1995

1995 South Dakota Beef Report

Department of Animal and Range Sciences, South Dakota State University

Agricultural Experiment Station, South Dakota State University

Cooperative Extension Service, South Dakota State University

Department of Animal and Range Sciences

1995 South Dakota BEEF REPORT

Agricultural Experiment Station
Cooperative Extension Service
South Dakota State University

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SDSU

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SDSU

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September 1995

Dear Beef Producer:

It's hard to believe it is already time for the 1995 Beef Report. The years keep getting shorter it seems. As usual, this Beef Report gives you a good overview of the many areas of research in which we are involved that affect beef production in South Dakota and the region.

Nutrition research on by-product, nonconventional feeds, and range utilization has been studied over the past couple of years. Feed and animal management continue to be an important research area for our scientists. We also have active research programs in reproductive management and meat science. This year you will also find articles on environmental issues, economics and marketing, and disease management.

South Dakota State University research covers a wide spectrum. Our faculty bring together the latest information from our own research as well as other pertinent information from other universities in order to better serve the beef industry of South Dakota.

Remember this is your Land Grant University and we need to hear from you. Let us know your questions and the types of things you would like to see us doing.

Sincerely,

James R. Males
Head, Department of Animal and Range Sciences

mjt

South Dakota
State University
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SERVICE

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Dear Beef Cattle Industry Friends:

Thank you for examining the 1995 South Dakota Beef Report. This report summarizes beef cattle related research for the past year at South Dakota State University. We hope you find the information interesting and useful in your farming, ranching, or agribusiness operation.

Most industry analysts agree that we are one to two years away from a peak in beef production across the United States. This suggests that downward pressure on prices will likely continue for a couple of more years. At South Dakota State University, we fully understand how closely South Dakota's economy is tied to the cattle markets. During these difficult times, I urge you to pursue knowledge. Difficult times provide opportunities. Knowledge prepares people to take advantage of their opportunities.

Some of the "knowledge" presented in this Beef Report can immediately be applied to your farming, ranching, or business situations. Other "knowledge" in this report may be applicable at a later date. In either case, the goal of our beef cattle extension, research, and teaching programs is to improve the efficiency of beef production leading to an increase in the quality of life for all South Dakotans.

I hope to see many of you at meetings and programs throughout the state. Please feel free to contact me with your questions and comments.

Sincerelv,

John J. Wagner
Extension Ruminant Nutrition Specialist

mjt

Creating Opportunities for a Lifetime

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Interpreting Experimental Results

Donald M. Marshall[1]
Department of Animal and Range Sciences

CATTLE 95-1

A typical experimental format involves evaluating the response caused by application of different treatments to experimental subjects (animals, carcasses, pens, pastures, etc.). The effect of a given treatment might be evaluated by comparison to a control group or to one or more other treatment groups. However, a problem with animal research (and other types as well) is that variation not due to treatments often exists among experimental subjects.

For example, suppose that animals receiving ration A grow faster than animals receiving ration B. Was the observed difference in growth rates actually due to differences in the rations or to other factors (i.e., genetics, age, sex, etc.) or some of each? Statistical analyses evaluate the amount of variation between treatment groups relative to the amount of variation within treatment groups. In addition, variation caused by factors other than treatments can sometimes be eliminated by the statistical analysis.

The statement "the difference was statistically significant (P = .05)" indicates the probability of a difference of that magnitude occurring from chance rather than from the research treatment is about 5%.

A correlation coefficient provides an indication of the relationship between two factors and can range from -1 to +1. A strong, positive correlation (close to 1) indicates that as one factor increases the other factor tends to increase, also. For example, several studies have shown a positive correlation between cow milk yield and calf weaning weight. A strong negative correlation (close to -1) indicates that as one factor increases the other factor tends to decrease. A correlation near zero indicates the two factors are unrelated.

Several of the reports in this publication refer to least squares means. In balanced experimental designs, least squares means are often the same as the simple raw means. However, when numbers of experimental subjects are not evenly distributed across treatments, adjustments to the means are needed. Appropriate adjustments are made by least squares procedures. In addition, least squares means are sometimes adjusted for extraneous sources of variation through a so-called analysis of variance.

Means (averages), correlations and other statistics presented in research results are sometimes followed by ± some figure known as the standard error. The standard error provides an indication of the possible error with which the statistic was measured. The size of the standard error of a treatment mean depends on the animal to animal variation within a treatment group and on the number of animals in the group.

All other factors being equal, the greater the number of animals and(or) replications per treatment, the smaller the difference required to achieve a given value for probability of significance. Stated another way, increasing the number of animals or replications increases the likelihood of detecting differences due to treatments when such differences do indeed exist.

Several of the research reports in this publication contain statistical terminology. Although such terms might be unfamiliar to some readers, the statistical analyses allow for more appropriate interpretation of results and make the reports more useful.

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[1]Professor.

SDSU Beef Cattle Teaching Herd

R.J. Pruitt[1]
Department of Animal and Range Sciences

CATTLE 95-2

A herd of Angus, Simmental and Simmental-Angus crossbreds are maintained at the Cow-Calf Teaching and Research Unit near the SDSU campus. Cattle are used for teaching, research, and extension activities. In addition to use in the classroom, cattle are used for the annual SDSU Little International, field days, and numerous 4-H, FFA, and other educational events. The herd is also used for reproductive physiology and cow/calf nutrition research.

For teaching purposes, cattle that vary in calving ease, growth rate, mature size, and maternal value are maintained. Although it is not feasible to maintain all of the breeds that are important in this region, two breeds that are distinctly different are represented. The goal for our breeding program is to produce bulls that are useful to the commercial beef industry that fit into the following four categories:

1. Low birth weight Angus bulls to breed to yearling heifers.
2. Higher growth Angus bulls to breed to cows.
3. High percentage Simmental bulls to breed to cows in a rotational crossbreeding system.
4. Simmental-Angus crossbred bulls (F_1 composites) to use in a simplified crossbreeding system to maintain the percentage Simmental and Angus close to 50% each.

The objective goals for the bulls produced are presented in the Tables 1 and 2. AI sires are selected to produce bulls that fit these objective goals and still produce females without problems (bad udders, feet and leg problems, etc.) that are reasonable in mature size and will maintain their body condition and reproduce in an nutritional environment similar to commercial herds in this area. A majority of the yearling heifers are bred and kept as replacements. This allows us to cull the cow herd closely for problems that require extra management.

Table 1. Goals for Angus bulls produced

	Low birth wt bulls	Higher growth bulls
Birth wt EPD	< +2	< +6
Weaning wt EPD	> +25	> +30
Milk EPD	> +10	> +10
Yearling wt EPD	> +50	> +60
Frame score	5 to 6	6
Yearling scrotal circumference	> 34 cm	>34 cm

Table 2. Goals for Simmental and SimAngus bulls produced

Calving ease EPD	>0
Birth wt EPD	<0
Weaning wt EPD	> +5
Yearling wt EPD	> +10
Maternal calving ease EPD	>0
Milk EPD	>-2
Frame score	6 to 7
Yearling scrotal circumference	>34 cm

Tables 3 and 4 show carcass information from steers sired by bulls bred at the Cow-Calf Unit. The steers were raised at the SDSU Cottonwood Research Station west of Philip, SD, and fed in a commercial feedyard. For the last two years, 14 head of steers sired by SDSU

[1]Associate Professor.

bulls fed in the South Dakota Retained Ownership Demonstration at Kimball have averaged $38.30/head more profit than the average steer on test. It is encouraging that we can select for a balance of traits, emphasize functional traits for the cow herd, and still produce cattle that are profitable for the feedlot industry.

