreased daily gains, overall feed intake, and the number of yield grade 1 and 2 carcasses, and worsened feed efficiency. Also, greater days on feed increased hot carcass weight, dressing percentage, and the number of prime and choice carcasses, as well as the number of yield grade 4 and 5 carcasses. Increasing days on feed decreased the abundance of mRNA for β_1-AR and β_3-AR, and increased the abundance of β_2-AR mRNA. Optaflexx had no effect on abundance of mRNA for β_1-AR or β_3-AR, but it increased the abundance of mRNA for β_2-AR. Optaflexx may affect expression of the β_2-AR gene in skeletal muscle, which could impact the performance responses to Optaflexx feeding in steers.

Introduction

Previous results with Optaflexx, an approved β-adrenergic agonist for beef cattle, have demonstrated increased daily gains, improved feed efficiency, increased carcass weight gain, and sometimes a slightly enhanced yield grade without detrimental effects on quality grade. No studies have determined if the response to Optaflexx is affected by the length of the total feeding period. Further, many studies report that the active ingredient of Optaflexx, ractopamine-HCl, functions as a β_1-adrenergic receptor agonist. Previous research has suggested that exposure to a β-

[1]Optaflexx is a registered trademark of Elanco Animal Health, Indianapolis, IN.
[2]Intervet, Inc.
[3]Cactus Research, LTD.
[4]Revalor is a registered trademark of Intervet, Inc.

agonist, such as ractopamine-HCl, can affect the amount of the β-adrenergic receptor (AR) through which ractopamine mediates its biological effect.

The objectives of our study were to evaluate the effects of feeding Optaflexx to yearling steers, harvested at three different harvest dates, on performance, carcass characteristics, and the abundance of β-adrenergic receptor mRNA in skeletal muscle tissue.

Experimental Procedures

This study was a collaboration between Intervet, Inc. (Millsboro, DE), Cactus Research, LTD, and Kansas State University. Two-thousand two-hundred fifty-two English × Continental steers (690 lb initial weight) were fed at Cactus Research, LTD. Treatments were arranged in a 3 × 2 factorial, and the experiment used a randomized complete-block design. Steers were blocked by arrival time, randomly assigned to treatments within block, and allotted to 24 pens, with 91 to 97 steers per pen. Pens of steers were assigned to harvest dates of 150, 171, or 192 days. Within each harvest date, steers either received Optaflexx (200 mg/steer daily of ractopamine-HCl) for the final 28 days, or did not receive Optaflexx (control). Upon entering the feedyard, steers were implanted with Revalor-IS (80 mg trenbolone acetate and 16 mg estradiol-17β), and 75 days later were reimplanted with Revalor-S (120 mg trenbolone acetate and 24 mg estradiol-17β). USDA yield and quality grades were obtained at harvest.

At harvest, a muscle sample was collected from the inside round of four randomly selected steers in each pen, snap-frozen, and shipped to the growth lab at Kansas State University. Samples were stored at -112°F, and RNA was isolated from the muscle tissue of two steers in each group. RNA was isolated by using the TRI Reagent RNA isolation technique. After isolation, RNA quality and quantity were measured; then the abundance of mRNA for β_1-AR, β_2-AR, and β_3-AR was measured by using a reverse transcription-polymerase chain reaction procedure.

Results and Discussion

Feeding Optaflexx increased average daily gain by 4.6% and improved feed efficiency by 3.8% (Table 1). There was no overall change in dry matter intake in response to Optaflexx during the entire feeding period, but during the 28 days in which Optaflexx was fed, feed intake did increase by 3.5%, compared with that of controls (data not shown).

Table 1. The effects of Optaflexx on steer performance and carcass characteristics

	Treatment	
Item	Control	Optaflexx
Total gain, lb[a]	570	601
Dry matter intake, lb/day	19.50	19.64
Daily gain, lb/day[a]	3.43	3.59
Feed:gain[a]	5.70	5.49
Dressing percentage	63.30	63.60
Hot carcass weight, lb[a]	816	834
% carcasses > 949 lb[a]	3.90	8.30
Marbling score[1]	492	496
Ribeye area, square inches[a]	14.05	14.32
USDA yield grade	2.8	2.8

[a]Optaflexx, $P \leq 0.05$.
[1]500 = small/choice.

Optaflexx did not significantly alter dressing percentage, but it increased hot carcass weight by 17 lb. There were also a greater number of heavy weight carcasses when Optaflexx was fed. Feeding Optaflexx increased ribeye area in cattle by 1.9%, but had no significant impact on the USDA quality and yield grades of the carcasses.

As expected, greater time on feed increased hot carcass weight, dressing percentage, and the percentage of USDA Prime and Choice carcasses. The number of yield grade 4 and 5 carcasses also was increased as days on feed increased. In addition, cattle performance worsened as time on feed increased; there were decreases in average daily gain and overall feed intake, and an increase in feed:gain (Table 2). The inclusion of Optaflexx in the diet for 28 days before each of the harvest dates provided a positive performance response in each of the three groups (data not shown).

Table 2. The effects of days on feed on steer performance and carcass characteristics

	Days on Feed		
Item	150	171	192
Total gain, lb[a]	564	571	620
Dry matter intake, lb/day	19.7	19.7	19.3
Daily gain, lb/day[a]	3.8	3.4	3.3
Feed:gain[a]	5.18	5.79	5.83
Dressing percentage[a]	62.4	63.6	64.2
Hot carcass weight, lb[a]	790	823	862
% carcasses > 949 lb[a]	1.4	4.8	12.1
Marbling score[a,1]	477	493	511
Ribeye area, square inches[a]	13.88	14.06	14.62
USDA yield grade[a]	2.7	2.9	2.8

[a]Days on feed, $P \leq 0.05$.
[1]500 = small/choice.

Optaflexx had no effect on the abundance of β_1-AR mRNA or β_3-AR mRNA (data not shown), but there was an Optaflexx effect on the abundance of β_2-AR mRNA (Figure 1). Also, the abundance of β_1-AR mRNA and β_3-AR mRNA decreased as days on feed increased (Figures 2 and 4). Conversely, β_2-AR mRNA abundance increased as days on feed increased (Figure 3). The amount of β_2-AR mRNA was nearly 200 times greater than the amount of β_1-AR mRNA after 171 days on feed, and was approximately 160 times greater at 192 days on feed.

It is believed that ractopamine-HCl mediates its response through the β_1-AR. The data from this study show a decrease in β_1-AR mRNA as cattle are on feed for a longer period of time, but there was still a positive response to Optaflexx for all three harvest dates. In addition, there was an increase in the abundance of β_2-AR mRNA as days on feed increased, and feeding Optaflexx also increased the abundance of β_2-AR mRNA. The results from this study provide evidence that cattle preferentially express more β_2-adrenergic receptors with increasing days on feed. These changes could have dramatic effects on performance if a high-affinity, β_2 adrenergic agonist (not ractopamine-HCl) was fed during this period.

Our data showed that Optaflexx feeding numerically increased the expression of the β_2-adrenergic receptor and had no effect on the β_1-adrenergic receptor. Much *in vitro* research suggests that a specific ligand down regulates its own receptor over time. Our data does not support previous findings because the β_1-adrenergic receptor was not affected, and the β_2-adrenergic receptor abundance increased, due to Optaflexx feeding.

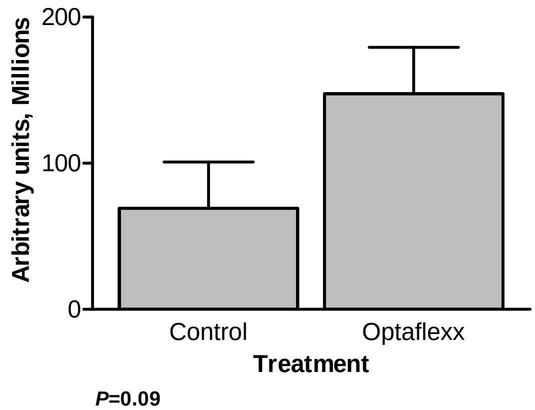

Figure 1. Main effects of Optaflexx on β_2-adrenergic receptor mRNA.

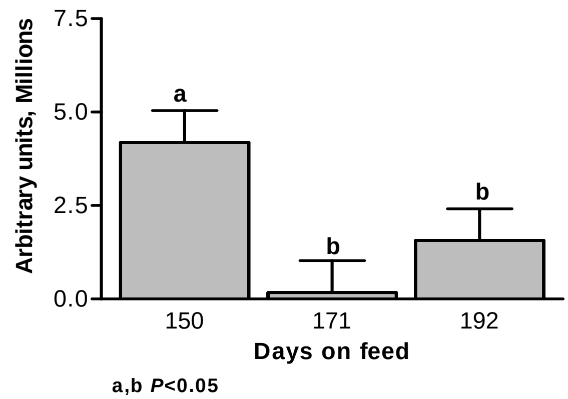

Figure 2. The abundance of β_1-adrenergic receptor mRNA at three different harvest dates.

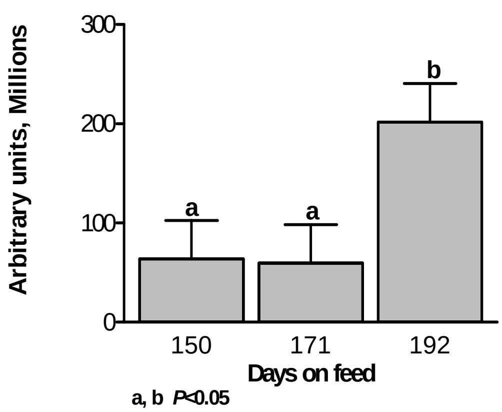

Figure 3. The abundance of β_2-adrenergic receptor mRNA at three different harvest dates.

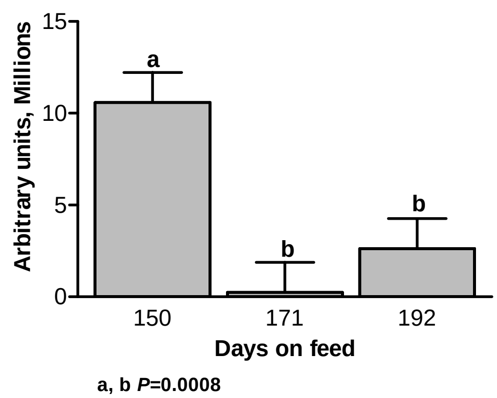

Figure 4. The abundance of β_3-adrenergic receptor mRNA at three different harvest dates.

EFFECT OF IMPLANT STRATEGY AND OPTAFLEXX[1] ADMINISTRATION ON FEEDLOT PERFORMANCE AND SKELETAL MUSCLE β-ADRENERGIC RECEPTOR AND INSULIN-LIKE GROWTH FACTOR I mRNA ABUNDANCE

E. K. Sissom, J. P. Hutcheson, D. A. Yates, and B. J. Johnson

Summary

Feedlot heifers (1,147) weighing 622 lb were used to evaluate the effects of implant strategy and Optaflexx administration. Implant treatments included Revalor[2]-200 (R200) at arrival, or Revalor-IH at arrival and reimplantation with Finaplix[2]-H on day 58 (RF). Optaflexx (200 mg/heifer daily of ractopamine-HCl) was fed the last 28 days. Treatments were randomly assigned to 16 pens. After 182 days, heifers were slaughtered, at which time carcass data were obtained and semimembranosus muscle tissue was excised for RNA isolation. Optaflexx administration significantly increased average daily gain (0.7 lb/day), feed efficiency (3%), hot carcass weight (10.5 lb), and ribeye area (0.42 square inches); decreased back fat thickness; and improved yield grade. There was no significant treatment effect on the expression of β1-adrenergic receptor (AR) mRNA, but there was a tendency for Optaflexx feeding to increase β2-AR mRNA concentrations. For β3-AR mRNA, Optaflexx treatment numerically increased β3-AR mRNA in heifers implanted with R200, but significantly decreased expression in heifers implanted with RF. Optaflexx also significantly decreased IGF-I mRNA in heifers implanted with RF, but numerically increased IGF-I mRNA in heifers implanted with R200. This data aids our understanding of the interaction between steroidal implants and Optaflexx in feedlot heifers. Knowledge about the modes of action of various growth promotants will aid in designing growth promotion strategies to enhance the efficiency of lean tissue deposition in feedlot cattle.

Introduction

Optaflexx is an orally active β-agonist (ractopamine-HCl) approved for use in feedlot cattle in the United States. It improves average daily gain, feed efficiency, carcass yield grade, hot carcass weight, and dressing percentage in feedlot steers when administered at the recommended daily dose of 200 mg/steer daily for the last 28 to 42 days of the feeding period. Optaflexx administration has resulted in more variable results in heifers than in steers. Optaflexx works through the β-AR; there are three different subtypes of β-AR found in cattle, with the β2-AR being the most abundant in bovine skeletal muscle. Optaflexx is believed to elicit its response through binding to the β1-AR. Binding to the β-AR leads to a cascade of events that is eventually followed by an increase in muscle protein synthesis and a decrease in protein degradation, which leads to an overall increase in lean tissue deposition.

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[1]Optaflexx is a registered trademark of Elanco Animal Health, Indianapolis, IN.
[2]Revalor and Finaplix are registered trademarks of Intervet, Inc.

Steroidal implants are also used in feedlot animals to improve average daily gain, feed efficiency, and total lean tissue deposition. One of the mechanisms through which increased muscle growth is achieved with implants is through increased production of muscle insulin-like growth factor I (IGF-I). Insulin-like growth factor I is a potent stimulator of skeletal muscle growth.

The purpose of this trial was to investigate the effect of Optaflexx administration, in combination with implant strategy, on feedlot heifer performance and the expression of messenger RNA (mRNA) for IGF-I and the three β-AR subtypes.

Experimental Procedures

One thousand, one hundred forty-seven heifer calves with an initial weight of 622 lb were randomly assigned to 16 pens. One of four treatments was applied to each pen: 1) initial Revalor-200 (200 mg trenbolone acetate/20 mg estradiol-17β) without or 2) with Optaflexx (200 mg/heifer daily of ractopamine-HCl), 3) initial Revalor-IH (80 mg trenbolone acetate/8 mg estradiol-17β) and reimplantation (day 58) with Finaplix-H (200 mg trenbolone acetate) without or 4) with Optaflexx (200 mg/heifer daily of ractopamine-HCl). Heifers were fed three times daily and allowed *ad libitum* access to feed. The finishing diet consisted of 82.7% flaked corn, 5.1% alfalfa hay, 3.8% choice white grease, 2.5% cane molasses, and 5.9% of a finisher supplement, on a dry matter basis. Optaflexx was administered the last 28 days of the trial, and all heifers received melengestrol acetate (0.5 mg/heifer daily). Heifers were slaughtered after 182 days on feed, at which time semimembranosus muscle samples were obtained. For the gene expression work, two heifers per pen were analyzed. Total RNA was isolated from muscle samples and reverse transcribed into complimentary DNA. The complimentary DNA was generated for use in real-time, quantitative polymerase chain reaction to evaluate the expression of mRNA for IGF-I, β1-AR, β2-AR, and β3-AR.