Table 3. Steers sired by Angus and Simmental bulls from the SDSU Cow/Calf Unit

Number of steers	48
Avg % Angus/Simmental	77/23
Birth date	April 7
Days on feed	200
Final wt, lb	1170
Slaughter date	May 6
Age at slaughter, days	394
Carcass wt, lb	706
Rib eye area, $in.^2$	12.3
12th rib fat, in.	.40
Yield grade	2.70
Percent choice	77.1

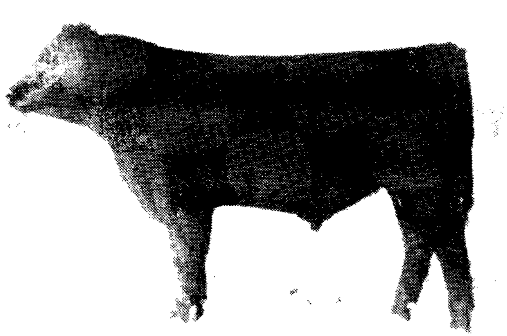
Table 4. Distribution of quality and yield grades

	Quality grade		
Yield grade	Percent Choice	Percent Select	Percent Standard
1	4.2	2.1	—
2	47.9	14.6	2.1
3	25.0	4.2	—
Total	77.1	20.8	2.1

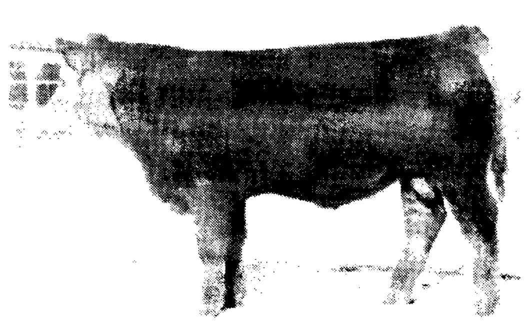
In mid-April bulls and heifers from the Cow/Calf Unit are sold in a "limited auction" managed by the SDSU Seedstock Merchandising Class. The class is responsible for advertising, promoting, organizing, and conducting the sale. A major objective in organizing the sale is to provide students an opportunity to learn about the industry by interacting with beef cattle producers about the cattle that sell. The prices for our 1995 sale are listed in Table 5. If you would like to be included on our mailing list, contact Kevin VanderWal (Unit Manager), Jarrod Johnson (Assistant Manager), or Dick Pruitt (faculty coordinator).

Table 5. Final bids for 1995 SDSU Limited Auction Bull and Heifer Sale

	Number	Average, $	Range, $
Angus bulls	14	2357	1200-4900
Purebred Simmental bulls	3	2000	1200-3600
SimAngus bulls	6	1333	1200-1600
SimAngus yearling heifers	11	800	650-1050



Top selling Angus bull in 1995 SDSU Limited Auction Sale



Top selling Simmental bull in 1995 SDSU Limited Auction Sale

Evaluation of Wheat Middlings as a Supplement for Beef Cows Grazing Native Winter Range

J.S. Heldt,[1] R.J. Pruitt,[2] R.H. Haigh,[3] and D.B. Young[4]
Department of Animal and Range Sciences

CATTLE 95-3

Summary

Two winter grazing trials were conducted at the SDSU Cottonwood Research Station near Cottonwood, SD, to compare wheat middlings to soybean meal and corn-soybean meal supplements. In consecutive years, grazing trials from December to February were conducted using Simmental x Angus crossbred cows grazing two pastures with differing amounts of available forage and fed four supplemental treatments that were balanced to provide the following amounts of crude protein (lb) and metabolizable energy (Mcal) per cow daily: 1) soybean meal .75 and 2.40, 2) low wheat middlings .75 and 4.76, 3) corn-soybean meal 1.50 and 9.40, and 4) high wheat middlings 1.50 and 9.40. Cows grazing the high available forage pasture gained 53 lb more than those grazing the low available forage pasture. The supplement x pasture interaction indicates that level of available forage affects response to the supplemental treatment. When available forage was low, wheat middlings was a less effective source of supplemental protein than soybean meal. When available forage was high, soybean meal and the low wheat middlings supplements resulted in similar cow weight gains. Regardless of forage availability, the high wheat middlings supplement was a less effective source of supplemental energy compared to the corn-soybean meal supplement balanced to provide equal protein and energy. The supplement x year interaction resulted from soybean meal being more beneficial than low wheat middlings in year 1 while in year 2, soybean meal and low wheat middlings resulted in similar cow performance.

Key Words: Beef Cows, Winter Range, Available Forage, Wheat Middlings, Supplement

Introduction

Previous studies at the SDSU Cottonwood Research Station demonstrated the importance of adequate cow body condition at calving and prior to the breeding season for high reproductive performance. Supplementation of cows grazing mature, low protein forage can be used to maintain adequate body condition by minimizing cow weight loss in the winter.

Protein is typically the first limiting nutrient for cows grazing native winter range pastures. The use of all natural high protein supplements has been shown to improve cow weight change during the winter grazing period by improving forage intake and digestibility. Previous research at the Cottonwood Station confirms that protein should be the first consideration. Additional supplemental energy may be beneficial only after protein needs are met.

The use of grain which is high in starch can be detrimental to cow performance due to a reduction in intake and digestibility of the base forage. Previous research at the Cottonwood station indicates that grain supplements are more likely to be beneficial when there is abundant forage to graze or when additional protein is provided with the grain supplement. Lower starch by-product feeds, such as wheat middlings, soybean hulls, brewers grains, and sugar beet pulp have the potential to increase energy consumption without the detrimental effects of the starch in grains.

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[1]Graduate Assistant.
[2]Associate Professor.
[3]Superintendent, SDSU Cottonwood Research Station.
[4]Ag Research Technician, SDSU Cottonwood Research Station.

This study was conducted to compare wheat middlings to soybean meal and corn-soybean meal supplements on the performance of beef cows grazing native winter range with two levels of forage availability.

Materials and Methods

Two winter grazing trials using 122 (year 1) and 127 (year 2) pregnant Simmental x Angus crossbred cows grazing native winter range were conducted at the SDSU Cottonwood Research Station. Cows were allotted by age and weight to four supplemental treatments (Table 1) and grazed on pastures with either high or low available forage from December to February. A soybean meal supplement was used as a base to provide .75 lb crude protein per cow daily. A low wheat middlings supplement was balanced to provide the same amount of protein daily. A high wheat middlings supplement was balanced to provide twice the amount of energy as the low wheat middlings supplement. A corn-soybean meal supplement was balanced to provide the same amount of protein and energy as the high wheat middlings supplement. Supplements were pelleted (3/16 in. diameter) and balanced to exceed NRC (1984) requirements for phosphorus and potassium (Table 2).

Table 1. Supplemental treatments[a]

Item	Supplement			
	Soybean meal	Low wheat middlings	Corn-soybean meal	High wheat middlings
Ingredients (years 1 and 2)				
Soybean meal	88.62	—	32.20	—
Corn	—	—	64.68	—
Wheat middlings	—	97.83	—	97.83
Beet molasses	2.24	2.17	2.21	2.17
Dicalcium phosphate	9.14	—	.91	—
Composition year 1				
Dry matter	87.77	87.92	86.44	86.40
Crude protein	44.34	18.30	23.74	18.23
Starch	7.90	18.17	45.48	18.17
Ether extract	.43	3.40	1.33	3.40
Neutral detergent fiber	7.82	37.81	10.50	38.19
Acid detergent fiber	5.29	11.75	4.35	11.60
Composition year 2				
Dry matter	89.41	85.78	86.29	85.78
Crude protein	47.62	16.72	21.86	16.72
Starch	7.53	37.03	63.37	37.03
Ether extract	.71	4.07	2.61	4.07
Neutral detergent fiber	8.27	36.89	8.58	36.89
Acid detergent fiber	5.67	11.90	4.67	11.90

[a]Percentage on a dry matter basis.

Table 2. Composition of daily supplemental intake per cow[a]

Item	Supplement			
	Soybean meal	Low wheat middlings	Corn-soybean meal	High wheat middlings
		Year 1		
Dry matter, lb	1.90	4.19	6.44	8.36
Metabolizable energy, Mcal/lb	2.36	5.43	9.19	10.84
Crude protein, lb	.84	.77	1.52	1.52
Starch, lb	.15	.76	2.93	1.52
Phosphorus, lb	.014	.046	.053	.092
Potassium, lb	.040	.056	.071	.099
		Year 2		
Dry matter, lb	1.92	4.08	6.44	8.29
Metabolizable energy, Mcal/lb	2.42	5.29	9.19	10.75
Crude protein, lb	.90	.68	1.41	1.39
Starch, lb	.14	1.51	4.08	3.07
Phosphorus, lb	.047	.039	.045	.080
Potassium, lb	.041	.051	.071	.103

[a]ME values are calculated from NRC (1984) feed tables. Other values are based on chemical analysis.

Two pastures used in the study were predominately western wheatgrass. The low available forage pasture (270 acres) was grazed for 5,575 (year 1) and 5,375 (year 2) animal unit days prior to the start of the trial to create differences in available forage. The high available forage pasture 351 acres (year 1) and 270 acres (year 2) had not been grazed since the previous April in both years.

From early December to early February, cows were gathered every morning, sorted into treatment groups, and bunk fed their respective supplements. At the beginning and end of the trials, cows were weighed in the morning on two consecutive days after overnight removal from feed and water. At the end of the supplemental feeding periods, cows were grazed on a common pasture without supplementation for four days to equalize fill. Initial and final cow weights were the average of the two consecutive weights. Condition scores (1 to 9, 1 = extremely emaciated) were assigned by two technicians at the beginning and end of the trials. On the second weigh day at the beginning and end of the trials subcutaneous fat was measured at the twelfth rib with an Aloka 500V ultrasound system using a 5 MHz, 5.8 cm probe. Cows were bred to either Angus or Simmental bulls. In year 1, 2-year-old heifers were to start calving February 15 and the cows on March 15. In year 2, 2-year-olds were to start calving on February 26 and the cows on March 18.

In early January of each year, forage samples were collected using four, mature esophageally fistulated steers fitted with screened collection bags. Steers grazed with the cows for 30 minutes following morning supplementation on two consecutive days per pasture. Samples were frozen, lyophilized, and ground for later analysis.

Data for the grazing trials were analyzed as a 2 x 4 factorial arrangement with two pastures and four treatments as main effects using the GLM procedure of SAS and treatment means were separated by the PDIFF option. Dependent variables included initial, final, and change in cow weight, condition score, and rib fat. Independent variables included supplement, pasture, cow age, year, supplement x pasture, and supplement x year. Initial measurements were included as covariates for weight change, condition score change, and change in rib fat.

Results and Discussion

Forage samples from year 1 were lower in crude protein and higher in NDF than year 2 (Table 3). Forage samples in year 1 indicated that cattle grazing the high available forage pasture were able to select a diet higher ($P<.05$) in crude protein than the low available forage pasture. In year 2 the high and low pastures were more similar in forage quality.

Cows grazing the high available forage pasture gained 53 lb more ($P<.01$) weight and lost less ($P<.01$) body condition than cows grazing the low available forage pasture.

Table 3. Composition of forage samples[ab]

Item	Year 1		Year 2	
	Low	High	Low	High
Organic matter basis, %				
Crude protein	3.39[c] (.26)	4.45[d] (.28)	5.06[e] (.22)	5.32[e] (.22)
Neutral detergent fiber	85.54[d] (.95)	83.87[d] (.72)	80.12[c] (.79)	81.23[c] (.79)
Acid detergent fiber	57.28 (1.06)	55.23 (.80)	56.87 (.88)	55.99 (.88)
Acid detergent lignin	5.65[c] (.41)	6.11[c] (.31)	5.14[d] (.34)	4.65[d] (.34)
Dry matter basis, %				
Ash	13.36 (.94)	12.92 (.71)	14.55 (.78)	13.12 (.78)

[a]Least squares means followed by standard errors.
[b]Uncorrected for salivary contamination.
[c,d,e]Means within a year with uncommon superscripts differ ($P<.10$).

There was a supplement x pasture interaction ($P<.01$) for both weight and condition score change, indicating that response to a supplement was dependent on the amount of available forage (Table 4).

When forage availability was low, cows fed low wheat middlings lost 32 lb more ($P<.05$) weight than the soybean meal fed cows. Cows supplemented with high wheat middlings gained less ($P<.05$) weight and lost more ($P<.05$) body condition than the corn-soybean meal fed cows. The high wheat middlings supplemented cows lost 62 lb less ($P<.05$) weight and lost .4 units less ($P<.05$) body condition score than low wheat middlings fed cows. When forage availability is low, wheat middlings appear to be a less effective protein source compared to soybean meal and a less effective source of energy compared to corn-soybean meal.

When forage availability was high, cows fed .75 lb crude protein from wheat middlings and soybean meal had similar weight and condition score changes. Cows that the high wheat middlings supplement gained 37 lb less ($P<.05$) weight than corn-soybean meal fed cows. The high wheat middlings supplemented cows gained 36 lb more ($P<.05$) weight and lost less ($P<.05$) body condition than the cows fed low wheat middlings. When forage availability is high, wheat middlings is an effective protein source compared to soybean meal and is a less effective energy source compared to corn-soybean meal balanced to provide equal protein.

The supplement x year interaction ($P<.01$) for weight and condition score change resulted from soybean meal being more beneficial to cow performance than low wheat middlings in year 1 and in year 2, soybean meal and low wheat middlings resulted in similar cow performance (Table 5). The forage grazed in year 2 was higher quality (Table 3) than the forage grazed in year 1. This may have caused the supplement x year interaction.

Table 4. Effect of available forage and supplement on cow performance[a]

Level of forage	Low				High			
Supplement	Soybean meal	Low wheat middlings	Corn-soybean meal	High wheat middlings	Soybean meal	Low wheat middlings	Corn-soybean meal	High wheat middlings
No. cows	30	32	31	31	32	31	32	30
Initial wt, lb	1110	1107	1111	1086	1097	1109	1095	1098
Initial CS, 1-9	5.4[bc]	5.3[bc]	5.4[bc]	5.2[c]	5.2[bc]	5.4[c]	5.3[bc]	5.3[bc]
Initial rib fat, cm	.31	.29	.27	.25	.30	.29	.31	.26
Wt change, lb	-34[c]	-66[d]	50[f]	-4[d]	14[e]	11[de]	84[g]	47[f]
CS change	-.4[c]	-.6[b]	.0[ef]	-.2[d]	-.2[d]	-.1[de]	.2[f]	.0[ef]
Rib fat change, cm	-.08[bc]	-.10[b]	-.03[de]	-.04[cde]	-.07[bcd]	-.05[cde]	-.01	-.02[de]

[a]Least squares means.
[b,c,d,e,f,g]Means in a row with uncommon superscripts differ ($P<.05$).

Table 5. Effect of year and supplement on cow performance[a]

	Supplement				Forage availability	
	Soybean meal	Low wheat middlings	Corn-soybean meal	High wheat middlings	Low	High
			Year 1			
No. cows	30	31	31	30	60	60
Initial wt, lb	1136	1139	1130	1120	1138	1124
Initial CS, 1-9	5.5	5.4	5.4	5.4	5.4	5.4
Initial rib fat, cm	$.40^{c}$	$.35^{bc}$	$.37^{bc}$	$.30^{b}$	.36	.35
Wt change, lb	21^{c}	-27^{b}	53^{d}	9^{c}	-14^{b}	42^{c}
CS change	$-.1^{cd}$	$-.3^{b}$	$.1^{d}$	$-.1^{c}$	$-.2^{b}$	$.0^{c}$
Rib fat change, cm	$-.05^{b}$	$-.05^{b}$	$.03^{c}$	$.00^{bc}$	-.03	.00
			Year 2			
No. cows	32	32	32	31	64	63
Initial wt, lb	1071	1077	1076	1065	1069	1075
Initial CS, 1-9	5.1^{b}	5.4^{c}	5.2^{bc}	5.1^{b}	5.2	5.2
Initial rib fat, cm	.21	.23	.22	.20	.20	.23
Wt change, lb	-41^{b}	-28^{b}	81^{d}	33^{c}	-13^{b}	36^{c}
CS change	$-.5^{b}$	$-.4^{b}$	$.1^{c}$	$-.1^{c}$	$-.4^{b}$	$-.0^{c}$
Rib fat change, cm	-.10	-.10	-.07	-.06	-.09	-.07

[a]Least squares means.
[b,c,d]Means within main effect with uncommon superscripts differ ($P<.05$).

Previous studies have shown that a grain-based supplement may be detrimental to cow performance. Grain supplements are more likely to improve cow weight change when there is abundant forage or when the amount of protein in the supplement is high. In this study, the lower starch wheat middlings supplement did not improve weight change compared to the corn-soybean meal supplement that was balanced to provide the same daily level of protein and energy. Regardless of forage availability, the wheat middlings supplement did not improve cow performance over the higher starch corn-soybean meal supplement.

Forage availability is a factor in determining the response to a supplement. When forage availability is low, wheat middlings are a less effective source of supplemental protein compared to soybean meal. With low forage availability, wheat middlings do not appear to be as beneficial as a corn-soybean meal supplement when added energy is needed. If abundant forage is available, wheat middlings will provide similar gain responses as a protein supplement compared to soybean meal. With a high amount of available forage, wheat middlings and corn-soybean meal supplements had positive and beneficial weight gains when used as a source of additional energy. When maximum weight gains are needed (usually when cows are thin in the fall), a corn-soybean meal supplement will provide the greatest weight gains.

In some areas wheat middlings are a very low cost source of supplemental protein and energy for cows grazing winter range. When only minimizing winter weight loss is the goal, wheat middlings can be a cost-effective supplement. When higher gains are needed because cows are thin, soybean meal or corn-soybean meal combinations may be more effective in improving cow weight and body condition.