Results and Discussion

Optaflexx administration significantly increased average daily gain and feed efficiency (Table 1). There was also a 10.5 lb increase in hot carcass weight, an increase in ribeye area, a decrease in back fat thickness, and improved yield grades in response to Optaflexx (Table 1). These responses to Optaflexx were similar to those typically observed for steers, and were larger than are often observed for heifers. These performance results are significant in that heifers have not always been observed to respond as well to the administration of Optaflexx as steers do. The response to Optaflexx in our study may be related to the implant strategy used.

There was no significant effect of treatments on the expression of β1-AR mRNA (Figure 1); there was a tendency for Optaflexx feeding to increase β2-AR mRNA (Figure 2). For the β3-AR mRNA, there was an implant by Optaflexx interaction, with Optaflexx leading to a numerical increase in β3-AR mRNA in heifers implanted with R200, but a significant decrease in heifers implanted with RF (Figure 3). There was also an implant by Optaflexx interaction on IGF-I mRNA, with Optaflexx leading to a significant decrease in IGF-I mRNA for heifers implanted with RF but numerical increases in IGF-I mRNA in heifers implanted with R200 (Figure 4).

The data from our study demonstrate that Optaflexx can have a positive effect on feedlot heifer performance and carcass characteristics. This may be related to the relative pay out of implants. At the initiation of Optaflexx feeding, the R200 group had been implanted for 154 days and the RF group had been implanted with Finaplix-H for 96 days. Under these conditions, the potency of both implants at the time of Optaflexx initiation was likely negligible.

The performance response in our study was different than some others that have been unable to detect responses to Optaflexx in heifers. Those studies often used heifers implanted closer in time to the initiation of Optaflexx feeding. The differences between our results and those of others could suggest a possible interaction between implants and Optaflexx administration. Results of our study also suggest that Optaflexx may increase the expression of the β2-AR, which has been observed in some other studies performed by our laboratory. The data obtained from our study can aid in our understanding of the mechanisms of action of β-agonists used as growth promotants in the feedlot industry. It can also help in the understanding of the potential for interactions between the use of steroidal implants and β-agonists. This knowledge will aid in our ability to improve efficiency of lean tissue deposition in beef cattle.

Table 1. Effect of implant and Optaflexx on performance and carcass characteristics of feedlot heifers

	Treatment[1]			
Item	RF	RF+OPT	R200	R200+OPT
Pens	4	4	4	4
Number of heifers	274	271	274	272
Starting weight, lb	623	622	622	622
Dry matter intake, lb/day	16.92	16.90	17.19	16.77
Average daily gain, lb[a]	3.04	3.14	3.10	3.14
Feed:gain[a]	5.56	5.38	5.54	5.35
Hot carcass weight, lb[a]	758	771	764	772
Ribeye area, square inches[a]	14.46	14.84	14.60	15.02
12th rib fat, inches[a]	0.49	0.45	0.49	0.46
Marbling score[2]	425	409	406	398
Kidney, pelvic, and heart fat, %	1.97	2.00	2.01	2.03
Calculated final yield grade[a]	2.61	2.45	2.61	2.43

[a]Optaflexx effect, $P<0.05$.
[1]RF = Revalor-IH initially plus reimplant with Finaplix-H at 58 days, OPT = Optaflexx fed during final 28 days of trial, R200 = Revalor-200 at trial initiation.
[2]400 = Small.

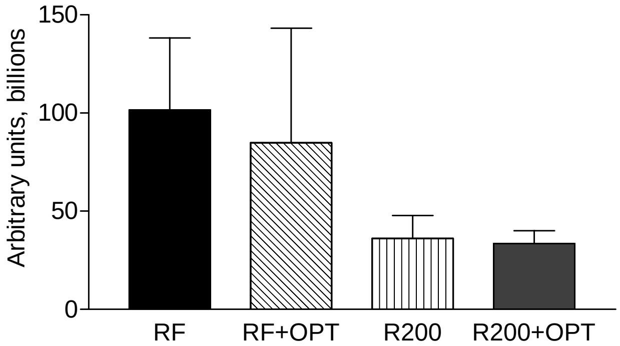

Figure 1. β1-adrenergic receptor mRNA relative abundance in semimembranosus muscle. RF = Revalor-IH initially plus reimplant with Finaplix-H at 58 days, OPT = Optaflexx fed during final 28 days of trial, R200 = Revalor-200 at trial initiation.

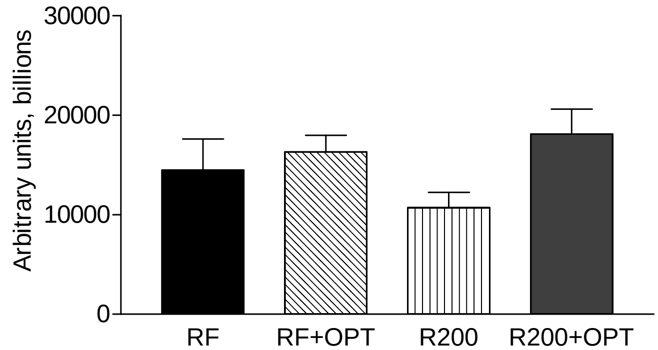

Figure 2. β2-adrenergic receptor mRNA relative abundance in semimembranosus muscle. RF = Revalor-IH initially plus reimplant with Finaplix-H at 58 days, OPT = Optaflexx fed during final 28 days of trial, R200 = Revalor-200 at trial initiation.

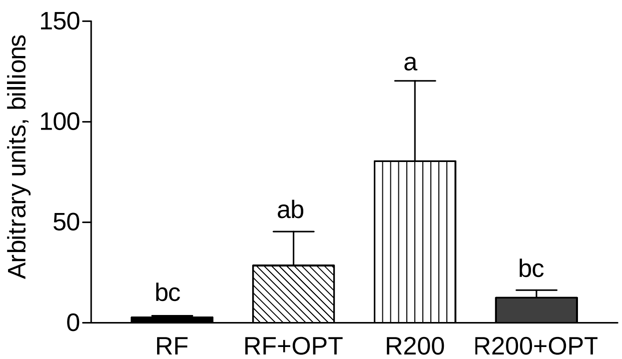

Figure 3. β3-adrenergic receptor mRNA relative abundance in semimembranosus muscle. Bars not bearing a common letter differ, P<0.05. RF = Revalor-IH initially plus reimplant with Finaplix-H at 58 days, OPT = Optaflexx fed during final 28 days of trial, R200 = Revalor-200 at trial initiation.

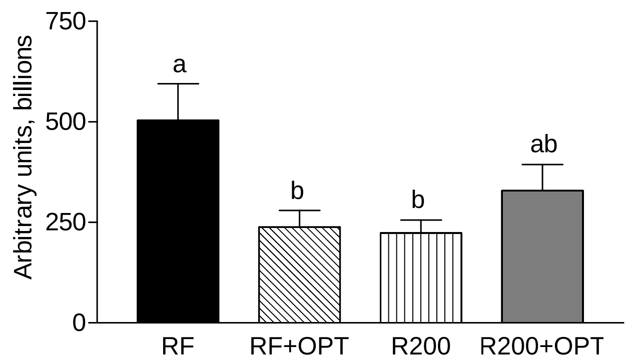

Figure 4. Insulin-like growth factor-I mRNA relative abundance in semimembranosus muscle. Bars not bearing a common letter differ, P<0.05. RF = Revalor-IH initially plus reimplant with Finaplix-H at 58 days, OPT = Optaflexx fed during final 28 days of trial, R200 = Revalor-200 at trial initiation.

COMPARISON OF DECTOMAX[1] AND VALBAZEN[1] ON BEEF CATTLE CARCASS TRAITS

J. A. Christopher, T. T. Marston, J. R. Brethour, and G. L. Stokka

Summary

The objective of this trial was to determine if types of dewormers affected carcass characteristics. Crossbred steers (n=428) were stratified by weight and ultrasound marbling score and administered either Dectomax (subcutaneous injection) or Valbazen (oral) dewormer. Fecal egg counts indicated that both dewormers cleared internal parasites from the cattle. Carcass data indicated that Dectomax increased fat deposition as measured by 12th rib back fat; kidney, pelvic, and heart fat; and marbling score, when compared with Valbazen. Deworming products may affect carcass traits that are used to value cattle.

Introduction

Cattle are routinely dewormed at feedlot arrival, during processing. Research indicates that a reduced internal parasite load will increase appetite and the amount of nutrients available for animal utilization and, therefore, improve body weight gain and feed conversion. The increases in available energy may be partitioned within the body to enhance growth of tissues (skeletal, muscle, and adipose) at different rates. The objective of this study was to determine if Dectomax Injectable Solution and Valbazen differently affected carcass traits, including marbling scores.

Experimental Procedures

Crossbred steers (n=428) from various sources were fed finishing diets during a 2-year period at the Western Kansas Agricultural Research Center – Hays. Most of the calves originated from the commercial cow/calf units of the KSU Department of Animal Sciences and Industry, Manhattan, and the Western Kansas Agricultural Research Center – Hays. These calves were primarily of British breed descent, and all contained some percentage of Angus genetics. Additional calves were purchased from a local feeder-calf provider to fill pens to capacity. These calves were gathered from herds within 50 miles of Hays and were of genetics similar to the University cattle. For statistical analysis, cattle were blocked into feeding groups (n=3) that reflected the date they were placed on feed.

Upon arrival, cattle were commingled, vaccinated for bovine respiratory disease, and administered an estrogenic implant. The first two feeding groups were fed a common finishing diet for about 60 days before being allotted to treatment. Steers were ultrasounded for marbling score (Cattle Performance Enhancement Company, CPEC, software), and the initial marbling score was used to determine changes in marbling during the finishing period. The first two feeding groups of steers

[1]Dectomax and Valbazen are registered trademarks of Pfizer, Inc.

averaged 103 days on feed from the time of ultrasound measurement and treatment application to slaughter. The third group was managed similarly, with the exception that steers were assigned to treatments approximately 45 days after weaning. Treatments and ultrasound in group 3 were initiated 203 days before slaughter. Treatments consisted of: 1) Valbazen oral drench at 4 ml/100 pounds body weight or 2) subcutaneous injection of Dectomax at 1 ml/110 pounds body weight.

Steers were fed a common finishing ration consisting primarily of finely ground grain sorghum (Table 1). The diet also contained sorghum silage, soybean meal, urea, and ammonium sulfate. The diet also included 100 g calcium carbonate, 25 g sodium chloride, 300 mg of Rumensin®, 90 mg Tylan®, and 30,000 IU vitamin A per steer daily, and a trace mineral premix that provided amounts of copper, manganese, zinc, iron, iodine, and cobalt to meet or slightly exceed requirements. Initial body weights were measured after about 12 hours of feed deprivation. Cattle were harvested at a commercial facility (National Beef, Dodge City, Kansas), and carcass data were collected after a 24-hour carcass chill.

Table 1. Composition of the finishing ration

Ingredient	Percentage of Diet, dry matter basis
Sorghum silage	32.4
Finely ground grain sorghum	59.1
Soybean meal	6.0
Rumensin®/Tylan® premix	0.5
Ammonium sulfate	0.2
Limestone	1.1
Urea	0.3
Salt	0.4

Statistical analysis was used to determine the effects of the treatments on animal performance and carcass traits. Comparisons of carcass traits took into consideration the different feeding groups and sources of cattle, as well as their initial body weight and ultrasound marbling and back fat measurements. Comparison between percentages of USDA quality grades used appropriate chi-square statistical analysis.

Results and Discussion

Fecal egg counts reported in an earlier summary of the first two feeding periods indicated that both treatments were efficacious in ridding the cattle of internal parasites. Table 2 describes the cattle as they were allotted to treatments. By using ultrasound, it was possible to balance the treatments for marbling score and back fat thickness.

Of particular interest in our study were the influences of the treatments on marbling scores used to determine USDA quality grade, the improvement in marbling score observed during the feeding periods, and the resulting USDA quality grades. These results are listed in Table 2. The marbling scores for steers treated with Dectomax were greater ($P<0.05$) than for steers treated with Valbazen. Research concerning growth and development of marbling during the finishing phase has indicated that the marbling score at the beginning of the feeding phase directly affects carcass marbling score. This trial is consistent with those findings, inasmuch as initial ultrasound marbling score was highly related to the final marbling score. Because we used initial ultrasound marbling scores as a covariate in the analysis, we conclude that the difference in treatment marbling score means is due to the dewormers and not a function of previous animal management or genetics.

Steers administered Dectomax had greater gains in marbling score from the date of ultrasound measurement until carcass data was collected ($P<0.05$) than did steers treated with Valbazen. While consuming the finishing diets, the cattle gained about one full increment of marbling score, which is equivalent to an increase in USDA quality grade from Select to Choice or from low Choice to Premium

Choice. Marketing grids usually use quality grades as major financial premiums offered to producers. Even though our study shows only trends (Table 2) of more Choice (3.8%) and Premium Choice (3.6%) carcasses by using Dectomax rather than Valbazen for parasite control, these differences could be financially significant under some marketing conditions.

Cattle administered Dectomax had greater 12th rib back fat measurements (P<0.006) and internal fat reserves (P<0.02) than did cattle treated with Valbazen. The reasons for differences in fat deposition between treatments are not explained by our experiment.

It was not the intent of this study to determine if treatment would affect cattle performance in the feedlot, but average daily gain and ending slaughter weight (P<0.92) did not differ between the treatments. The ability of cattle feeders to improve quality grade categories can have significant economic benefits. Often cattle are marketed by predicting the fewest number of days on feed to achieve a particular quality grade or mix of grades. This trial did not examine the effects that dewormers may have on carcass characteristics used to determine USDA yield and quality grades, but it was designed to examine the potential differences between two different classes of deworming agents available to cattle feeders. With the many factors (genetic and environmental) that affect marbling development, producers need to consider management decisions that increase the probability of cattle grading Choice and higher. The use of Dectomax rather than Valbazen may lead to increases in marbling scores.

Table 2. Steer performance and carcass characteristics

	Treatment			
Item	Dectomax	Valbazen	SEM	P-value
No. of steers	212	216		
Initial weight, lb	885	889	109	
Initial back fat, inches	0.14	0.14	0.003	
Initial marbling score[1]	430	431	48	
Hot carcass wt, lb	844	843	3.8	0.93
Back fat, inches	0.56	0.51	0.02	0.006
Kidney, pelvic, and heart fat, % carcass wt	2.46	2.38	0.03	0.02
Ribeye area, square inches	14.2	14.6	0.11	0.01
USDA yield grade[2]	3.04	2.79	0.05	0.0008
Marbling score[1]	527	511	5	0.02
Change in marbling score[3]	101	86	5	0.03
USDA quality grades				
No roll, %	4.25	1.85		0.15
Select, %	36.8	43.0		0.19
Choice, %	56.1	52.3		0.43
Premium Choice, %	20.3	16.7		0.34
Prime, %	2.8	2.8		0.97

[1]Scale of marbling score: 300 = Trace 00, 400 = Slight 00, 500 = Small 00, 600 = Modest 00, etc.
[2]Yield grade calculated using the official USDA formula = 2.5 + (2.5 × adjusted 12th rib back fat thickness) + (0.0038 × hot carcass weight, lb) + (0.2 × percentage kidney, pelvic, and heart fat) – (0.32 × ribeye area, square inches).
[3]Change in marbling score was calculated as the difference between the carcass marbling score and the initial animal ultrasound marbling score.