Effects of Wheat Middlings on Utilization of Mature Prairie Hay by Steers

J.S. Heldt[1] and R.J. Pruitt[2]
Department of Animal and Range Sciences

CATTLE 95-4

Summary

A digestibility trial measuring intake, digestibility, ruminal nutrient disappearance, and ruminal pH was conducted to determine the effects of wheat middlings on utilization of mature prairie hay. Treatments included supplements used in a previous winter grazing trial at the SDSU Cottonwood Research Station that were balanced to provide the following amounts of crude protein (lb) and metabolizable energy (Mcal) per cow daily: 1) soybean meal .75 and 2.40, 2) low wheat middlings .75 and 4.76, 3) corn-soybean meal 1.50 and 9.40, and 4) high wheat middlings 1.50 and 9.40. These supplements were fed to the steers in proportional amounts based on $BW^{.75}$. Steers receiving the low wheat middlings supplement had similar hay and total diet intake but lower digestible dry matter intake than steers receiving soybean meal. High wheat middlings supplementation decreased hay intake and digestible hay and total diet intake compared to corn-soybean meal and low wheat middlings. The high level of wheat middlings and corn-soybean meal reduced ruminal pH at 4 and 8 hours post-supplementation. The high level of wheat middlings depressed overall ruminal disappearance of hay dry matter and NDF compared to the corn-soybean meal supplement and the low level of wheat middlings. This study indicates that wheat middlings may depress utilization of mature, low protein forages compared to soybean meal or corn-soybean meal supplements balanced to provide the same level of protein.

Key Words: Mature Prairie Hay, Supplements, Wheat Middlings, Soybean Meal, Corn

Introduction

Protein is typically the first limiting nutrient for cattle consuming mature, low protein forages. The use of all natural high protein supplements has been shown to increase cow weight change by improving forage intake and digestibility. The use of high starch grain-based supplements can be detrimental to cow performance due to a reduction in intake and digestibility of the base forage. High fiber low starch by-product feeds, such as wheat middlings, soybean hulls, brewers grains, and sugar beet pulp have the potential to provide supplemental protein and energy without the detrimental effects of the starch in grains on forage utilization. The objective of this study was to determine the effects of wheat middlings on intake, digestibility, ruminal nutrient disappearance, and ruminal pH of steers consuming mature prairie hay.

Materials and Methods

Four, mature ruminally fistulated steers (1687 lb) were used in a 4 x 4 Latin square. The trial consisted of four 20-day periods. Each period included a 7-day adaptation phase, a 7-day intake measurement phase, and a 6-day phase with total fecal collections, ruminal nutrient disappearance and ruminal pH being measured. Steers were individually housed indoors in a continuously lighted, climate controlled room (68° F) with slatted floors (6 x 8 foot pens) and had continuous access to water, trace mineral salt, and prairie hay.

Supplements used in this trial were used in a previous winter grazing trial conducted at the SDSU Cottonwood Range and Livestock

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Research Station (Table 1). A soybean meal supplement (SBM) was used as a base to provide .75 lb crude protein per cow daily. A low wheat middling supplement (LWM) was balanced to provide the same amount of protein daily. A high wheat middling supplement (HWM) was balanced to provide twice the amount of energy as the low wheat middlings supplement. A corn-soybean meal supplement (CS) was balanced to provide the same amount of protein and energy as the high wheat middlings supplement. Supplements were pelleted (3/16 in. diameter) and balanced to exceed NRC (1984) requirements for phosphorus and potassium. Steers were fed supplements in proportional amounts on a metabolic body weight basis ($BW^{.75}$) to what cows received in the winter grazing trial (Table 2). Supplements were fed at 0700 and were consumed within 20 minutes. Mature prairie hay (Table 3) harvested in October was ground through a tub grinder (2 in. screen) and offered twice daily at 130% of each steer's previous day's hay intake.

During the intake and fecal collection phases, individual orts were weighed and sampled (10% aliquots) at each hay feeding and refed at the next hay feeding. Hay was sampled daily and composited by period. Supplement and orts were composited by steer. Hay supplement and orts were weighed, subsampled, oven dried in a forced air oven at 140° F for 48 hours, ground through a Wiley mill (1-mm screen), and stored in air tight containers. Samples were analyzed for crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), and ash content. Hay samples were also analyzed for acid detergent lignin. Supplement samples were also analyzed for starch, ether extract, phosphorus, and potassium.

An in situ dacron bag technique was used to determine ruminal nutrient disappearance. Approximately 5 g of the dried hay (ground in a Wiley mill with a 2-mm screen) was placed in each dacron bag (10 x 20 cm) and heat sealed. On day 15 of each period, duplicate hay samples and empty bags (blanks) were soaked in warm tap water (102° F) for 15 minutes to hydrate prior to incubation and then placed in unanchored lingerie bags (43 x 53 cm) inside the rumen. Bags were introduced into the rumen at the same time and removed at 0, 4, 8, 12, 24, 48, and 72 hours post-supplementation. Zero hour bags were only hydrated in the tap water for 15 minutes. Bags were individually rinsed with tap water until rinse water was clear and then frozen for later analysis. Bags were thawed and oven dried at 140° F for 12 hours, allowed to air equilibrate for 3 hours, and weighed. Samples were analyzed for NDF content. The apparent extent of dry matter and NDF disappearance was calculated from residues remaining after incubation. Blank bags were used to adjust for influx and outflux of particles from the dacron bag.

Steers were fitted with fecal bags and harnesses on day 15 of each period for 5-day total fecal collections. Fecal bags were emptied three times daily and contents were weighed and sampled (10% aliquots) and stored in air tight containers at -1° F for later analysis. Samples were composited by steer, oven dried in a forced air oven at 140° F for 72 hours, and stored in air tight containers. Fecal samples were analyzed for CP, NDF, ADF, and ash.

On day 19 of each period rumen fluid samples were taken from the ventral sac of the rumen at 0, 4, 8, 12, 16, 20, and 24 hours post-supplementation. Ruminal fluid samples were analyzed for pH at the appropriate sampling time.

Dry matter digestibility of mature prairie hay was calculated by difference, assuming the digestibility of soybean meal, corn, and wheat middlings to be 84%, 90%, and 79%, respectively (NRC, 1984).

Intake and digestibility data were analyzed using the GLM procedure of SAS appropriate for a 4 x 4 Latin square. Main effects included steer, period, and treatment. Statistical analysis for the ruminal pH and in situ data was analyzed in a 4 x 4 Latin square split-plot in time design with repeated measures using the GLM procedure of SAS. Pre-planned comparisons were used to compare LWM vs SBM, HWM vs CS, and LWM vs HWM.

Table 1. Supplemental treatments[a]

Item	Supplement			
	Soybean meal	Low wheat middlings	Corn-soybean meal	High wheat middlings
Ingredients				
Soybean meal	88.62	—	32.20	—
Corn	—	—	64.68	—
Wheat middlings	—	97.83	—	97.83
Beet molasses	2.24	2.17	2.21	2.17
Dicalcium phosphate	9.14	—	.91	—
Composition				
Dry matter	87.77	87.92	86.44	86.40
Crude protein	44.34	18.30	23.74	18.23
Starch	7.90	18.17	45.48	18.17
Ether extract	.43	3.40	1.33	3.40
Neutral detergent fiber	7.82	37.81	10.50	38.19
Acid detergent fiber	5.29	11.75	4.35	11.60

[a]Percentage on a dry matter basis.

Table 2. Composition of average daily supplemental intake per steer

Item	SBM	LWM	CS	HWM
Dry matter, lb	2.57	5.11	8.74	11.10
Crude protein, lb	1.14	.94	2.07	2.02
Metabolizable energy, Mcal[a]	3.25	6.64	12.46	14.43
Phosphorus, lb	.019	.056	.072	.122
Potassium, lb	.054	.068	.096	.132

[a]Calculated values (NRC, 1984).

Table 3. Chemical composition of mature prairie hay[a]

Item	Composition
Dry matter, %	95.8
Crude protein, %	4.9
Neutral detergent fiber, %	76.8
Acid detergent fiber, %	44.5
Acid detergent lignin, %	6.6
Ash, %	6.2

[a]Percentage on a dry matter basis.

Results and Discussion

Hay and total diet intake and digestibility were similar for low wheat middlings (LWM) and soybean meal (SBM) supplemented steers (Tables 4 and 5). Digestible hay intake was reduced by LWM ($P=.08$) but total diet digestible intake was not affected.

Compared to the corn-soybean meal (CS) supplement, high wheat middlings (HWM) depressed hay ($P<.01$) and total diet ($P=.02$) intake but did not affect hay or total diet digestibilities. This resulted in a depression of digestible hay ($P=.02$) and total diet ($P=.08$) intake.

Increasing the level of supplement from LWM to HWM depressed hay intake ($P<.01$) and total diet digestibility ($P=.02$) and digestible hay ($P<.01$) and total diet ($P=.02$) intake.

Apparent ADF and NDF digestibility of the total diet was similar for LWM and SBM and for HWM and LWM. Supplementation with HWM increased apparent ADF ($P=.05$) digestibility over CS.