PERFORMANCE OF CALVES BORN TO BEEF COWS SEROPOSITIVE BUT SUBCLINICAL FOR BOVINE LEUKOSIS VIRUS

L. C. Hollis, D. A. Llewellyn, K. L. Teutemacher, T. T. Marston, and M. W. Sanderson[1]

Summary

Calves from a commercial beef herd were evaluated for weight gain differences based upon the bovine leukosis virus (BLV) serological status of their dams. One hundred forty-two multiparous cows from a commercial beef herd were tested for BLV by agar gel immunodiffusion. Eighty-nine cows (62.6%) were found to be seropositive for BLV. Weights were collected from all calves at weaning, from heifers on the date when selection of replacement heifers was made, and from steers on the day of harvest after being fed to finish weight in a feedlot. Offspring from seronegative cows tended to have heavier weaning weights (+17 lb) and heifer selection weights (+31 lb) than those from seropositive cows.

Introduction

Bovine leukosis (BLV) is a viral disease of cattle that usually produces a subclinical leukemia-like syndrome, or, less often, neoplastic nodular masses visible under the skin and/or scattered throughout the body. The virus is transmitted primarily by the transfer of blood from infected animals to non-infected animals. Common management practices that lead to animal-to-animal transmission include using blood-contaminated equipment such as vaccination needles, ear-taggers, dehorners, castration knives, etc., on multiple animals in succession. The BLV is transmitted to a much lesser extent by blood-sucking insects, and it is occasionally transmitted directly from the cow to the calf during pregnancy or at birth. Infection with BLV often remains unobserved until late in the course of the disease, when it causes loss of body condition, decreased milk production, and premature culling in clinically affected cows. If affected cows are not culled in a timely fashion, the disease will lead to death loss. Calves nursing clinically affected cows have reduced performance. The purpose of our study was to determine the influence of subclinical bovine leukosis in cows on calf weaning weights, replacement-heifer selection weights, and finished steer weights.

Experimental Procedures

A commercial spring-calving beef herd grazing native pasture and known to contain individuals naturally infected with BLV was selected for the study. Before calving, blood samples were collected from all cows, forwarded to the Kansas State Veterinary Diagnostic Laboratory, and screened for the presence of antibodies to the BLV by using the agar gel immunodiffusion test. Cows were calved on pasture and observed until weaning. Cows that developed clinical signs of bovine leukosis or were culled for any other reason, as well as their calves, were removed from the study. Calves that did not reach the end points of the study, along with their dams, were also removed. One hundred forty-two cows and their calves met final criteria for inclusion in

[1]Veterinary Clinical Sciences.

the study, based upon cows remaining non-clinical for BLV until after their calves were weaned in the fall, and either their heifer calves being weighed as candidates for replacement heifers or their steer calves being harvested after completion of a feedlot finishing phase. Eighty-nine (62.6%) of the 142 cows were seropositive for BLV, whereas 53 (37.3%) were seronegative. Cows and calves were maintained on native grass pasture throughout the pre-weaning portion of the study. Precautions were taken during springtime, pre-weaning, weaning, pre-breeding, and feedlot vaccinations and processing to reduce the likelihood that blood-borne transmission of BLV would occur in the cows or calves. Heifers were maintained on native grass pasture and managed collectively after weaning. Steers were moved to a feedlot and managed collectively after weaning.

Results and Discussion

It was suspected that subclinical bovine leukosis might interfere with the milking ability of the cows sufficiently to reduce the weaning weights of their offspring. Weaning weights of all calves, heifer replacement weights, and steer finished weights are shown in Table 1. Although the weaning weights were not statistically affected by the dam's serological status (P=0.11), the differences suggested that subclinical bovine leukosis tended to have a negative effect on weaning weights of calves born to seropositive cows. This tendency was also observed for heifers selected as potential replacements (P=0.08). Weights of the steers did not tend to be statistically different at the time they completed the feedlot phase, although the numerical difference between the groups was actually greater for finished weights (19 lb) than for weaning weights (17 lb). The lack of statistical difference at slaughter could be due to greater variation among the steers at slaughter preventing an accurate assessment of treatment differences.

Our findings reinforce the need for beef producers to know the BLV status of their herds and take appropriate actions to reduce the impact of the disease. If only a few animals are positive, aggressive culling is recommended. If, as in this case, a high percentage of the cows are positive, management steps should be taken to reduce the transmission of the disease from infected to non-infected animals. Such steps include changing needles on every syringe between every animal and liberal use of disinfectants on all equipment that contacts blood, including ear-taggers, dehorners, castration equipment, tattoo equipment, calving chains, etc. Attention to these details should help reduce secondary performance losses in calves from herds in which BLV is present.

Table 1. Weights of offspring from BLV seropositive and seronegative cows

Item	Calves from Seronegative Cows	Calves from Seropositive Cows	P-value
Weaning weight, lb	600	583	0.11
Heifer replacement weight, lb	837	806	0.08
Steer finished weight, lb	1105	1086	0.53

VARIATION IN PERFORMANCE OF ELECTRONIC CATTLE EAR TAGS AND READERS

A. M. Bryant, D. A. Blasi, B. B. Barnhardt, M. P. Epp, and S. J. Glaenzer

Summary

This study was conducted to evaluate the performance of ISO 11785 radio frequency identification (RFID) cattle ear tags and readers under ideal laboratory conditions. Tag and reader manufacturer identities are masked to prevent unintentional conclusions being drawn about any particular tag or reader at this stage of the U.S. National Animal Identification System (US-NAIS) proposed plan. Eight commercially available tag designs were evaluated, and included the half-duplex and full-duplex air interface technologies. Performance parameters of interest for tags were tensile strength, tampering evidence characteristics, as well as the average reading range. Three fixed-antenna stationary readers were used to determine the variability between reading ranges of each reader. Tensile strength parameters differed among tag designs. Only one tag design did not display tamper-evident characteristics. Average reading ranges differed among all eight tag designs, and there were significant differences in performance ranges among the three readers. Performance variation in tags and readers exists due to differences in material makeup (die and copper) and design characteristics. The results of this study support the need for minimum performance standards for ISO 11785 RFID technology as it applies to the US-NAIS.

Introduction

The ability to individually identify beef cattle from farm of origin to harvest for health traceback purposes is the fundamental objective of the US-NAIS. The goal of the US NAIS is to have an identification health program in place that can trace any animal within 48 hours to its farm of origin and to identify all other animals that came in contact with the diseased animal. There currently are many programs that have their own procedures for identifying animals for one purpose or another, but there is not one nationally recognized program or technology that has the capability to accurately and efficiently identify all species of livestock in commerce, either individually or by group, from birth to harvest. The use of RFID is one of the automatic information and data-capture technologies being considered for use within the US-NAIS. The objective of our study was to determine if there were differences in performance characteristics among commercially available low-frequency RFID cattle-ear-tag designs and fixed-antenna stationary readers tested under an electromagnetically controlled laboratory environment where performance conditions were ideal.

Experimental Procedures

Tags and Readers. This study focused on eight commercially available low-frequency (134.2 KHz) cattle ear tags (n = 390; 40, 50, or 60 tags for each brand) that were purchased from various suppliers, and included both half-duplex and full-duplex technologies defined by ISO Standard 11785. The half-duplex designs were Tags B and E, and the full-duplex designs were Tags A, C, D, F, G, and H. Three fixed-antenna stationary readers were used to evaluate the average reading range of the tags; they included Reader X, with a 24×16×1 inch panel antenna; Reader Y, with a 23×18×1 inch panel antenna; and Reader Z, with a 31.5×24×1 inch panel antenna.

Tensile Strength and Tampering Evidence. Twenty tags of each design (n = 160) were randomly selected to measure the tensile strength. Each tag was loaded into its designated tag applicator and the male 'pin' section and female 'receiving' section of the tag were locked together. Each locked tag was loaded into a custom attachment designed for use with the Instron Universal Testing Machine and was forcefully pulled apart. The measurements gathered by this test were peak height (inches), peak force (pounds of force), and peak energy (feet × pounds). Peak height referred to the greatest distance that a tag stretched before it tore apart or unlocked. Peak force was defined as the pounds of force reached in tearing apart or unlocking the tag. Peak energy was the amount of measurable energy required to tear a tag apart or unlock it. The ability of the tags to display evidence of tampering was evaluated. In the NAIS guidelines, tags can only be used one time; removal of the tag should prevent the tag from being used again, and must leave physical evidence that the tag had been tampered with.

Baseline Average Reading Range. The KSU Animal Identification Knowledge Laboratory presently does not have an anechoic chamber (a chamber that removes all radio frequency interferences); therefore, the laboratory was evaluated by the KSU Electronic Design Laboratory to measure any environmental interference at 134.2 ± 25 KHz that could interfere with the evaluation of reading ranges of low-frequency tags. Measurements taken with a spectrum analyzer (Hewlett Packard 4396B) revealed no measurable noises within the frequencies of interest.

A tag trolley (Figure 1) was designed and built to measure the average reading range. The baseline average reading range was the distance that a tag was from the antenna of the reader when it was successfully interrogated.

The center of the low-frequency ear tag in the cradle approached the center of the antenna at a rate of about 6 inches/second at an orientation parallel to the antenna. (i.e., the face of the tag approached the face of the antenna when being tested). An electric motor attached to one pulley was activated by the evaluator via a rheostat control, which moved the cradle and tag toward the antenna. The motor was switched off when the reader indicated a successful interrogation by an audible beeper, immediately stopping the cradle and tag, and the distance between the tag and the antenna was determined with a measuring tape that stretched on the floor from the reader's antenna to the beginning position of the cradle and tag. When each tag was interrogated, the 15-digit electronic identification number, as defined in ISO 11784, was automatically recorded into a spreadsheet. The sample of tags (n = 390) was measured in triplicate for each reader (1,170 data points per reader; 3,510 total).

Results and Discussion

Tensile Strength and Tampering Evidence. Table 1 contains the results from the tensile strength tests. There were significant differences ($P<0.05$) for all three variables (peak height, peak force, and peak energy) among all tags. Tags G and C had the largest measurements for each variable because these two tags were made from a strong, flexible plastic and had a sturdy locking mechanism that enabled the tag to stretch a longer distance and required greater force and energy to break the tag apart. Tag F had the smallest measurements for each of the three variables of interest because this tag design had a weaker plastic and a weaker locking mechanism that required less energy to unlock the tag. The tensile-strength performances differed in this study due to the differences in materials and design characteristics of the ear tags.

Table 1. Average tensile strength of low-frequency cattle ear tags

	Tensile Strength Variables			
Tag Design	Peak Height[1], inches	Peak Force[2], pounds of force	Peak Energy[2], feet × pounds	Tamper Evident[3]
A	1.88	69.5	7604	Yes
B	2.15	74.6	9459	Yes
C	2.04	97.3	11676	Yes
D	1.94	61.0	7244	Yes
E	1.77	62.9	6840	Yes
F	1.19	44.8	3446	No
G	2.24	99.7	13633	Yes
H	2.00	75.1	8768	Yes

[1]The distance a locked tag stretched before it broke apart or was unlocked.
[2]The measured pounds of force and energy required to break apart or unlock a locked tag.
[3]If the tag physically broke when it was pulled apart, then it revealed evidence of tampering. It did not reveal tamper evidence if it simply unlocked.

There were no tamper-evident characteristics for Tag F; when Tag F was pulled apart using the Instron Universal testing machine, the tag simply unlocked and could be locked back together, revealing no evidence that it had been tampered with. All other tags were designed with a locking system that did not allow the tags to be reused. When these tags broke apart, the tip of the 'male' pin section of the tag broke off inside the 'female' section of the tag, blocking the tag from being relocked with another pin. The only way to remove the pin tip would be to cut away the front of the female section, thereby revealing evidence of tampering.

Baseline Average Reading Ranges. There were significant differences for reading ranges among tags, as well as among readers (Table 2). The average reading range for each low-frequency tag design was significantly different for each reader. This outcome may be linked to the fact that the manufacturers of Reader X and Y each manufacture two tag designs that we tested, and their readers may have been tuned to optimally read their tags. The manufacturer of Reader Z does not manufacture any commercially available low-frequency cattle ear tags; therefore, this reader may be tuned for optimal reading of as many tag designs as possible.

For Reader X, the greatest average reading range was for Tag B, followed closely by Tags A, C, and G (Table 2). The average reading ranges for Tags D and E were similar, with intermediate reading ranges. All other tag combinations were significantly different (Table 2 and Figure 2).

Table 2. Average reading ranges for eight low-frequency cattle ear tag designs

	Average Reading Ranges[1], inches		
Tag Design	Reader X	Reader Y	Reader Z
A	26.5	16.3	22.6
B	31.6	14.6	29.7
C	26.4	16.8	37.5
D	24.2	14.0	34.3
E	24.7	10.1	20.5
F	20.5	12.4	28.6
G	26.6	17.2	37.7
H	19.4	11.4	26.6

[1]The distance a radio frequency tag was from the antenna of a reader when it was first successfully interrogated.

For Reader Y, the average reading ranges were greatest for Tags A, G, and C, and were intermediate for Tags B and D (Table 2 and Figure 2).

Tags C and G had the greatest average reading ranges when Reader Z was used (Table 2). All other tags had average reading ranges that were significantly different (Figure 2).

In conclusion, variation in performance of tags and readers exists due to differences in materials and design characteristics. Minimum performance standards should be established for current radio-frequency technology designated for livestock identification. Appropriate regulatory authorities should address the issue of technology performance in any further development of a National Animal Identification Program.

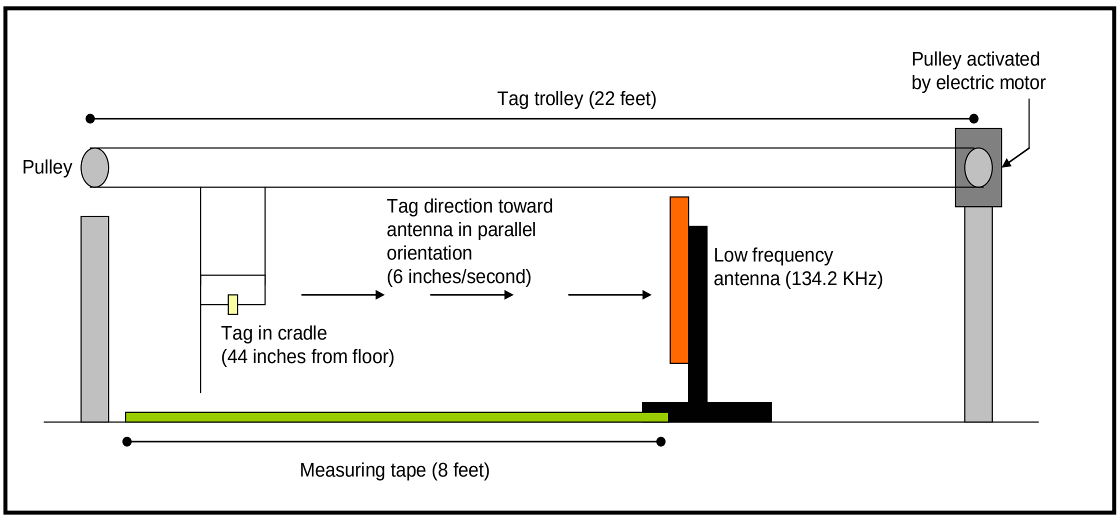

Figure 1. Tag trolley design used to measure reading ranges of low-frequency cattle ear tags.

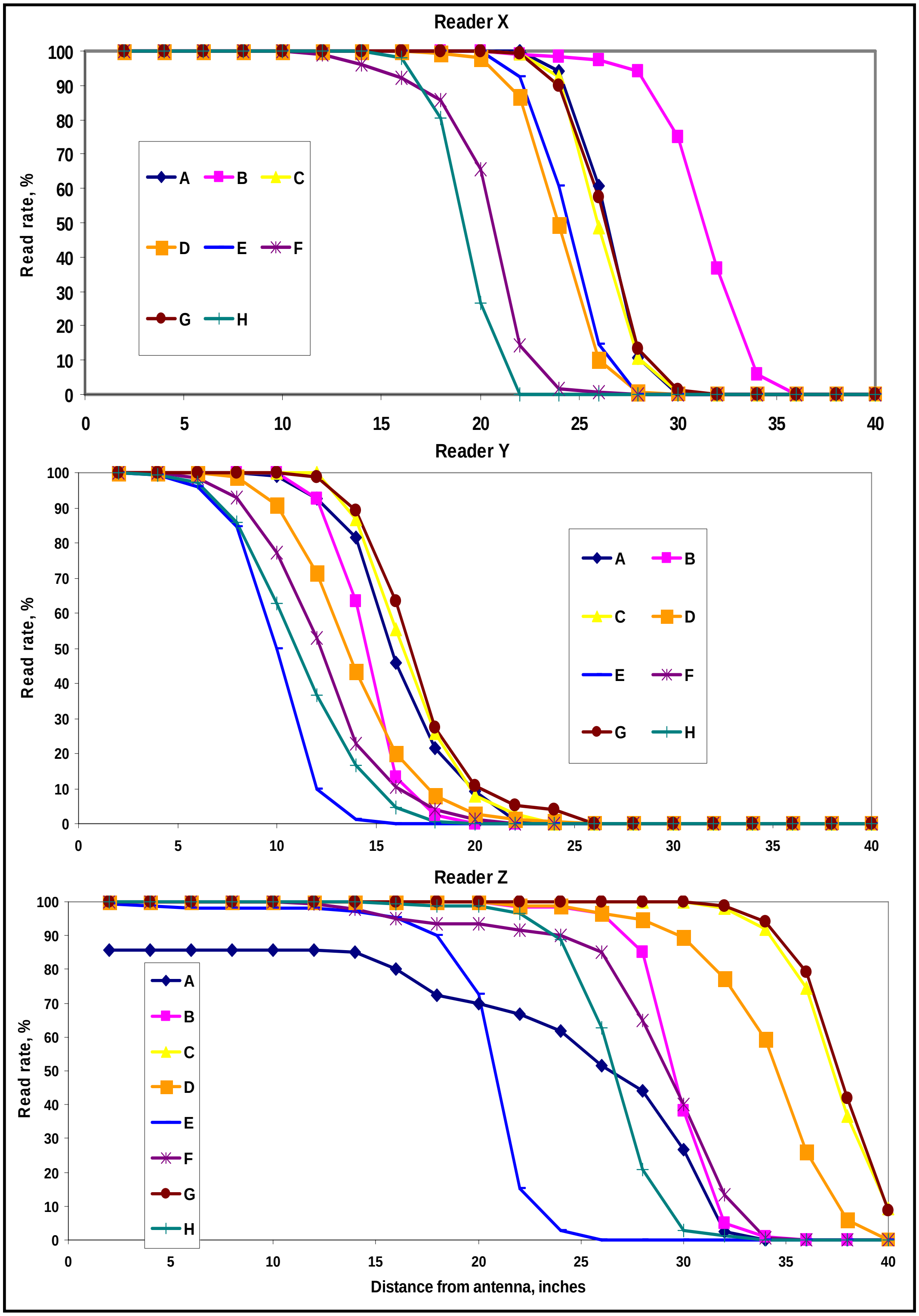

Figure 2. Reading rate versus distance from antenna for eight low-frequency cattle ear tags interrogated with three readers.

EXAMINING COST OF GAIN IN KANSAS FEEDLOTS

A. Babcock[1]*, R. Jones*[1]*, and M. Langemeier*[1]

Summary

This study had three primary objectives: 1) to examine the effects that individual performance and ingredient price factors have on cost of gain; 2) to quantify the annual and/or seasonal trend in cost of gain in Kansas feedlots; and 3) to examine the difference in cost of gain between steers and heifers. For both steers and heifers, corn price was significant and positive, indicating that as the price of corn increases so does cost of gain. The price of hay, which is a feedstuff in the majority of feedlot diets, has a positive, but insignificant, effect on feeding cost of gain. As average daily gain increased, predicted cost of gain decreased for both steers and heifers, but the result was only significant in steers. Death loss had a positive impact on cost of gain, but may be a more important factor when feeding steers. The trend over time was positive. Feed conversion is positive and highly significantly related to cost of gain for both steers and heifers. As feed conversion (feed/gain) increases, the cost of gain increases. There seems to be a significant negative trend over time in the difference between steer and heifer cost of gain, and the difference seems to be seasonal.

Introduction

Cost of gain has a direct impact on the profitability of cattle feeding, and there are many factors that affect profitability indirectly through cost of gain. Previous studies have demonstrated that corn price, feed conversion, and average daily gain explain the majority of variability in cost of gain. Other factors, such as length of the feeding period, yardage rates, etc., will impact feeding costs. In addition, factors such as death loss may or may not have a direct impact on cost of gain, but do have a direct impact on feed conversion, which could indirectly affect cost of gain. It is important for feedlots to understand these relationships and have an idea of their relative magnitudes so they are able to prioritize, focusing management attention on the most important factors to maximize profits.

In this study we examined cost of gain for a sample of feedlots in Kansas. Our objectives were to determine which factors significantly contribute to cost of gain, to quantify the seasonal trends, and to explore the differences between the cost of gain for steers and heifers.

Procedures

Data for this study were obtained from Kansas State University, Department of Animal Sciences, *Focus on Feedlot* report that is published monthly, dating back to the early 1980s. For the purpose of this study, the 1992 to 2004 time frame was used. The first year that the report recorded percentage of death loss was 1992. The survey was based on a consistent sample of approximately eight feedlots from the cattle feeding region of Kansas. All numbers are reported at closeout, and in-

[1]Department of Agricultural Economics.

clude number of cattle, final weight, average days on feed, average daily gain, dry matter feed conversion (feed/gain), percentage of death loss, average cost per cwt of gain, projected cost of gain for replacement cattle, corn price, and alfalfa price. The reported figures are the mean of individual feedlot monthly averages. Corn and hay prices are the current inventory prices. The actual survey is conducted with each individual feedlot over the telephone. Our measure of "cost of gain" is an industry-accepted measure technically referred to as "feeding cost of gain," which captures all costs except interest on a pay-weight in to pay-weight out basis. Adding interest cost results in a measure referred to as "total cost of gain."

The analysis for this study was performed by estimating two generalized least squares regressions. The first regression model specified the natural log of cost of gain (LnCOG) as a function of a series of seasonal and time-period dummy variables, the natural log of corn and hay price (LnCORN, LnHAY), the natural log of average daily gain and feed conversion (LnADG, LnFCONV), the natural log of the percentage of death loss (LnDL), and a monthly time trend. The model was estimated separately for steers and heifers.

From the first regression, two questions can be examined. First, is there a seasonal trend in cost of gain? Second, do the independent variables have an effect on cost of gain? The base month for the monthly dummy variable is January, which cannot be included in the regressions for statistical reasons. The interpretation of the results is then relative to January closeouts. In addition, an extra time period (Nev) is included as a seasonal dummy variable. This dummy variable is for the time period of January 1993 through June 1993. This is a period of time when there were abnormal weather conditions, and many of the performance variables were more than two standard deviations from the mean. Previous studies have "dummied out" this same time period when examining feedlot performance. Corn and hay prices were lagged by a weighted average of prices over the previous five months because the data are by closeout month, such that the relevant price at closeout would be the price of corn and hay over the past five months. Average daily gain, feed conversion, and death loss are all measured at time t, the closeout month for the observation pen. The trend variable was used to examine a possible change over time in cost of gain. This trend will tell us if it has become more expensive to feed an animal from placement weight to closeout over the time period of the data set.

The second model was formulated by subtracting the heifer cost-of-gain data for each observation (month) from the steer cost-of-gain data, and regressing it against the time-trend variable, along with seasonal and time-period performance dummy variables. The purpose of this model is to explore differences in cost of gain between steers and heifers, and to determine if that difference has changed over time. In this model, the dependent variable is defined as the difference between the natural logs of steer cost of gain and heifer cost of gain for a particular time period (LnSCOG – LnHCOG).

All the regressions were corrected for autocorrelation by using the Cochrane-Orcutt method. For this reason, generalized least square regressions were used.

Results and Discussion

Tables 1 and 2 summarize the results of cost of gain for steers and heifers, respectively. Previous research has found that corn price (a proxy for all energy sources) has a major influence on cost of gain, and this research supports that conclusion. Because the model is estimated in log-log form, most of the coefficients can be directly interpreted as "elasticities". For example, for steers, a 1% increase in corn price will result in a 0.5744% increase in cost of gain, holding all else constant. The average corn price over the sample period was $2.83/bushel, and cost of gain was $53.12/cwt. A 1% increase in corn price would result in a corn price of $2.86/bushel. This three-cent increase in corn price causes the cost of gain to jump to $53.43. With respect to the heifers, the same 1% increase in the price of corn will result in average cost of gain going from $55.72/cwt to $56.02/cwt. This $0.30/cwt may not seem like much but, on average, the feeder would be increasing costs by $1.49 per steer and $1.33 per heifer with the 1% increase in the corn price (calculated by multiplying the change in cost of gain by the average weight gained). Furthermore, corn prices routinely change in very short time periods by much more that the 1% illustrated in this example. The price of alfalfa hay has a positive coefficient, but it is relatively small and not significant in impacting the cost of gain for either steers or heifers.

The results for average daily gain are different between steers and heifers. The coefficients for both are negative, but the average daily gain coefficient is significant for steers and not for heifers. For the steers, a 1% increase in average daily gain results in a 0.1789% decrease in cost of gain, holding all else constant. The average daily gain for steers is 3.30 lb/day, so the average daily gain after the 1% increase is 3.33 lb/day. The average cost of gain is $53.12, so, if it decreases by 0.1789%, the new value is $53.02. For every 0.03 lb/day increase in average daily gain, a producer, on average, saves an extra $0.10/cwt on feeding costs.

Dry feed conversion has a positive and significant coefficient, although a positive coefficient results in an economically detrimental effect on cost of gain. When feed conversion (feed/gain) increases, a producer must feed the animal more feed to get a pound of gain, and the cost of gain will increase. For steers, a 1% increase in feed conversion results in a 0.5942% increase in cost of gain, holding all else constant. To put this in perspective, if you have a 1% increase in feed conversion, 6.23 pounds of feed per pound of gain on average would increase to 6.29 pounds of feed per pound of gain. Cost of gain will go from $53.12/cwt to $53.44/cwt. For the heifers, a 1% increase in feed conversion results in a 0.6605% increase in cost of gain, holding all else constant. The average feed conversion for heifers is 6.45 pounds of feed per pound of gain. With a 1% increase, this would increase to 6.52 pounds of feed per pound of gain. This increase will cause cost of gain to go from $55.72/cwt to $56.09/cwt. This could have a significant impact on the profitability of a feeding program. The aforementioned examples would result in additional costs of $1.38 per steer and $1.78 per heifer.

Results from Tables 1 and 2 reveal that that there is a trend in cost of gain for both heifers and steers. When interpreted for heifers, this means that each additional year results in a 0.6% increase in feeding cost of gain (0.05% monthly trend multiplied by 12). This is a significant trend, but the magnitude is relatively small. The steer trend coefficient is also relatively small and is interpreted as each additional year resulting in a 0.48% increase in feeding cost of gain (0.04% monthly trend multiplied by 12). Recognizing that this trend exists will help feeders make adjustments in their break-even calculations when considering cattle-feeding programs.

The results in Tables 1 and 2 indicate that death loss is significant in the steer regression and not significant in the heifer regression. Although the magnitude of death loss seems to be small in our model, keep in mind that a small percentage change in death loss could have a significant impact on feeding cost of gain.

Results reported in Tables 1 and 2 reveal little significant seasonality when it comes to cost of gain, only a few months are statistically different from the base month of January. For steer closeouts, the months of June and July are statistically significant, with cost of gain being less in these two closeout months than in January. The most likely reason the model showed little seasonality is the use of the base month January. When looking at Chart 1 and 2, it is easy to see that there is seasonality in the data. January is more in the middle of the data as far as cost of gain is concerned. If another base month were used, there is a possibility that more of the months would be statistically significant. It could also be true that seasonality in cost of gain is being captured in average daily gain, feed conversion, or possibly in the price of corn. This would explain why many seasonal dummies are not statistically significant. The variable Nev is significant, meaning that cost of gain for heifers was higher during the early-1993 closeout time period than during the average January.

Table 3 summarizes the comparison of steers and heifers (the difference model) with respect to cost of gain. The primary variable of interest in this study is the trend variable. Results indicate that there is a significant trend over time in the difference between steer and heifer cost of gain. The coefficient is negative, so the difference in cost of gain has been increasing over time. Multiplying the monthly trend elasticity reported in Table 3 (0.02%) by 12 months/year reveals that the difference between steer and heifer cost of gain has been growing by an average of 0.24% per year. Monthly dummy variables were also included. All of the dummy variables are negative, indicating that other months (and the early-1993 time period) have a greater difference between steer and heifer cost of gain than the average January closeout period does.

When a feeder is evaluating cost of gain, which directly affects profitability, a few factors stand out as important considerations. From this study, the important factors are the two variables with coefficients that are significant and fairly big in magnitude. The feeder must be cognizant of the price of feed grains, and feed conversion, because both could play a significant role in their cost of gain. The cost of gain of steers and heifers individually does not seem to be seasonal with our model (perhaps because of the use of January as the base month or the possibility that other variables in the models are already capturing the underlying seasonality). The difference between the cost of gain of steers and heifers does have a seasonal component, however, a consideration for those feeders faced with the choice of feeding steers or heifers.