Supplementation with LWM decreased ($P=.04$) CP digestibility compared to SBM. HWM and CS had similar CP digestibilities. Increasing the level of wheat middlings from low to high increased ($P=.01$) CP digestibility.

Ruminal pH measurements indicated that higher levels of supplementation (CS and HWM) resulted in dramatic decreases in ruminal pH, levels that remained below the critical 6.2 limit for 8 hours post-supplementation (Table 6). Increasing the level of supplement from LWM to HWM decreased ruminal pH at 4 and 8 hours post-supplementation.

The LWM supplement did not improve apparent in situ hay dry matter or NDF disappearance over SBM (Tables 7 and 8). HWM decreased dry matter ($P=.10$) and NDF ($P=.04$) disappearance over CS. The HWM supplement decreased apparent dry matter ($P=.04$) and NDF ($P=.07$) disappearance compared to LWM.

The results from this digestibility trial demonstrate that soybean meal slightly increased forage utilization compared to low wheat middlings. Supplementation with wheat middlings decreased forage intake and utilization compared to a corn-soybean meal supplement providing the same level of protein and energy. Increasing the level of supplement from low to high wheat middlings decreased forage utilization indicated by the reduced digestible hay and total diet intakes.

This research suggests that wheat middlings will decrease the utilization of mature, low protein forage. Increasing the level from low to high wheat middlings will result in detrimental effects on intake and digestibility.

Table 4. Daily intake of mature prairie hay and total diet of steers receiving supplements

Item	Supplement				SE[a]	Comparisons[b]		
	SBM	LWM	CS	HWM		LWM vs SBM	HWM vs CS	LWM vs HWM
DM								
Hay, lb	20.5	19.0	17.0	10.8	.34	.19	<.01	<.01
Hay, % BW	1.2	1.1	1.1	.6	.05	.33	<.01	<.01
Total diet, lb	23.2	24.0	25.8	21.8	.38	.47	.02	.12
Digestible DM								
Hay, lb	9.0	7.3	6.2	3.5	.27	.08	.02	<.01
Total diet, lb	11.5	12.6	11.5	9.0	.35	.39	.08	.02

[a]Standard error of the mean.
[b]Probability of a greater F-value.

Table 5. Apparent digestibility coefficients

Item	Supplement				SE[a]	Comparisons[b]		
	SBM	LWM	CS	HWM		LWM vs SBM	HWM vs CS	LWM vs HWM
DM	49.9	52.1	44.2	41.8	2.29	.51	.48	.02
Hay DM	44.4	38.7	35.9	32.5	2.85	.21	.43	.18
NDF	54.4	50.0	49.2	53.2	1.98	.17	.20	.29
ADF	50.7	45.0	35.8	46.8	3.28	.26	.05	.71
CP	59.8	46.1	60.8	64.6	3.65	.04	.49	.01

[a]Standard error of the mean.
[b]Probability of a greater F-value.

Table 6. Ruminal pH measurements of steers consuming low quality hay and supplements

Hour	Supplement				SE[a]	Comparisons[b]		
	SBM	LWM	CS	HWM		LWM vs SBM	HWM vs CS	LWM vs HWM
0	6.25	6.48	6.46	6.53	.05	.02	.37	.50
4	6.10	6.05	5.81	5.72	.10	.74	.54	.06
8	6.17	6.17	5.95	5.83	.07	.96	.30	.02
12	6.12	6.27	6.16	6.12	.07	.17	.69	.15
16	6.14	6.35	6.34	6.44	.07	.09	.37	.40
20	6.17	6.38	6.45	6.55	.04	<.01	.12	.02
24	6.42	6.65	6.72	6.62	.07	.05	.34	.76
Overall	6.20	6.34	6.27	6.26	.04	.06	.86	.25

[a]Standard error of the mean.
[b]Probability of a greater F-value.

Table 7. Apparent in situ disappearance of hay dry matter

Hour	Supplement				SE[a]	Comparisons[b]		
	SBM	LWM	CS	HWM		LWM vs SBM	HWM vs CS	LWM vs HWM
4	11.1	11.6	10.0	10.5	.64	.64	.59	.28
8	14.2	13.5	14.4	13.6	1.00	.62	.58	.95
12	18.7	17.2	16.2	14.0	1.02	.33	.18	.07
24	37.3	31.6	31.8	25.4	1.79	.06	.05	.05
48	55.2	52.5	50.8	44.4	3.28	.58	.22	.13
72	60.2	60.6	58.4	53.1	2.21	.92	.14	.06
Overall	9.4	28.2	27.2	24.2	1.08	.46	.10	.04

[a]Standard error of the mean.
[b]Probability of a greater F-value.

Table 8. Apparent in situ disappearance of hay NDF

Hour	Supplement				SE[a]	Comparisons[b]		
	SBM	LWM	CS	HWM		LWM vs SBM	HWM vs CS	LWM vs HWM
4	28.7	27.5	29.0	27.9	.98	.39	.44	.75
8	31.6	29.2	32.1	30.0	.98	.13	.17	.57
12	35.6	32.5	34.4	30.2	1.23	.12	.05	.23
24	52.4	46.0	47.5	40.1	1.80	.05	.03	.06
48	67.5	64.9	63.8	55.8	3.04	.58	.11	.08
72	70.9	71.2	69.0	64.0	1.87	.91	.11	.03
Overall	44.8	42.5	43.3	39.0	1.15	.21	.04	.07

[a]Standard error of the mean.
[b]Probability of a greater F-value.

Wheat Tailings in Feedlot Finishing Diets

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CATTLE 95-5

Summary

One hundred twenty-eight yearling steers (average initial weight 854 lb) were fed one of four finishing diets containing (dry matter basis) either 1) 83% high moisture corn, 2) 44% high moisture corn and 37% high moisture wheat tailings, 3) 82% high moisture wheat tailings, or 4) 42% high moisture corn and 40% dry wheat tailings. Wheat tailings consisted of small wheat kernels removed during cleaning that had low test weights (41.5 to 52.0 lb/bushel) and high vomitoxin levels (17 to 42 ppm). High moisture wheat tailings were coursely cracked, reconstituted to 29% moisture, and ensiled. Dry wheat tailings were cracked only. Average daily gain declined up to 25% (P<.01) with increasing levels of high moisture wheat tailings as a result of a linear decline in dry matter intake (P<.05). Feed efficiency tended to worsen (P<.14). However, calculated net energy values for high moisture wheat tailings were similar to that of corn. Dry wheat tailings, on the other hand, resulted in similar intake (P>.20) but 15% lower average daily gain (P<.01) than high moisture wheat tailings fed at a comparable level and net energy values were approximately 75% of corn. Wheat tailings, regardless of form or level, decreased quality grade (P<.05) but did not affect dressing percent, yield grade, or liver abscesses (P>.20).

Key Words: Wheat Tailings, Finishing Diets, Steers

Introduction

Head blight (scab) is a recurring problem in the Northern Plains. Excessively wet growing conditions promote fungal infection of small grains resulting in shriveled kernels that often contain mycotoxins such as vomitoxin. Infected wheat is usually cleaned, concentrating the shriveled kernels in what are referred to as "tailings." Wheat tailings are characterized by low test weights and variable vomitoxin levels.

Mildly scabbed wheat appears to be utilized efficiently in high concentrate finishing diets. However, the feeding value of more severly affected wheat found in tailings is uncertain and may depend on diet level and processing.

The objectives of this study were to determine the effects of increasing levels of wheat tailings in finishing diets on yearling cattle performance and to compare coarse cracking with reconstitution plus ensiling as methods for processing wheat tailings.

Materials and Methods

Three loads of wheat tailings were received during the course of the study. Test weights were 43.5, 41.5, and 52.0 lb/bushel, respectively. The wheat tailings were coarsely cracked with some whole kernels still evident after processing. A portion of the wheat tailings were reconstituted with enough water to reduce dry matter content to approximately 70% and stored in a silage bag.

One hundred twenty-eight yearling steers (average initial weight 854 lb) used in a previous growing trial were weighed, reimplanted with Revalor[3] and allotted to pens (8 head per pen, 4 pens per treatment). Experimental treatments consisted of finishing diets containing (dry matter basis) either 1) 83% whole, high moisture corn (HMC), 2) 44% HMC and 37%

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high moisture wheat tailings (HMWT), 3) 82% HMWT tailings, or 4) 42% HMC and 40% dry wheat tailings (DWT). Finishing diet compositions are shown in Table 1. Dry corn was used in the diets during the final 23 days of the 101-day trial after supplies of high moisture corn were depleted. Four receiving/step-up diets were fed from day 1 through 19. The finishing diets were formulated to contain at least 12% crude protein, .57% Ca, .38% P, and .74% K.