Table 1. Estimated log-linear results for feeding cost of gain for steers

Independent Variable	Coefficient	Standard Error	P-statistic
Constant	2.1743	0.2850	<0.01
LnCORN[1]	0.5744	0.0388	<0.01
LnHAY	0.0683	0.0445	0.12
LnADG	-0.1789	0.0699	0.01
LnFCONV	0.5942	0.0758	<0.01
Time (month)	0.0004	0.0002	0.09
LnDL	0.0142	0.0055	0.01
February[2]	0.0032	0.0050	0.53
March	-0.0005	0.0070	0.95
April	-0.0081	0.0095	0.39
May	-0.0202	0.0106	0.06
June	-0.0229	0.0095	0.02
July	-0.0214	0.0085	0.01
August	-0.0036	0.0083	0.67
September	0.0074	0.0080	0.35
October	0.0098	0.0074	0.19
November	0.0013	0.0065	0.05
December	0.0083	0.0048	0.08
Nev	0.0237	0.0132	0.07
RHO	0.8716	0.0394	<0.01

[1]LnCORN = Natural log of weighted average of previous five months corn prices in dollars per bushel.
LnHAY = Natural log of weighted average of previous five months hay prices in dollars per ton.
LnADG = Natural log of average daily gain in pounds per day, at time t.
LnFCONV = Natural log of dry feed conversion in pounds of feed per pound of gain, at time t.
Time (month) = Monthly trend, with 1 representing the first month of the data sample.
February through December = monthly dummy variables.
Nev = dummy variable for the time period of January 1993 through June 1993.
RHO = Coefficient that is used to correct for autocorrelation.
[2]The “January” dummy variable cannot be included directly in the model for statistical purposes (perfect multicollinearity). Therefore, all results are interpreted relative to the base seasonal period, January closeouts.

Table 2. Estimated log-linear results for feeding cost of gain for heifers

Independent Variable	Coefficient	Standard Error	P-statistic
Constant	1.9074	0.2638	<0.01
LnCORN[1]	0.5440	0.0409	<0.01
LnHAY	0.0835	0.0474	0.08
LnADG	-0.0870	0.0603	0.15
LnFCONV	0.6605	0.0663	<0.01
Time (month)	0.0005	0.0002	0.04
LnDL	0.0075	0.0051	0.15
February[2]	0.0051	0.0048	0.29
March	0.0058	0.0072	0.42
April	0.0007	0.0092	0.94
May	-0.0037	0.0098	0.71
June	-0.0115	0.0091	0.21
July	-0.0130	0.0087	0.13
August	-0.0008	0.0083	0.92
September	0.0075	0.0080	0.35
October	0.0079	0.0073	0.28
November	0.0072	0.0064	0.25
December	0.0030	0.0048	0.54
Nev	0.0341	0.0136	0.01
RHO	0.8843	0.0375	<0.01

[1]LnCORN = Natural log of weighted average of previous five months corn prices in dollars per bushel.
LnHAY = Natural log of weighted average of previous five months hay prices in dollars per ton.
LnADG = Natural log of average daily gain in pounds per day, at time t.
LnFCONV = Natural log of dry feed conversion in pounds of feed per pound of gain, at time t.
Time (month) = Monthly trend, with 1 representing the first month of the data sample.
February through December = monthly dummy variables.
Nev = dummy variable for the time period of January 1993 through June 1993.
RHO = Coefficient that is used to correct for autocorrelation.
[2]The "January" dummy variable cannot be included directly in the model for statistical purposes (perfect multicollinearity). Therefore, all results are interpreted relative to the base seasonal period, January closeouts.

Table 3. Estimated log-linear results for feeding cost of gain (data for steers minus heifers)

Independent Variable	Coefficient	Standard Error	P-statistic
Constant	-0.0143	0.0061	0.02
Time (month)[1]	-0.0002	0.0000	<0.01
February[2]	-0.0018	0.0060	0.77
March	-0.0081	0.0067	0.23
April	-0.0109	0.0069	0.11
May	-0.0290	0.0069	<0.01
June	-0.3831	0.0069	<0.01
July	-0.0370	0.0068	<0.01
August	-0.0349	0.6823	<0.01
September	-0.0279	0.0068	<0.01
October	-0.0217	0.0068	<0.01
November	-0.0068	0.0066	0.30
December	-0.0023	0.0060	0.70
Nev	-0.0303	0.0099	<0.01
RHO	0.2438	0.0779	<0.01

[1]Time (month)= Monthly trend, with 1 representing the first month of the data sample.
February through December = monthly dummy variables.
Nev = dummy variable for the time period of January 1993 through June 1993.
RHO = Coefficient that is used to correct for autocorrelation.
[2]The "January" dummy variable cannot be included directly in the model for statistical purposes (perfect multicollinearity). Therefore, all results are interpreted relative to the base seasonal period, January closeouts.

Chart 1: Cost of Gain (Steers)

Source: *Focus on Feedlots*

Chart 2: Cost of Gain (Heifers)

Source: *Focus on Feedlots*

EXAMINING DEATH LOSS IN KANSAS FEEDLOTS

A. Babcock[1], R. Jones[1], and M. Langemeier[1]

Summary

This study had three primary objectives: 1) to determine if there is an annual and/or seasonal trend in percentage of death loss in Kansas feedlots; 2) to examine the difference in death loss between steers and heifers; and 3) to evaluate if "in" weight has had an effect on percentage of death loss in Kansas feedlots. The annual trend in death loss for both steers and heifers was found to be significant and positive, indicating that death loss has been increasing over the sample period. Seasonal increases in death loss were significant for early-spring closeouts for both steers and heifers. The annual trend in the difference between the death loss for steers and heifers, though not significant, was negative. There were, however, certain closeout months in which there were significant differences in the death loss of steers relative to heifers. Placement weight had a significant negative impact on death loss in heifer finishing, but no significant impact on steer finishing. Our regression analysis indicates that death loss has been increasing over the sample period, that certain closeout months tend to impact steer and heifer death loss differently, and that placement weight in heifers has had a significant impact on percentage of death loss in cattle.

Introduction

Percentage of death loss has a direct impact on the pounds of saleable product, and therefore on feed conversions, average daily gains, and cost of gain when calculated on a weight-in to weight-out basis. Therefore, on the surface it would seem that there would be an incentive to minimize death loss, and that, with changing technology, we could observe a decrease in death loss over time. After all, animal health products have improved significantly, from preventive medicine to treatments, over the past 10 years. Other costs associated with mortality have increased over time as well, with more emphasis on handling of animals, and increased costs associated with dead animal removal from the facility. Improvements in other performance measures may more than offset the cost of increased death loss, however, when pushing feeding performance to the limit. In this study we examined death loss for a sample of feedlots in Kansas. We wanted to determine if death loss had been increasing or decreasing over the past decade, if there were seasonal trends in death loss, and if there were differences between steers and heifers.

Procedures

Data for this study were obtained from Kansas State University, Department of Animal Sciences, *Focus on Feedlot* report that is published monthly, dating back to the early 1980s. For the purpose of this study, the 1992 to 2004 time frame was used. 1992 is the first year that the report included percentage of death loss, which is crucial data for our study.

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Over the study time period, the survey was based on a consistent sample of approximately eight feedlots from the cattle feeding region of Kansas. All numbers are reported at closeout, and include number of cattle, final weight, average days on feed, average daily gain, dry matter feed conversion, percentage of death loss, average cost per cwt of gain, projected cost of gain for replacement cattle, corn price, and alfalfa price. The reported figures are the mean of individual feedlot monthly averages. Corn and hay prices are the current inventory prices. The actual survey is conducted with each individual feedlot over the telephone. It is important to note that cause of death is not reported in the survey. The purpose of this study is to simply examine aggregate patterns in death loss over time. Cause of death is obviously an important issue, and would be a natural extension of this study for future research.

The analysis for this study was performed by estimating two generalized least squares regressions. The first regression model simply specified the natural log of the reported percentage of death loss (LnDL) as a function of a series of seasonal and time-period dummy variables (February, March, etc.), a monthly time trend (Trend), and the weight of the cattle when entering the feedlot (Placement weight).

The first regression model was applied to the data sets for both steers and heifers. From this regression analysis, three questions can be investigated. First, is the annual trend in percentage of death loss increasing? Second, is there a seasonal trend in percentage of death loss? Third, does placement weight have a significant impact on death loss in Kansas feedlots? The base month for the monthly dummy variable was January, which cannot be included in the regressions for statistical reasons. The interpretation of the results is then relative to January closeouts. In addition, an extra time period (Nev) was included as a seasonal dummy variable. This dummy variable represented the time period of January 1993 to June 1993, when there were abnormal weather conditions and many of the performance variables were more than two standard deviations from the mean. Previous studies have "dummied out" this same time period when examining feedlot performance.

The second regression model was formulated by subtracting the heifer death loss data for each observation (month) from the steer death loss data (LnSDL – LnHDL), and regressing it against the trend variable (Trend), along with the seasonal and time-period performance dummy variables (February, March, etc.). This model allowed us to determine if there has been a significant difference in death loss over time between steers and heifers.

Both models were corrected for significant autocorrelation by using the Cochrane-Orcutt method, thus dictating the need for the generalized least squares estimation technique.

Results and Discussion

Table 1 summarizes the results for steers. The coefficient for the trend variable is positive and significant, which means that death loss has been increasing since the start of the sample period. Each additional year results in a 0.0467% increase in death loss on average, holding all else constant (calculated by multiplying the coefficient, 0.0036, by the mean of the death loss data, 1.08, then multiplying this number by 12 months). Because the model is in log-linear form, the coefficient must be multiplied by the mean to obtain an elasticity measure. The placement weight coefficient is negative, but not significant for steers. Thus, placement weight does not significantly affect percentage of death loss in the feedlots examined. When interpreted as an elasticity, a 1% increase in placement weight is expected to result in only a 0.0096% decrease in death loss, holding all else constant. Again, this result is not significant. The results of this model suggest that there is a seasonal component to death loss in steer finishing. In addition to the model results, this seasonality can easily be observed by examining Figure 1, which displays percentage of death loss on a monthly basis. Compared with the base month of January, there are months that are statistically different. Closeout months in early fall have a lower percentage of death loss than January, whereas closeout months in early spring such as April and May have a higher percentage of death loss.

Table 2 summarizes the results for percentage of death loss in heifers. The coefficient for the trend variable is positive and significant. As with the steers, this means that death loss has been on the rise since the beginning of the sample period. Each additional year results in a 0.0672% increase in death loss on average, holding all else constant. The placement weight results for heifers are a much different story than for steers. Here, placement weight is again negative, but in this case is highly significant. A 1% increase in placement weight is expected to result in a 0.050% decrease in death loss, holding all else constant. When feeding heifers, feedlots must be concerned with placement weight because it has a significant impact on how many of those heifers the feedlot is expected to lose. Heifers also demonstrate some seasonality in percentage of death loss. Although heifers do not exhibit the same seasonality in the early-fall closeout months, they do tend to have increased death loss in late-spring closeout months. Another interesting result is that the dummy variable Nev, which represents that unusual weather pattern in 1993, had a positive significant impact on death loss for heifer finishing, which means that death loss during this period was greater than the average January. This effect was not significant for steer finishing.

Table 3 summarizes the comparison of steers and heifers (the difference model) regarding death loss. The main variable of interest in this regression is the trend variable. Results indicate that there is not a significant trend over time in the difference between steer and heifer death loss. The coefficient is negative, so the difference in percentage of death loss has been shrinking over time, but not significantly. Monthly dummy variables were also included. All of the dummy variables are negative, indicating that the other months (and the early 1993 time period) have a smaller difference between steer and heifer death loss than the average January closeout period.

This study illustrates that there has been a significant increase in feedlot death loss since January 1992, which is counter to preconceived notions, given improved technologies in the cattle feeding industry. This is an important finding that warrants additional research, in that we did not attempt to identify any causes of the increase in death loss over time. Several possible explanations come to mind. Perhaps feedlot cattle are being "pushed" harder now than in previous years, resulting in increased death loss. Perhaps there has been some slippage in the ability to identify and manage sick cattle. Perhaps the industry as a whole is better at keeping cattle alive in the pre-feedlot phases, resulting in higher death loss in the feedlot. We defer to future research to explore potential causes of the apparent increase in feedlot death loss over time. In addition to the trend result, we find that placement weight has a significant impact on death loss when feeding heifers, indicating that feedlot operators may need to be more cognizant of placement weight when making heifer placement decisions. There were seasonal trends in both models. The steers and heifers both had a seasonal trend in death loss (an increase) that revealed itself in spring closeouts, and steers displayed a seasonal decrease in death loss in early-fall closeouts.

Table 1. Estimated log-linear results for percentage of death loss in steers

Independent Variable	Coefficient	Standard Error	P-statistic	Elasticity
Constant	5.6938	6.2279	0.36	
Time (Month)[1]	0.0036	0.0011	<0.01	0.0467
Placement weight, lb	-0.8924	0.9351	0.34	-0.0096
February[2]	-0.1119	0.0770	0.15	
March	0.1249	0.1001	0.21	
April	0.2982	0.1316	0.02	
May	0.2768	0.1383	0.05	
June	0.1420	0.1282	0.27	
July	-0.0635	0.1182	0.59	
August	-0.2203	0.1145	0.05	
September	-0.3502	0.1162	<0.01	
October	-0.3156	0.1084	<0.01	
November	-0.3338	0.0999	<0.01	
December	-0.1286	0.0812	0.11	
Nev	0.0731	0.1908	0.70	
RHO	0.6042	0.0640	<0.01	

[1]Time (month) = Monthly trend, with 1 representing the first month of the data sample. Placement weight = Placement weight of cattle when entering the feedlot (lb). February through December = monthly dummy variables. Nev = dummy variable for the time period January 1993 through June 1993. RHO = Coefficient that is used to correct for autocorrelation.
[2]The "January" dummy variable cannot be included directly in the model for statistical purposes (perfect multicollinearity). Therefore, all results are interpreted relative to the base seasonal period, January closeouts.

Table 2. Estimated log-linear results for percentage of death loss in heifers

Independent Variable	Coefficient	Standard Error	P-statistic	Elasticity
Constant	28.2681	4.7715	<0.01	
Time (month)[1]	0.0049	0.0005	<0.01	0.0672
Placement weight, lb	-4.3916	0.7271	<0.01	-0.0500
February[2]	0.1468	0.0844	0.08	
March	0.2140	0.0963	0.03	
April	0.1696	0.1148	0.14	
May	0.2721	0.1153	0.02	
June	0.2256	0.1099	0.04	
July	0.1307	0.1015	0.20	
August	0.1117	0.0950	0.24	
September	0.0127	0.0935	0.89	
October	-0.0583	0.0935	0.53	
November	-0.0102	0.0916	0.91	
December	-0.0538	0.0852	0.53	
Nev	0.5661	0.1357	<0.01	
RHO	0.2116	0.0785	0.01	

[1]Time (month) = Monthly trend, with 1 representing the first month of the data sample. Placement weight = Placement weight of cattle when entering the feedlot (lb). February through December = monthly dummy variables. Nev = dummy variable for the time period of January 1993 through June 1993. RHO = Coefficient that is used to correct for autocorrelation.
[2]The "January" dummy variable cannot be included directly in the model for statistical purposes (perfect multicollinearity). Therefore, all results are interpreted relative to the base seasonal period, January closeouts.