Initial and final weights were determined after an overnight shrink off feed and water. Carcass data were collected on a subsample of 12 steers from each treatment. All data were statistically analyzed in a manner appropriate for a completely random design.

Table 1. Finishing diet compositions (dry matter basis)

	Treatment			
Item	100 HMC —	50 HMC 50 HMWT	— 100 HMWT	50 HMC 50 DWT
High moisture corn	82.71	44.10	—	42.08
High moisture wheat	—	37.45	81.90	—
Dry wheat	—	—	—	40.31
Molasses blend	3.10	3.28	3.49	3.13
Corn stalks	8.23	8.70	9.27	8.30
Soybean meal	2.81	1.53	—	1.46
Ground corn	—	1.69	2.79	1.62
Urea	.80	.43	—	.41
Limestone	1.03	1.43	1.45	1.38
Dicalcium phosphate	.38	.20	—	.19
Potassium chloride	.28	.36	.33	.34
Trace mineral salt	.47	.59	.56	.56
Premix[a]	.19	.24	.21	.21
Dry matter, %	75.95	71.86	67.34	80.91
Crude protein, %	12.03	13.64	15.72	13.84

[a]Provided 28 g of monensin, 8.2 g of tylosin, and 4,500,000 IU of vitamin A per ton of diet dry matter.

Results and Discussion

Performance data are presented in Table 2. Feed dry matter intake was negatively affected by the replacement of corn with HMWT in the finishing diet. The linear decrease in dry matter intake across treatments 1, 2, and 3 was equal to approximately .5 lb for each 10% increase in HMWT content ($P<.05$). Daily gain declined in a similar manner ($P<.01$) with steers fed treatment 3 gaining 25% less per day than steers fed treatment 1. Steers fed treatment 2 were intermediate. There was only a tendency for poorer feed efficiency with increasing level of HMWT ($P<.14$). On the other hand, steers fed treatment 4 had poorer feed efficiency ($P<.01$) than those fed treatment 2 (HMWT vs. DWT at comparable levels) as a result of similar intakes ($P>.20$) but 15% lower gains ($P<.01$).

Despite poorer performance, diet net energy values calculated from cattle performance and

Table 2. Performance of steers fed finishing diets containing varying levels of dry or high moisture wheat tailings

Item	Treatment				SE
	100 HMC —	50 HMC 50 HMWT	— 100 HMWT	50 HMC 50 DWT	
No. of steers	32	32	32	32	
Initial wt, lb	854	854	854	854	
Final wt, lb	1176[a]	1143[b]	1094[c]	1100[c]	9.9
DM intake, lb/day	22.4[d]	20.8[de]	17.9[f]	20.3[e]	.62
Daily gain, lb	3.19[a]	2.87[b]	2.38[c]	2.43[c]	.098
Feed:gain	7.02[a]	7.23[a]	7.54[ab]	8.34[b]	.254

[a,b,c]$P < .01$.
[d,e,f]$P < .05$.

feed intake data indicated that HMWT contained as much available energy as corn. Decreased performance with increased HMWT was apparently a function of intake and not altered digestion/ metabolism. Diet levels of vomitoxin contributed by added wheat tailings in treatments 2, 3, and 4 were 10, 23, and 13 ppm, respectively. Previous work has demonstrated that cattle are less susceptible to vomitoxin than other species, with no effects on feedlot performance being found at concentrations of up to 18 ppm. Much higher levels have been fed experimentally to lactating dairy cows without problem, although only for short periods of time. Other mycotoxins may have been present but were not analyzed. Faster rate of gain at a similar intake for steers fed treatment 2 compared to those fed treatment 4 reflects the benefits of reconstitution compared to coarse cracking alone. Calculated estimates of DWT net energy for maintenance and gain were 74% and 77% of corn, respectively.

A subsample of 12 steers from each treatment were slaughtered approximately 12 hours after being weighed off test (29 hours after removal of feed and water; Table 3). Neither dressing percent, yield grade nor liver score differed between treatments ($P > .20$). However, quality grade was .3 to .4 units lower ($P < .05$) for steers fed wheat tailings regardless of level or processing and may be due to the lighter weights at slaughter.

In conclusion, wheat tailings contain available energy comparable to whole corn if adequately processed. However, intake may be reduced, perhaps as a result of mycotoxin contamination, and should be monitored closely when deciding on the appropriate level to feed.

Table 3. Carcass characteristics of steers fed finishing diets containing varying levels of dry or high moisture wheat tailings

Item	Treatment				SE
	100 HMC —	50 HMC 50 HMWT	— 100 HMWT	50 HMC 50 DWT	
Dressing percent	63.2	63.4	62.7	62.8	.40
Quality grade[a]	4.5[c]	4.1[d]	4.1[d]	4.2[d]	.33
Yield grade	2.5	2.6	2.4	2.7	.16
Liver score[b]	.17	0	.08	.17	.13

[a]4.0 = Select°, 5.0 = Choice°.
[b]0 = no abscesses, 1 = 1 small abscess, 2 = 2+ small abscesses, 3 = severe abscesses.
[c,d]$P<.05$.

Ground vs. Unground Ammoniated Oat Hulls for Growing Calves

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CATTLE 95-6

Summary

One hundred forty-four steer calves were fed growing diets that contained either 1) 50% ground alfalfa hay (ALF), 2) 25% ground alfalfa hay and 25% ground, ammoniated oat hulls (ALF/GOH), 3) 50% ground, ammoniated oat hulls (GOH) or 4) 50% unground, ammoniated oat hulls (UGOH). Oat hulls were treated with ammonia at 3.3% by weight and enough water to raise the moisture content to approximately 20%. They were allowed to react for 32 days prior to feeding. Daily gains were greater for calves consuming the ammoniated oat hull diets, regardless of form (P<.10). Daily gain differences occurred in spite of the fact that dry matter intake was lower for GOH-fed calves than for the others (P<.10). As a result, feed efficiency was better for the GOH diet than ALF and ALF/GOH (P<.10) but did not differ from UGOH (P>.10). Ammoniated oat hulls, whether ground or unground, are a viable substitute for more conventional roughages in feedlot growing diets.

Key Words: Oat hulls, Ammoniation, Growing Diets

Introduction

Oats have been an important crop in South Dakota for many years. Oat hulls are a by-product of oat processing. Previous research at SDSU demonstrated that ammoniated, unground oat hulls have a feed energy value at least 20% greater than that of brome hay in calf growing diets. Unground oat hulls were used in the earlier work because of their larger particle size and decreased dustiness compared to ground hulls. However, ground oat hulls are usually less expensive, in large part due to lower handling and freight costs.

The objective of this study was to determine if, and to what extent, ground, ammoniated oat hulls could replace unground, ammoniated oat hulls in growing calf diets.

Materials and Methods

Ground and unground oat hulls were purchased and treated as in previous work at this facility. Briefly, the oat hulls were mixed in a mixer wagon with enough water to bring the moisture content up to approximately 20% and then piled on bare ground. The piles were covered with 6-mil plastic and sealed around the edges. Plastic tubing under the pile was used to inject anhydrous ammonia (3.3% of the weight of the oat hulls) at two sites in each pile. The oat hulls, ammonia and water were allowed to react for 32 days prior to feeding.

One hundred forty-four steer calves with an average initial weight of 606 lb were vaccinated (IBR, BVD, BRSV, Lepto and 7-way clostridium), dewormed (Ivermectin[3]), implanted (Synovex-S[4]) and ear tagged shortly after arrival at the feedlot. The calves were blocked by source and allotted within block to pens (9 head per pen, 4 pens per treatment) and fed diets containing either 1) 50% ground alfalfa hay (ALF), 2) 25% ground alfalfa hay and 25% ground, ammoniated oat hulls (ALF/GOH), 3) 50% ground, ammoniated oat hulls (GOH) or 4) 50% unground, ammoniated oat hulls (UGOH). The

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balance of the diets consisted of rolled corn, molasses and supplement. Diet compositions are presented in Table 1.

Initial and final weights were taken after overnight removal of feed and water. The calves were fed for 79 days. Pen data were analyzed in a manner appropriate for a randomized complete block design.

Table 1. Test diet compositions (dry matter basis)

Ingredient	Diet			
	ALF	ALF/GOH	GOH	UGOH
	Percent			
Rolled corn	45.04	37.62	29.32	29.32
Molasses	4.00	4.00	4.00	4.00
Alfalfa hay	50.00	25.00		
Unground NH_3 oat hulls				50.00
Ground NH_3 oat hulls		25.00	50.00	
Soybean meal		7.00	14.50	14.50
Limestone		.35	1.00	1.00
Dicalcium phosphate	.30	.35	.35	.35
Trace mineral salt	.50	.50	.50	.50
Premix[a]	.16	.18	.33	.33
Analysis				
Dry matter	84.1	83.4	82.8	80.5
Crude protein	11.3	14.5	16.2	16.1

[a]Provided 190 mg Rumensin and 52,000 IU vitamin A per day.

Results and Discussion

Two injection sites were used for ammonia application in each approximately 20-ton pile. This appeared to be quite effective for the unground oat hulls, as the degree of treatment was fairly even throughout the pile. However, there was considerable variation in the ground oat hulls, apparently due to the fact that they became rather tightly packed as the pile settled which, in turn, could have reduced the distance the ammonia could migrate. Crude protein content of the unground oat hulls was fairly consistent and averaged 12.5% while that of the unground hulls averaged 12.9% but ranged from 6.0% to 17.1%.

The diets were originally formulated to contain 12% crude protein from natural sources (i.e., from feeds rather than ammonia or urea) for the purpose of finding treatment differences that were the result of digestibility and intake rather than crude protein source. Oat hull diets would otherwise not need such high levels of soybean meal. Diet crude protein levels were somewhat lower than 12% due to the lower crude protein of the light test weight corn prevalent at the time of the study (8.4% of dry matter). However, they were still in excess of expected requirements and were assumed to have not affected the results of the study.

Daily gains were almost .3 lb/day greater for calves consuming the ammoniated oat hull diets than those consuming the ground alfalfa hay-based diet, regardless of form of the oat hulls ($P<.10$; Table 2). Daily gain differences occurred in spite of the fact that dry matter intake was lower for GOH-fed calves than for the others ($P<.10$). As a result, feed efficiency was better for the GOH diet than ALF and ALF/GOH ($P<.10$) but did not differ from UGOH ($P>.10$). Based on cattle performance and published values, NE_m and NE_g estimates for the ground and unground ammoniated oat hulls are 73.5 and 47.4 Mcal and 59.7 and 37.0 Mcal/cwt dry matter, respectively. These are in good agreement with previously reported estimates and at least 20% greater than the medium quality alfalfa used in this study (average 17.7% crude protein).

In conclusion, ammoniated oat hulls, whether ground or unground, are a viable substitute for more conventional roughages in feedlot growing diets. However, ammonia application technique may have to be altered for ground oat hulls.

Table ?. Performance data for steers fed growing diets containing either alfalfa hay (ALF), alfalfa and ground, ammoniated oat hulls (ALF/GOH), ground, ammoniated oat hulls (GOH) or unground, ammoniated oat hulls (UGOH)

	Diet				
Item	ALF	ALF/GOH	GOH	UGOH	SE
No. of steers	36	36	36	36	
Initial wt, lb	605	611	602	605	3.4
Final wt, lb	805	832	823	827	7.5
Wt gain, lb/day	2.53[b]	2.80[a]	2.80[a]	2.81[a]	.083
Dry matter intake, lb/day	19.2[a]	20.1[a]	17.5[b]	19.3[a]	.66
Feed:gain	7.59[a]	7.21[a]	6.25[b]	6.88[ab]	.319

[a,b]Means with different superscripts differ ($P<.10$).

Effect of a Blood Meal/Corn Gluten Meal Supplement After Calving on Performance of Cows Grazing Native Range

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CATTLE 95-7

Summary

A spring grazing trial was conducted to determine the effect of a supplement with lower rumen degradability (sometimes referred to as escape protein or bypass protein) than soybean meal on cow and calf performance. Three supplement treatments based on corn, soybean meal and blood meal/corn gluten meal were fed to 70 Simmental-Angus crossbred cows grazing native range from early April to late May. There was no advantage to the escape protein as measured by cow weight change, reproductive performance or calf gain. Corn supplemented cows performed similar to soybean meal supplemented cows.

Key Words: Beef Cows, Blood Meal, Corn Gluten Meal, Range, Escape Protein, Supplement

Introduction

The time from calving to rebreeding is a critical nutritional period affecting reproductive performance of beef cows. Protein and energy requirements are the highest during this stage of production. Cattle may meet their protein requirements from protein produced in the rumen by rumen microorganisms or from feed protein that "escapes" degradation in the rumen but is absorbed in the small intestine. Research in Nebraska suggests that cows grazing lush green forages in the spring may benefit from an escape protein supplement. Other research has shown that in some situations improved reproduction can result when heifers or young cows are fed escape protein supplements. The improved reproduction may be from metabolic effects independent of meeting the animal's protein requirement. Two earlier grazing trials at the SDSU Cottonwood Research Station did not demonstrate an advantage in feeding a more expensive escape protein supplement (blood meal and corn gluten meal) compared to soybean meal for cows grazing native range after calving. Those trials were conducted from early March to mid May with cows that had calved from mid February to late March. The objective of this trial was to reevaluate the effect of an escape protein supplement for cows grazing native range during the time from early April to late May.

Materials and Methods

A grazing trial was conducted from April 7 to May 26 using 70 lactating Angus-Simmental crossbred cows grazing native range at the SDSU Cottonwood Research Station west of Philip, South Dakota. Treatments (Table 1) included a corn-based supplement, a soybean meal-based supplement and an escape protein supplement. The escape supplement provided equal amounts of rumen undegradable protein from blood meal and corn gluten meal. The escape and soybean meal treatments provided 1.35 lb of crude protein per cow daily. The corn supplement was formulated to provide equal amounts of energy as the other higher protein supplements. All treatments were balanced to supply equal amounts of phosphorous, potassium, and sulfur that exceeded NRC (1984) requirements. Cows grazed the same pasture (primarily western wheatgrass) and were gathered every morning, sorted into treatment groups, and bunk fed their respective supplements in pellet form (3/8 inch diameter).

Cows were allotted to treatment by age and calving date. Initial and final weights were the

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Table 1. Composition of supplements

	Corn	Escape	Soybean meal
Ingredients, % dry matter basis			
Corn	80.5	24.7	—
Soybean meal	—	—	86.2
Blood meal	—	19.3	—
Corn gluten meal	—	37.6	—
Molasses	9.1	9.1	9.0
Dicalcium phosphate	6.4	6.1	4.6
Potassium chloride	2.6	3.3	—
K/Mg/S premix	1.4	—	.2
Daily supplemental intake per cow			
Dry matter, lb	2.97	2.99	3.02
Crude protein, lb	.24	1.35	1.35
Rumen undegradable protein, lb[a]	.16	.88	.38
NE_m, Mcal[b]	2.65	2.64	2.65
Phosphorus, g	21	21	21
Potassium, g	30	30	30
Sulfur, g	7	7	7

[a]Calculated from NRC Ruminant Nitrogen Usage (1985) values.
[b]Calculated from NRC (1984) values.

average of two weights on consecutive days taken in the morning after overnight removal from feed and water. Cows received no supplement for 4 days prior to the first final weight to remove any treatment effects of gut fill on cow weight. Condition scores (1 to 9, 1 = extremely emaciated and 9 = obese) were assigned by the same two people at the beginning and end of the trial. Subcutaneous fat thickness at the 12th rib was measured with an Aloka 500v ultrasound system using a 5 MHZ, 5.8 cm probe (Corometrics Medical Systems, Inc., Wallingford, CT).

Twenty-four two-year-olds in the study were bred to Angus bulls to start calving on February 15. The 46 cows 3 to 11 years old were bred to Angus or Simmental bulls to start calving on March 15. The breeding season started on June 6 with 14 days of heat detection and artificial insemination. Cows that had not been detected in estrus after 6 days were injected with prostaglandin to synchronize estrus. Following the AI period, cows were exposed to bulls for 50 days. Pregnancy was determined in mid October using the same ultrasound system used for measuring fat thickness. Conception date was determined by subtracting 283 days from the calving date the following year.

Four mature esophageally fistulated steers fitted with screened collection bags were used to collect forage samples (Table 2) while grazing with the cows for 3 days in mid May. Samples were frozen, freeze dried, and ground for later chemical analysis.

Cow and calf performance was analyzed using the Proc GLM procedure of SAS with means separated by the PDIFF option. The model included supplement, cow age, and supplement x cow age. Initial measurements were included as a covariable for analysis of weight, condition score, and backfat change. The model to analyze calf performance also

Table 2. Composition of forage collected in mid May by esophageally fistulated steers

	Mean	SE
% organic matter basis		
Crude protein	13.9	1.0
NDF	65.4	4.0
ADF	43.5	2.1
Lignin	5.0	.8
% dry matter basis		
Ash	11.1	.9

included calf sex and date of birth. Cow cycling rate and pregnancy rate were analyzed using the Chi-Square analysis of SAS.