Table 3. Estimated log-linear results for percentage of death loss (data for steers minus heifers)

Independent Variable	Coefficient	Standard Error	P-statistic
Constant	0.2629	0.0986	0.01
Time (month)[1]	-0.0006	0.0006	0.37
February[2]	-0.2797	0.1013	0.01
March	-0.2163	0.1118	0.05
April	-0.1906	0.1139	0.09
May	-0.3164	0.1144	0.01
June	-0.3516	0.1143	<0.01
July	-0.3889	0.1123	<0.01
August	-0.4271	0.1123	<0.01
September	-0.3618	0.1122	<0.01
October	-0.3116	0.1119	0.01
November	-0.3371	0.1100	<0.01
December	-0.1956	0.1008	0.05
Nev	-0.4253	0.1601	0.01
RHO	0.2108	0.0785	0.01

[1]Time (month) = Monthly trend with 1 representing the first month of the data sample. February through December = monthly dummy variables. Nev = dummy variable for the time period of January 1993 through June 1993. RHO = Coefficient that is used to correct for autocorrelation.
[2]The “January” dummy variable cannot be included directly in the model for statistical purposes (perfect multicollinearity). Therefore, all results are interpreted relative to the base seasonal period, January closeouts.

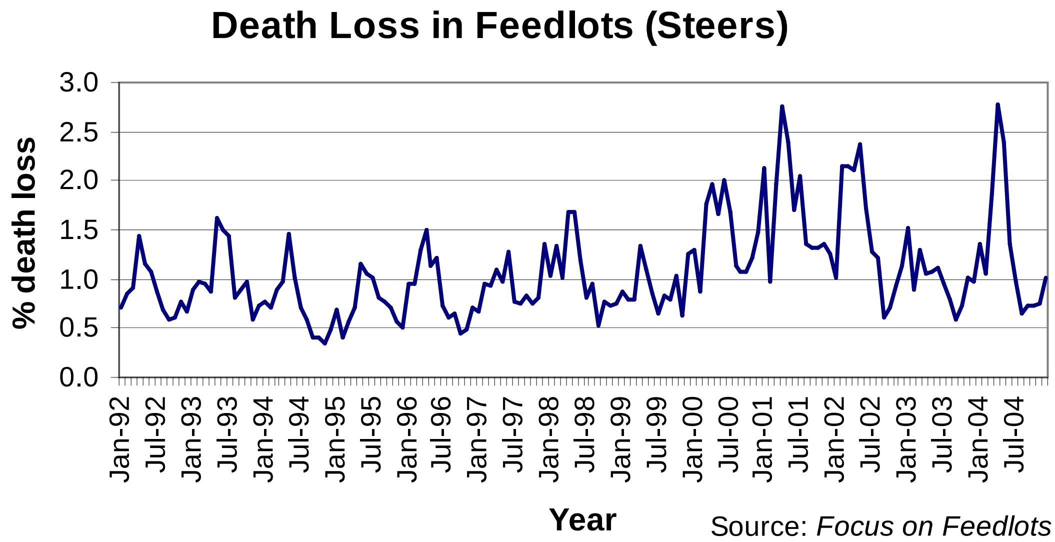

Table 1. Percentage of death loss in steers.

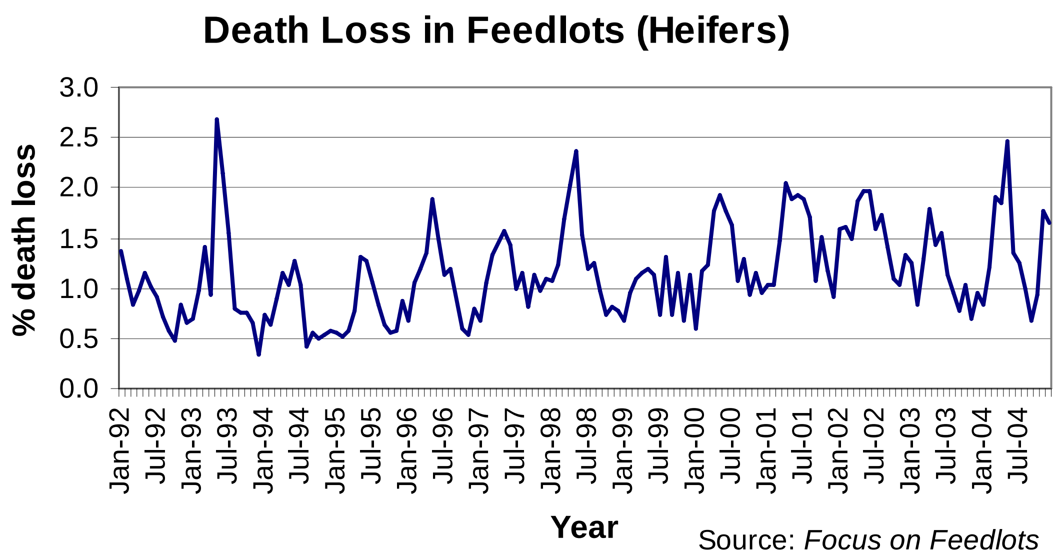

Table 2. Percentage of death loss in heifers.

MEASURING SCOPE EFFICIENCY FOR CROP AND BEEF FARMS

M. R. Langemeier[1] and R. D. Jones[1]

Summary

This study evaluated scope efficiency (the degree of efficiency gained from producing more than one product within the same farm) for a sample of crop and beef farms in Kansas. Scope and economic efficiency were estimated for each individual farm. Average scope efficiency was 0.25, indicating that joint production of crop and beef enterprises on the same farm reduced cost approximately 25%. Scope efficiency was significantly higher for smaller farms. Despite the relatively higher scope efficiency levels, economic efficiency (relative cost efficiency) was significantly lower for smaller farms. Economic efficiency is related to cost control and economies of size, which are both positively related to farm size.

Introduction

Both the percentage of income from livestock and the percentage of farms with livestock income in Kansas have declined over the last 30 years. Although this decline has occurred for beef, swine, and dairy, the percentage decline is not nearly as large for beef as it is for swine and dairy. Moreover, the majority of farms still have a beef enterprise. In 2003, approximately 51% of the farms in Kansas had a beef enterprise (Kansas Agricultural Statistical Service). The existence of economies of scope or scope efficiency for a combination of crop and beef enterprises would help explain the persistence of this farm type in the Great Plains. Scope efficiency exists when the total cost of producing two enterprises together on the same farm is less than the total cost of producing the enterprises on separate farms.

This study explores scope efficiency for crop and beef enterprises. There are three potential sources of scope efficiency. First, a farm may be able to more effectively utilize labor in winter months if they produce both crop and beef enterprises. Second, a farm may be able to more effectively utilize machinery and equipment if they produce both crop and beef enterprises. Third, beef enterprises can often utilize wheat pasture or crop aftermath with little or no loss in crop revenue. The use of these items would reduce the total cost of producing both enterprises, and would thus be associated with economies of scope.

Experimental Procedures

Scope and economic efficiency were estimated by using linear programming. Scope efficiency compares the cost of producing individual outputs separately with the cost of producing outputs jointly. If scope efficiency is greater than zero,

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there is an advantage associated with producing crop and beef enterprises on the same farm. Conversely, if scope efficiency is less than zero, there is a disadvantage associated with producing crop and beef enterprises on the same farm. Scope efficiency could lead to improvements in economic efficiency. Economic efficiency measures a farm's ability to produce at the lowest possible cost for a given level of output or on the cost frontier. Economic efficiency indices vary between zero and one, with one representing an economically efficient farm.

Scope and economic efficiency estimates were summarized for several farm-size categories. Specifically, three measures of farm size were used: gross farm income, total acres, and pounds of beef produced. Gross farm income categories included farms with a gross farm income less than $100,000, farms with a gross farm income between $100,000 and $250,000, farms with a gross farm income between $250,000 and $500,000, and farms with a gross farm income in excess of $500,000. The mean and standard deviation of total acres were used to categorize farms into three categories: farms with total acres more than one standard deviation below the mean, farms with total acres that are between one standard deviation below the mean and one standard deviation above the mean, and farms with total acres more than one standard deviation above the mean. The mean and standard deviation of pounds of beef produced were also used to categorize farms by size. The standard deviation of pounds of beef produced was larger than the average pounds of beef produced, so there were only two categories: farms with pounds of beef produced up to one standard deviation above the mean and farms with pounds of beef produced greater than one standard above the mean.

To determine whether scope efficiency by farm size category was significantly different from zero, t-tests were used. Tests were also conducted to determine whether scope and economic efficiency differed across farm size categories. On the basis of previous research, average scope efficiency was expected to be significantly different from zero, scope efficiency was expected to be inversely related to farm size, and economic efficiency was expected to be positively related to farm size.

Efficiency estimates were obtained by using a sample of farms that were members of the Kansas Farm Management Association. To be included in the analysis, a farm had to have continuous whole-farm data over the 1994 to 2003 period, and be typed as a dryland crop farm, as an irrigated crop farm, as a beef cow farm, or as a mixed crop/beef farm. Table 1 contains summary information for the sample of farms. Information is summarized for all of the farms with crop and/or beef enterprises, and for beef farms or farms that produced at least some beef. It is important to note that most of the beef farms also produced crop enterprises and received income from government payments, crop insurance, custom work, and/or patronage dividends (these sources of income are summarized in the output labeled "other"). It is also important to note that 10-year averages of the outputs, inputs, and input prices were used in the estimation of scope and economic efficiency. Using 10-year averages reduces the impact of weather in a particular year on scope efficiency.

Production costs were divided into three categories. Labor costs included unpaid operator and family labor and hired labor. Average family living expenses were multiplied by the number of operators on the farm to obtain an opportunity charge for unpaid operator and family labor. Purchased-input costs included feed, seed, fertilizer, veterinarian expenses, marketing expenses, herbicide and insecticide, and crop insurance. Capital costs included depreciation, repairs, fuel and utilities, machine hire, property taxes, general insurance, and an opportunity charge on assets. The opportunity charge on assets included opportunity charges for purchased inputs, current crop and livestock inventories, breeding livestock, machinery and equipment, buildings, and land.

Data for all of the sample farms were used to estimate scope and economic efficiency. To effectively measure scope efficiency, farms with various enterprise combinations are needed. Given the focus of this paper, scope efficiency results discussed later are presented only for the farms with a beef enterprise (i.e., beef farms).

Results and Discussion

The average scope efficiency index was 0.25, indicating that joint production of beef and crop enterprises on the same farm reduced cost approximately 25%. The average economic efficiency index was 0.7884, indicating that, on average, farms could reduce cost by approximately 21% by producing at the lowest possible cost for a given level of output or on the cost frontier.

Table 2 presents scope and economic efficiency indices by farm size category. Scope efficiency was significantly higher for smaller farms. Farms with a gross farm income less than $100,000 had an average scope efficiency index of 0.4873. In contrast, farms with a gross farm income between $250,000 and $500,000 had an average scope efficiency index of 0.1311, and farms with a gross farm income more than $500,000 had an average scope efficiency index of 0.1392. Similarly, farms with above-average total acres or beef output also had significantly lower scope efficiency indices, compared with indices of farms with below-average total acres or beef output. Smaller farms clearly have strong incentives to produce crop and beef enterprises on their farm. This result is intuitively plausible. Smaller farms often have higher labor and capital costs per unit of output. Producing both crop and beef enterprises allows smaller farms to spread these overhead costs over more output. As farms become larger, overhead cost per unit of output can be effectively reduced by expanding crop acres, if the farm is a crop farm, or by expanding livestock units, if the farm is a livestock farm.

Despite the relatively higher scope efficiency levels, economic efficiency was significantly lower for smaller farms. Thus, even though scope efficiency helps improve the relative competitive position of smaller farms, these farms still have considerably higher per-unit costs, on average. These higher costs could be the result of technical or allocative inefficiency. Technical inefficiency is related to technology adoption, whereas allocative efficiency is related to the mix of inputs used. Smaller farms typically have larger off-farm incomes, which may enable them to continue to produce even under a scenario in which they are relatively inefficient.

Although not shown in Table 2, many of the large farms had both crop and beef enterprises. Scope efficiency was relatively small for these farms, so there must be other reasons why the larger farms are diversifying. The larger farms may be diversifying to reduce risk and/or to gain multiproduct economies of scale. Investigating the reason the larger farms are diversifying is beyond the scope of this paper.

Given the results in this study, we would expect the crop/beef farm type to continue to be a common farm type. There are significant cost advantages associated with producing both crop and beef enterprises on the same farm. These cost advantages are particularly strong for smaller farms, which use diversification to reduce per-unit capital and labor costs.

Table 1. Summary statistics for a sample of crop and beef farms

Variable	Units	All Farms	Beef Farms
Number of farms		473	377
Outputs		-------- Mean (standard deviation) --------	
Small grains	bushels	16,279 (35,612)	15,617 (16,670)
Feed grains	bushels	31,187 (35,612)	27,410 (32,527)
Oilseeds	bushels	7,831 (11,082)	7,202 (10,608)
Hay and forage	tons	205 (412)	217 (419)
Beef	pounds	64,796 (109,817)	81,296 (117,447)
Other	dollars	47,227 (44,834)	45,396 (45,754)
Inputs			
Labor	number	1.39 (0.71)	1.42 (0.75)
Purchased inputs	implicit index	113,248 (102,936)	113,333 (107,358)
Capital	implicit index	125,151 (85,607)	124,525 (87,430)
Input prices			
Labor	dollars	34,028 (5,092)	33,711 (5,051)
Purchased inputs	index	1.0305 (0.0152)	1.0328 (0.0144)
Capital	index	1.0261 (0.0174)	1.0269 (0.0170)
Farm size			
Gross farm income	dollars	236,309 (181,548)	235,473 (187,485)
Total acres	number	1,833 (1,203)	1,930 (1,258)

Table 2. Scope and economic efficiency by farm size category

Farm Type	Number of Farms	Scope Efficiency	Economic Efficiency
Gross farm income			
Less than $100,000	79	0.4873*[a]	0.6804[a]
$100,000 to $250,000	170	0.2177*[b]	0.7796[b]
$250,000 to $500,000	101	0.1311*[c]	0.8547[c]
Greater than $500,000	27	0.1392*[c]	0.9124[d]
Total acres			
Less than 673	32	0.5280*[a]	0.6669[a]
673 to 3,188	293	0.2309*[b]	0.7859[b]
Greater than 3,188	52	0.1530*[c]	0.8775[c]
Beef output			
Less than 198,743 lb	341	0.2523*[a]	0.7745[a]
Greater than 198,743 lb	36	0.1792*[b]	0.9208[b]

*An asterisk indicates that the scope efficiency index was significantly different from zero at the 5% level.
[a,b,c]A different superscript within a column indicates that the indices are significantly different across size categories.

COMPARISON OF CIDR TO MGA IN A 7-11 COSYNCH PROTOCOL WITH TIMED INSEMINATION OF BEEF HEIFERS

D. R. Eborn, G. E. Freneau, and D. M. Grieger

Summary

Previous research has shown that the 7-11 Cosynch protocol using melengestrol acetate (MGA) is effective in synchronizing beef heifers. This study compared MGA and a vaginal insert containing progesterone (CIDR) in the 7-11 Cosynch protocol on beef heifers. Replacement beef heifers (n=179) from three herds were assigned to MGA or CIDR treatments. Beginning on day 1, heifers on the MGA treatment were fed to consume 0.5 mg daily of MGA for 7 days. On day 7, the last day of MGA feeding, the MGA heifers received an injection of Lutalyse[1] ($PGF_{2\alpha}$). Heifers on the CIDR treatment received a CIDR on day 3; on day 9 the CIDR was removed, and heifers received an injection of Lutalyse. On day 11, all heifers received an injection of OvaCyst[2] (gonadotrophin-releasing hormone; GnRH), followed by another injection of Lutalyse® 7 days later (day 18). At 48 hours after the final Lutalyse injection, all heifers were time inseminated and received an injection of OvaCyst. Pregnancy status was determined 33 days after breeding by ultrasonography. No difference in pregnancy rate was observed between the CIDR (46%) and MGA (47%) treatments.

Introduction

Artificial insemination offers several advantages, including improving genetics, shortening the calving season, and creating a more uniform calf crop, yet many beef producers have yet to embrace this technology. One possible explanation is that conception rates are not yet acceptable, given the time and cost involved. Time could be reduced by shortening the synchronization time and by more effectively synchronizing the estrous cycle and time of ovulation to yield greater conception rates to a timed artificial insemination.

Use of a progestin in synchronization protocols is desirable because it synchronizes the estrous cycle by extending the luteal phase and also induces cyclicity in anestrus or prepubertal females. The progestins most commonly used by beef producers are melengestrol acetate (MGA), given orally, and the Eazi-Breed CIDR[1], a vaginal insert containing progesterone. Gonadotrophin-releasing hormone (GnRH) is also regularly included in estrous synchronization to control timing of follicular waves and ovulation.

The most commonly used synchronization protocol for beef heifers consists of feeding MGA for 14 days, followed by heat detection and breeding 17 to 19 days later. More recently, protocols have been tested that shorten the time of progestin administration (7 vs. 14 days) and overall time to breeding (11 vs. 33 days). One example is the 7-11 Cosynch, which is composed of 7 days of MGA feeding,

[1]Lutalyse and Eazi-Breed CIDR are registered trademarks of Pharmacia Animal Health.
[2]OvaCyst is a registered trademark of Phoenix Scientific.

followed by the Cosynch protocol starting on day 11 (Figure 1).

We previously have reported acceptable conception rates from using MGA with the 7-11 Cosynch protocol. Here, we compare MGA and the CIDR as progestin sources in the 7-11 Cosynch protocol.

Experimental Procedures

Three groups of yearling heifers (n=179) from the Kansas State University Purebred Unit and the Cow-Calf Unit were used in this study. Heifers were blocked by weight (and breed for the purebred heifers) and assigned to one of two treatments: MGA or CIDR. Heifers in the MGA treatment (Figure 1) were group-fed 0.5 mg/heifer daily of MGA (Pharmacia Animal Health, Kalamazoo, MI) in a grain sorghum carrier, beginning on day 1. On the last day of MGA feeding (day 7), heifers were injected with Lutalyse (5 mL intramuscular). Heifers in the CIDR treatment (Figure 1) received an Eazi-Breed CIDR on day 3. On day 9, the CIDR was removed and heifers received an injection of Lutalyse. On day 11, heifers from both treatment groups received 2 mL (intramuscular) of OvaCyst. On day 18, all heifers received an injection of Lutalyse. Timed insemination followed 48 hours later, at which time heifers were injected with OvaCyst. Pregnancy status was determined by ultrasonography 33 days after insemination.

Results and Discussion

Overall, 84 of 179 (47%) heifers were pregnant. There were no treatment differences between MGA and CIDR in pregnancy rate; 42 of 89 (47%) for MGA and 42 of 90 (46%) for CIDR. These pregnancy rates were as much as 15 to 20% lower than in previous trials using the 7-11 Cosynch timed artificial insemination treatment with MGA. In this direct comparison of MGA and CIDR, however, there was no advantage of using a CIDR in place of MGA.

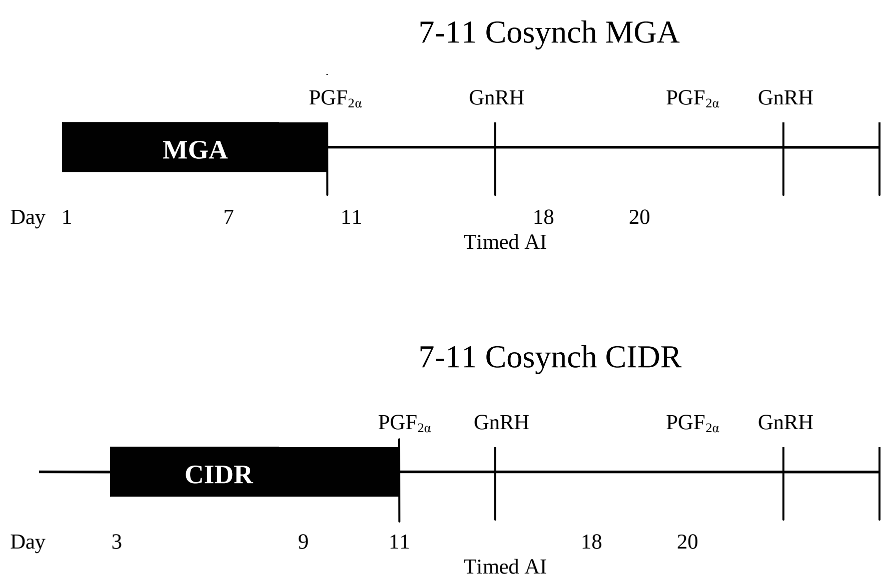

Figure 1. The 7-11 Cosynch protocols using either melengestrol acetate (MGA) or a vaginal insert containing progesterone CIDR as the progestin source. Prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) was provided as Lutalyse (5 mL, intramuscular). OvaCyst (2 mL, intramuscular) served as the source of gonadotrophin-releasing hormone (GnRH).

A NOVEL METHOD TO DRY AGE BEEF BY USING VACUUM PACKAGING

M. L. Ahnström*[1]*, M. Seyfert, M. C. Hunt, and D. E. Johnson

Summary

The traditional dry-aging method for beef was compared with a novel technique of dry aging in a highly moisture-permeable vacuum bag. Paired beef strip loins were cut into four sections and were dry aged traditionally (unpackaged) or packaged in the novel bag for 14 or 21 days. Cooking loss, tenderness, juiciness, and all flavor attributes were similar for the aging methods. Beef dry aged in the bag had less weight loss during aging, less trim loss after 21 days, and lower yeast counts after either aging time, compared with beef dry aged unpackaged. This novel method of dry aging beef in a vacuum bag can increase yields, decrease microbial contamination, and provide processors greater flexibility of facility use, all of which would positively impact processors' profits.

Introduction

Two basic methods of aging beef postmortem exist. Beef subprimals for retail and most food service outlets are aged in highly moisture-impermeable, vacuum-package bags, a process known as wet aging. A unique, high-end segment of the industry still ages unpackaged subprimal cuts in coolers tightly controlled for temperature, humidity, airflow, and air quality. This process is termed dry aging, and creates a highly prized product with superior aged flavor that is sold at a premium, compared with wet-aged beef.

Dry-aged beef experiences considerable surface drying and discoloration during aging. These areas must be trimmed before steak cutting and cooking. As a consequence, the yields associated with dry aging are lower than wet aging, resulting in an economic loss to the processor. Nonetheless, consumers have a definite preference for dry-aged beef, and willingly pay for the perceived improvement in quality and eating experience.

Technology has allowed for the development of vacuum-package bags that facilitate the efficient transfer of water vapor from the cut surface of meat. Thus, it may be feasible to dry-age beef in a vacuum package. This aging format has the potential to decrease surface desiccation and crusting, and permit dry aging of cuts in multi-use coolers, rather than having coolers dedicated solely to dry aging.

The objective of this experiment was to compare traditional, unpackaged, dry aging of beef strip loins with dry aging in a highly moisture-permeable vacuum bag.

Experimental Procedures

Six pairs of Certified Angus Beef ™ strip loins were obtained 2 days postmortem. Each pair of loins was divided into four total sections, and one of four treatments was assigned to each section within a loin pair: traditional dry aging or dry aging for 14 or 21 days in an experimental bag with a high water-vapor

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transmission rate (8000 grams H_2O/15μ/m²/24 hours at 100°F and 50% relative humidity). Loins were aged unpackaged on racks (traditional) or vacuum packaged in a bag in a 37ºF cooler with 87% relative humidity. Total aerobic bacteria, lactic acid bacteria, and yeast counts were determined before and after aging. Loin sections were weighed before and after aging and after trimming aged meat. Next, loin sections were cut into 1-inch-thick steaks for sensory analysis and cooking-loss determination. Sensory analysis was conducted at the KSU Sensory Analysis Center, where six panelists rated steaks cooked to a medium degree of doneness (internal temperature 160º F) for eight sensory attributes on a 15-point scale, where 0 = low intensity of the attribute and 15 = high intensity of the attribute.

Results and Discussion

Traditional and in-the-bag dry aging yielded similar results for tenderness, juiciness, and other measured flavor attributes (Table 1). All samples were of acceptable tenderness, juiciness, and flavor.

Aging method significantly impacted loin section yield. After 14 days of aging, weight and trim losses were similar between loins aged traditionally and in the bag; after 21 days, however, traditionally aged loins had greater weight loss and trim loss (Table 1). Further, dry aging for 21 days in the bag did not increase trim loss, compared with dry aging 14 days, but traditional dry aging did lead to greater trim loss at 21 days than at 14 days. Cooking loss was similar among treatments (Table 1). Overall, dry aging for 21 days in the bag will increase yields, decreasing the primary cost associated with dry aging.

Dry aging in the bag decreased yeast counts after both aging periods (Table 1). Counts of lactic acid bacteria decreased from 14 to 21 days of aging, possibly due to surface desiccation that occurred during aging, which reduced the amount of available water for microbial growth. No differences existed among treatments for total plate counts. The dry-aging technique using novel vacuum packaging will effectively decrease potential yeast load and be similar to traditional dry aging for total plate counts and lactic acid bacteria.

This study demonstrates that the novel vacuum-packaging bag can increase yields and decrease yeast counts, and could provide business management efficiencies without affecting the quality of dry-aged beef. Given consumers' preference for this uniquely flavored product and its greater value per pound, it is clear why many top-end processors practice dry aging. For those who wish to dry age beef, our research suggests that the novel method of dry aging increases the economic feasibility.

Table 1. Sensory attributes, yields, and microbial counts of beef strip loins and steaks

	Treatments[1]				
Trait	Dry 14	Bag 14	Dry 21	Bag 21	SEM[2]
Sensory traits[3]					
Tenderness	8.6	8.5	8.6	9.3	0.46
Juiciness	4.4	4.8	4.8	5.1	0.41
Aged-beef flavor	8.5	9.0	8.9	9.1	0.51
Beef flavor	9.8	9.8	9.5	9.7	0.48
Brown-roasted flavor	9.5	9.7	9.4	9.3	0.40
Bloody/serumy flavor	3.3	4.0	3.4	3.4	0.36
Metallic flavor	1.3	1.4	1.2	1.3	0.18
Astringent flavor	2.1[y]	2.1[y]	1.4[x]	1.2[x]	0.16
Yields, %					
Weight loss during aging[4]	6.5[x]	6.3[x]	10.2[z]	8.8[y]	0.42
Trim loss[5]	15.0[x]	15.3[x]	17.9[y]	15.6[x]	1.16
Cook loss[6]	23.5	22.7	22.9	23.7	1.33
Microbial counts, log CFU/gram					
Total plate	5.1	5.1	4.3	4.2	0.46
Lactic acid bacteria	5.5[x]	6.7[x]	2.7[y]	3.0[y]	0.76
Yeast	4.2[y]	2.4[x]	5.2[z]	4.2[y]	0.45

[1]Dry refers to traditional dry aging and bag refers to dry aging in a highly moisture-permeable vacuum bag for 14 or 21 days.
[2]Standard error of the mean.
[3]Evaluated on a 15-point scale, where 1 was the lowest intensity and 15 the greatest.
[4](Weight loss during aging ÷ weight before aging) × 100.
[5](Weight loss due to trimming ÷ untrimmed weight) × 100.
[6](Weight loss during cooking ÷ raw weight) × 100.
[x,y,z] Means having different superscript letters within a row differ ($P<0.05$).

COLOR OF COOKED GROUND BEEF PATTIES IS AFFECTED BY COOKING RATE AND POST-COOKING HOLDING TIME

S. M. Ryan, M. Seyfert, M. C. Hunt, and R. A. Mancini

Summary

Two experiments investigated the effects of cooking rate and post-cooking holding time on the internal cooked color of ground beef patties. In Experiment 1, patties were cooked rapidly (1.8ºF/second) or slowly (0.4ºF/second). At temperatures below 180ºF, rapidly cooked patties were redder and appeared less well done than those cooked slowly. All slowly cooked patties appeared well done, even at unsafe final internal temperatures. In Experiment 2, patties were cooked rapidly and held for 1, 3, 6, or 12 minutes after cooking. Increasing the post-cooking holding time to 6 minutes after rapid cooking decreased pinkness and maximized well-done appearance. This allowed ground beef patties to be cooked to a lower temperature, likely preserving juiciness and flavor. Employing either a slow cooking rate or rapid cooking with a post-cooking holding time will foster a well-done appearance. Internal cooked color is not an adequate indicator of ground beef doneness. Only strict temperature control and monitoring can ensure product safety.

Introduction

Due to risks associated with pathogenic bacteria, it is very important not to consume undercooked ground beef patties, but consumers may do so without realizing it. In fast-food restaurants, consumers often judge ground beef doneness by its color. Consumers frequently believe a brown internal color indicates that ground beef is fully cooked and safe to eat, whereas they think that a pink color means it has been undercooked and is unsafe to eat. Both assumptions may be wrong. Two occurrences cause this thinking to be unreliable and incorrect: persistent pinking and premature browning. Persistent pinking occurs when a pinkish internal color remains after patties have been cooked to a safe endpoint temperature, whereas premature browning occurs when ground beef patties appear well done when they have not been cooked to a safe endpoint temperature.

Internal cooked color is influenced by many factors, but two factors that have received little attention are cooking rate and post-cooking holding time. Fast-food restaurants use rapid cooking rates to cook ground beef, and frequently hold product after cooking for some time before consumption. The objective of our study was to examine the effects of cooking rate and post-cooking holding time on the internal color of ground beef.

Experimental Procedures

Ground beef patties, similar to those used in fast-food restaurants, were cooked by using one of two cooking devices: a flat surface grill (slow cooking, 0.4ºF/second) that required flipping during cooking or a double-sided, clam-shell grill (rapid cooking, 1.8ºF/second) that cooked both sides of the patty at once. Patties held after cooking were placed in a 220ºF warmer for the assigned holding time. In Experiment 1, ground beef patties were cooked rapidly or slowly to 1 of 5 internal temperatures (150, 160, 170, 180, or 190ºF). In Experiment 2, patties were cooked rapidly to 160, 170, or 180ºF and subsequently were held for 1, 3, 6, or 12 minutes.

Instrumental redness (a*) and visual color were evaluated on the interior of the patties after cooking. The following visual scale was used: 1 = raw red center, pink border, tan edge (medium rare); 2 = reddish-pink center, pink border, tan edge; 3 = slightly pink center, light brown to tan edge (medium); 4 = tan/brown center and edges, no evidence of pink; and 5 = dry, brown throughout (well done).

Results and Discussion

In Experiment 1, rapidly cooked patties were redder (greater a* values) than slow-cooked patties at all temperatures except 180ºF (Table 1). In general, increasing temperature had the predictable effect of decreasing interior redness (a* values), regardless of cooking rate. Visually, slowly cooked patties always appeared more well done than did rapidly cooked patties, except at 190ºF (Table 1). Rapidly cooked patties cooked to 170ºF or less remained slightly pink, whereas patties cooked rapidly to 180ºF and above appeared well done. All temperatures for slowly cooked patties resulted in a well-done appearance (visual score greater than 4.0). Thus, at 150ºF, slowly cooked patties appeared well done even though they had not reached temperatures ensuring safety. Patties cooked rapidly to 160 or 170ºF, although safe, might be rejected by consumers.

In Experiment 2, increasing the post-cooking holding time of ground beef patties decreased their redness and increased their well-done appearance (Table 2). As post-cooking holding time increased to 6 minutes, a minimum redness (a* values) was attained for patties cooked rapidly to 160 or 170ºF. After 12 minutes of holding time, patties from all temperatures were similar. A well-done appearance in rapidly cooked patties was attained by cooking to 170 or 180ºF and holding for 1 minute, or cooking to 160ºF and holding for 6 minutes.

These experiments reaffirmed that internal cooked color is not an adequate indicator of ground beef doneness. Consumers may reject patties rapidly cooked to 160 or 170ºF, with their slightly pink appearance, because of unfounded fears that they are undercooked and unsafe, although the patties are, in fact, safe to eat. To alleviate this concern, restaurants may overcook patties (to 180ºF or higher) to ensure a well-done appearance. This prolonged cooking may eliminate the undesirable pink color, but not without a loss of quality. The real concern comes when patties are slow cooked, because they will appear well done at temperatures below those ensuring safety (150ºF). Ironically, consumers might not question the safety of such patties on the basis of their appearance. For fast-food restaurants to maintain consumer acceptability and preserve eating quality, while maintaining safety standards and high-volume output, ground beef patties should be cooked to a minimum safe temperature (160ºF) and then subjected to a least a 6-minute post-cooking holding time.

Table 1. Internal cooked color traits of quarter-pound ground beef patties cooked rapidly (1.8ºF/second) or slowly (0.4ºF/second)

	Cooking	Internal Endpoint Temperature (ºF)					
Trait	Rate	150	160	170	180	190	SEM[1]
a* (redness)	Slow	10.5[bxy]	11.3[bx]	9.8[by]	10.7[axy]	8.3[bz]	0.62
	Rapid	18.5[aw]	14.7[ax]	12.6[ay]	11.6[ayz]	10.5[az]	
Visual color[2]	Slow	4.2[az]	5.0[ay]	5.0[ay]	5.0[ay]	5.0[ay]	0.17
	Rapid	2.5[bz]	3.1[by]	3.4[bx]	4.1[bw]	4.8[av]	

[1]Standard error of the mean.
[2]3 = slightly pink center, light brown to tan edge (medium appearance); 5 = dry, brown throughout (well-done appearance).
[a,b]Means having different superscript letters in a column within a trait differ (P<0.05).
[v,w,x,y,z]Means having different superscript letters in a row differ (P<0.05).

Table 2. Internal cooked color traits of quarter-pound ground beef patties cooked rapidly (1.8ºF/second) and held after cooking

	Hold Time	Internal Endpoint Temperature (ºF)			
Trait	(minutes)[1]	160	170	180	SEM[2]
a* (redness)	1	12.7[ax]	12.0[ay]	10.9[bz]	
	3	12.6[ay]	11.5[abz]	11.4[abz]	0.30
	6	11.5[by]	11.2[byz]	10.8[abz]	
	12	11.1[bz]	11.2[bz]	11.4[az]	
Visual color[3]	1	3.6[az]	4.0[ay]	4.9[ax]	
	3	3.4[az]	4.1[ay]	4.9[ax]	0.11
	6	4.0[bz]	4.3[by]	4.9[ax]	
	12	4.2[bz]	4.3[bz]	4.9[ay]	

[1]Time (minutes) patties were held at 220ºF after rapid cooking.
[2]Standard error of the mean.
[3]3 = slightly pink center, light brown to tan edge (medium appearance); 5 = dry, brown throughout (well-done appearance).
[a,b]Means having different superscript letters in a column within a trait differ (P<0.05).
[x,y,z] Means having different superscripts in a row differ (P<0.05).

ACCELERATED AND "NATURAL" PRODUCTION-SYSTEM EFFECTS ON PERFORMANCE AND CARCASS TRAITS

L. Veloso, J. A. Unruh, and E. Loe

Summary

Sixteen crossbred steers were used to compare performance and carcass characteristics of animals from accelerated and "natural" cattle production systems. Steers in the accelerated group (8 head) were implanted with Component[1] TE-S (120 mg of trenbolone acetate, 24 mg estradiol), and received 200 mg/steer daily of ractopamine-HCl (Optaflexx[2]) during the last 33 days of feeding. Tylan[2] and Rumensin[2] were also fed to the accelerated group. "Natural" steers were not implanted and were not given feed additives. Steers in the accelerated group had improved gain; heavier final weights; heavier carcasses; larger ribeye areas; and less kidney, pelvic, and heart fat. "Natural" cattle had better quality grades, but would require a $3/cwt carcass premium to offset the performance advantages of accelerated cattle.

Introduction

Changing consumer attitudes and concerns about production-enhancing compounds has led to an increasing demand for "natural" beef. The term "natural" often refers to animals fed a vegetarian diet, and produced without antibiotics, metabolism modifiers, or implants.

Our study was part of a course (ASI 315, Livestock and Meat Evaluation) that related live cattle characteristics to carcass traits, and demonstrated the effects of some available production modifiers on production and carcass characteristics.

Procedures

Sixteen steers were backgrounded on flint hills pasture for 163 days and divided into two pens (accelerated and "natural") on the basis of their pasture average daily gain and ending body weight. The ending pasture weight and gain of cattle assigned to the accelerated treatment were 801 lb and 1.29 lb/day, whereas those for the "natural" treatment were 801 lb and 1.30 lb/day. After 16 days of feeding, the trial was initiated by implanting the accelerated group with Component TE-S (120 mg of trenbolone acetate, 24 mg estradiol) and feeding Rumensin and Tylan for the entire feeding period. The "natural" group received no additives or implants. After 72 days on feed, steers in the two pens were separated into six pens (3 pens per treatment). Pens were assigned by weight at entry to the feedlot. Steers in the heaviest pen (2 steers/pen) for each treatment were harvested after 106 days on feed, steers in the second-heaviest pen (3 steers/pen) were harvested after 113 days on

[1]Component is a registered trademark of Ivy Animal Health, Overland Park, KS.

[2]Optaflexx, Tylan, and Rumensin are registered trademarks of Elanco Animal Health, Indianapolis, IN.

feed, and steers in the lightest pen for each treatment (3 steers/pen) were harvested after 120 days on feed. Weekly harvest facilitated class evaluation of live animals and their corresponding carcasses. During the last 33 days of the feeding period, the accelerated pens were fed 200 mg/steer of ractopamine-HCl (Optaflexx).

Cattle were harvested in the KSU Meat Science Laboratory after quality grade, yield grade, and price/cwt of the live cattle were evaluated in class. Carcass cutability and quality characteristics were evaluated at 24 hours postmortem. A one-inch ribeye (longissimus) steak was removed from the 12th rib, vacuum packaged, and aged until 14 days postmortem. Steaks were cooked to 160°F internal temperature according to thermocouples placed in the center of the steak, and were evaluated for cooking loss and Warner-Bratzler shear force.

Results and Discussion

Few statistical differences were observed between the accelerated and the “natural” cattle, likely because of the limited number of experimental units.

During the last 33 days on feed, accelerated cattle (fed Optaflexx) had greater daily gains and were more efficient in converting feed into gain than “natural” cattle were (Table 1). Although not statistically significant, daily gain seemed greater during the first 72 days on feed for accelerated cattle (implanted and fed with Rumensin and Tylan). Over the entire feedlot period, accelerated cattle had greater daily gains and gained 68 lb more than did “natural” cattle.

For carcass traits, only carcass maturity was statistically different (Table 2). Accelerated cattle had higher maturity scores due principally to the very aggressive implant used in the study. Carcasses from accelerated cattle were numerically 25 lb heavier and contained ribeye areas numerically 1 square inch larger than those from “natural” cattle. As a result, accelerated cattle had greater cutability (numerically lower yield grade numbers) despite having similar fat thickness, compared with that of “natural” cattle. The “natural” cattle had numerical advantages in quality as indicated by more marbling, resulting in a greater percentage that graded Choice, and lower Warner-Bratzler shear force values.

On the basis of USDA average premiums and discounts reported on February 21, 2005, accelerated cattle had $23.81 more carcass value than “natural” cattle had (Table 3). After subtracting costs, accelerated cattle had $24.46 greater return. As a result, a $3/cwt carcass premium would be needed for the “natural” cattle to offset the performance advantages of the accelerated cattle.

Overall, the accelerated cattle had improved gains while consuming similar amounts of feed, compared with performance of “natural” cattle. As a result, accelerated cattle had heavier final live weights and carcass weights. They also had carcasses with greater cutability, resulting from larger ribeye areas and less kidney, pelvic, and heart fat. “Natural” cattle had higher quality grades, but would require a $3/cwt carcass premium to offset the advantages in performance from accelerated cattle.

Table 1. Accelerated and "natural" production-system effects on feedlot performance

Item	Accelerated	Natural	SEM	P-value
Number of cattle	8	8	---	---
Weight, lb				
Initial	855	871	25	0.52
At 72 days	1250	1232	37	0.64
At slaughter	1400	1350	42	0.24
Feedlot weight gain[1]	548	480	33	0.07
Daily gain, lb/day				
Days 1 to 72	5.4	5.0	0.37	0.22
Optaflexx[2]	4.3	3.0	0.21	<0.01
Day 1 to slaughter[1]	4.8	4.2	0.28	0.07
Dry matter intake, lb/day				
Days 1 to 72	23.1	23.8	---	---
Optaflexx[2]	24.3	24.5	1.96	0.89
Day 1 to slaughter[1]	26.8	27.4	---	---
Feed:gain				
Days 1 to 72 days	4.5	5.0	---	---
Optaflexx[2]	5.8	8.6	0.56	0.03
Day 1 to slaughter[1]	5.5	6.5	---	---

[1]Cattle were fed in an accelerated or natural treatment for 72 days. Cattle were then divided into three pens per treatment, and accelerated cattle were fed Optaflexx for the last 33 days on feed. Cattle were slaughtered after 106, 113 or 120 days on feed.
[2]Final 33 days on feed.

Table 2. Accelerated and "natural" production-system effects on carcass characteristics and Warner-Bratzler shear force (WBSF)

Item	Accelerated	Natural	SEM	P-value
Number of cattle	8	8	---	---
Hot carcass weight, lb	842	817	25	0.33
Dressing percentage	60.5	60.9	1.0	0.24
Fat thickness, inches	0.36	0.38	0.05	0.67
Ribeye area, square inches	16.1	15.1	0.95	0.36
Kidney, pelvic, and heart fat, %	1.6	2.0	0.19	0.07
Yield grade	1.8	2.2	0.42	0.40
Maturity	A-71	A-60	3.2	<0.01
Marbling[1]	356	396	37	0.30
Quality grade[2]	248	278	26.4	0.36
Choice, %	12.5	50.0	---	---
Cook weight loss, %[3]	18.9	17.5	1.6	0.38
WBSF, kg	4.0	3.7	0.28	0.32
Ribeye color score[4]	3.42	3.29	0.43	0.77
L*	44.1	45.0	2.2	0.70
a*	32.0	33.0	0.70	0.22
b*	24.8	25.7	0.76	0.27
Hue angle	37.73	37.96	0.35	0.52
Saturation index	40.5	41.8	1.0	0.23

[1]Slight = 300, small = 400.
[2]Select = 200, Choice = 300.
[3]Cooking loss = (raw sample weight – cooked sample weight) / 100.
[4]Ribeye color was evaluated at 24 hours postmortem.

Table 3. Financial comparison of accelerated and "natural" production systems

Item	Accelerated	Natural	Difference[1]
Number of cattle	8	8	---
Carcass value, $/steer[2]	1182.87	1159.06	–23.81
Purchase cost, $/steer[3]	898.02	915.04	+17.02
Processing cost, $/steer	10.50	7.60	–2.90
Feed costs, $/steer	262.98	249.51	–13.47
Yardage, $/steer	28.50	28.50	0.00
Net return, %	–17.13	–41.59	–24.46

[1]"natural" - accelerated.
[2]Carcass price was derived from USDA average premiums and discounts reported on February 21, 2005. (www.ams.usda.gov/mnreports/lm_ctlss.txt) Base Choice carcass price was $142.85/cwt, with average Choice (+$0.69), Select (-$4.88), Yield grade 1.0-1.9 (+$2.85), Yield grade 2.0-2.4 (+$1.63), Yield grade 2.5-2.9 (+$1.21), Yield grade 3.0-3.4 (-$0.08), and carcass weights 900-950 (-$0.58) premiums and discounts.
[3]Purchase price was $106.40/cwt.

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<0.05." That means the probability that the observed difference was due to chance is less than 5%. If two averages are said to be "significantly different," the probability is less than 5% that the difference is due to chance, and 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 ± 0.1. The 2.5 is the average; 0.1 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.

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