Results and Discussion

Supplement treatment did not affect cow weight change. Cows receiving the escape protein supplement gained less body condition than the corn supplemented cows ($P<.05$) and less backfat ($P<.05$) than the corn or soybean meal supplemented cows. Supplement treatment did not affect calf weight gain during the trial indicating that cow milk production was not improved by either the escape or soybean supplement compared to corn.

Supplement treatment did not significantly affect the percentage of cows detected in estrus during the 14-day AI period (Table 3). Pregnancy rate and mean conception date were similar for all treatments.

In previous trials conducted at the SDSU Cottonwood Station from early March to mid May, soybean meal supplemented cows gained more than corn supplemented fed cows suggesting that protein was limiting. In this study starting in early April when there is more growing forage available, there was no indication that additional protein in the form of soybean meal was needed. Using a supplement that provides more escape protein did not improve performance as measured by weight change or reproductive performance.

Table 3. Effect of supplement treatment on cow and calf performance[a]

Item	Corn	Escape	Soybean meal
Cow performance			
Number of cows	24	22	24
Initial wt, lb	1026 (17)	997 (18)	1004 (17)
Initial condition score	4.7 (.1)	4.8 (.1)	4.9 (.1)
Init. 12th rib backfat, in.	.05 (.01)	.06 (.01)	.06 (.01)
Wt change, lb	19 (6)	29 (6)	24 (6)
Condition score change	.53[a] (.07)	.28[c] (.07)	.36[bc] (.07)
12th rib backfat change, in.	.03[b] (.01)	.00[c] (.01,	.02[b] (.01)
Calf performance			
Init. calf wt, lb	136 (4)	129 (4)	133 (4)
Calf wt change, lb	98 (3)	99 (3)	94 (3)
Cow reproductive performance			
No. of cows	24	22	23
% in estrus during 14-day AI period	66.7	59.1	47.8
% pregnant	95.8	100.0	100.0
Conception date	June 23 (4.0)	June 27 (4.2)	June 28 (3.8)

[a]Least squares means followed by standard errors.
[b,c]Means within a row with uncommon superscripts differ ($P<.05$).

Energetic Response of Angus and Simmental Crossbred Cows to Low and Moderate Intakes

SDSU

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CATTLE 95-8

Summary

Mature Angus-Hereford (AH; n=15) and Simmental-Hereford (SH; n=16) cows were used to evaluate the effects of adaptation to moderate (adequate to at least maintain body condition) and low (76% of moderate) intakes on feed energy partitioning by cows of different genotypes. Cows were fed individually in drylot for one complete production cycle (12 months). Conventional energy balance techniques and respiration calorimetry were used once during gestation and twice during lactation to evaluate energy utilization. Condition scores differed by .7 units (5.0 vs 4.3; P<.001) between intake levels by the end of the study. Heat production at 195 days of gestation was affected by intake level (P<.001) but not by genotype (P>.20), and there was no interaction between the main effects (GxI P>.20). During lactation measurements, milk energy production did not differ between genotypes and intake levels (P>.15). However, heat productions for AH and SH cows adapted to the low intake were 12% and 7% less than AH and SH adapted to the moderate intake, respectively (GxI P<.05). Additionally, deposition of tissue energy was reduced 20% and 39% by low intake AH and SH cows relative to moderate intake AH and SH cows, respectively (GxI P<.06). The results are interpreted to indicate that genotypes traditionally selected for greater milk production rely more on tissue energy adjustment to support milk production than on reduction of metabolic rate (maintenance).

Key Words: Intake Level, Energy Partitioning, Genotype, Beef Cow

Introduction

It has been estimated that up to 75% of the feed energy needed for beef production is required by the cow-calf segment of the industry. Of that, 70 to 75% is used to cover cow maintenance requirements. As a result, factors affecting cow maintenance requirements can be expected to affect overall beef production efficiency. The following are data describing some aspects of the relationship between genotype and level of intake relative to feed energy utilization by the beef cow. They were derived from a multi-year project designed with the purpose of investigating factors that affect efficiency in cow-calf production.

Materials and Methods

Animals: Energy balance measurements were made on 8 Angus x Hereford (AH) and 8 Simmental x Hereford (SH) cows in year 1 and 7 AH and 8 SH cows in year 2 of this study. They were part of a larger group of cows involved in a production efficiency study that were managed in the same manner except for the energy balance procedures. The cows ranged from 5 to 7 years of age and were the result of a two-way rotational breeding system. Selection of replacements in the herd from which these cows were obtained was random but in adequate numbers within rotational matings to maintain herd size. These breed crosses were selected for this study because they represented genotypes differing in genetic potential for milk production and mature size.

Starting in October of each year, the cows were placed in drylot (approximately 150 days

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of gestation) and assigned to either moderate (197 and 260 kcal ME*kg initial body weight$^{-.75}$*day^{-1} pre- and postcalving, respectively) or low (76% of moderate intake) intakes. The moderate intake was set, based on previous data, at a level expected to at least maintain body condition. The cows were fed individually for 1 year during which body weights and condition scores (1 = emaciated, 9 = obese) were determined monthly. Calves were born in March and April of each year. They were allowed access to the dams twice daily for 1 hour during the feeding period to nurse and were provided with a high roughage creep feed ad libitum at other times. Milk production was measured by weigh-suckle-weigh technique.

Energy Partitioning: In late November (average 195 days of gestation), the cows were brought into the metabolism facilities for a 3-week acclimation and training period. Heat production was then determined by indirect respiration calorimetry using four modified hood calorimeters. The cows were confined to the calorimeters for two consecutive 23-hour periods for fed measurements at their assigned intake levels, during which gaseous exchange was measured. Samples of air entering and leaving the calorimeters were analyzed for oxygen, carbon dioxide and methane content and, together with air flow volume, were used to calculate heat production. The cows were then fasted for 5 days with measurements taken again on days 4 and 5 of the fast.

The cows were returned to the metabolism facility in June and September (average 45 and 150 days of lactation) for a repeat of the procedure with the exception that only fed measurements were made and milk energy output was determined by a combination of weigh-suckle-weigh and machine milking over a period of 5 days. Change in body energy content (tissue energy deposition/mobilization) was calculated as the difference between metabolizable energy (ME) intake and the sum of heat and milk energy.

Diet metabolizability and its adjustment for intake level were determined separately using steers during two 7-day collection periods. Energy partitioning data were statistically analyzed for the effects of genotype, level of intake, their interaction and year, as well as stage of lactation and length of gestation, where appropriate. Least-squares means are reported.

Results and Discussion

Intake levels were fixed and based on body weights measured at the beginning of the trial. Body weights and condition scores changed over time creating differences between moderate and low intake groups of 103 lb (1211 vs 1108 lb.; $P<.001$) and .7 units (5.0 vs. 4.3; $P<.001$), respectively, as determined with the larger group of cows on the production efficiency study. Milk production results (212-day lactation) from the larger group reflected both genotype and intake effects. The SH cows produced 15% more milk than AH at the moderate intake (3892 vs 3375 lb, respectively) but were not significantly different at the low intake (3276 vs 3377 lb., respectively; GxI $P<.05$). Body weight, condition score, and milk production data indicate that genotypes and intakes chosen for this study were adequate to produce the performance differences desired.

Energy partitioning data are presented in Table 1. Heat production by an animal is, to a large degree, the result of using feed energy to perform maintenance functions and, therefore reflects differences in requirements. Heat production at 195 days of gestation was affected by intake level ($P<.001$) as expected but not by genotype ($P>.20$). Additionally, there was no interaction between the main effects (GxI $P>.20$). During lactation measurements, milk energy output also did not differ between genotypes or intake levels. However, not only did intake level affect heat production but it also affected SH differently than AH cows. Heat production by AH cows adapted to the low intake was 12% less than moderate intake AH, whereas it was only 7% less for low intake SH cows compared to moderate SH (GxI $P<.05$; Figure 1). A differential response was also found in deposition of tissue energy with a 20% reduction by AH and a 39% reduction by SH cows at low intake relative to moderate intake AH and SH cows, respectively (GxI $P<.06$).

Table 1. Energy partitioning data[a]

Intake	Low		Moderate	
Genotype	AH	SH	AH	SH
Heat production				
Gestation[c]	123.4	121.6	135.3	137.5
Lactation[d]	136.9	144.1	155.1	154.3
Milk	53.3	50.3	54.6	53.0
Tissue[e]	36.6	29.7	45.7	48.9

[a]kcal*body weight$^{-.75}$*day^{-1}.
[b]AH = Angus x Hereford; SH = Simmental x Hereford.
[c]Intake P<.001.
[d]Genotype x intake P<.05.
[e]Genotype x intake P<.06.

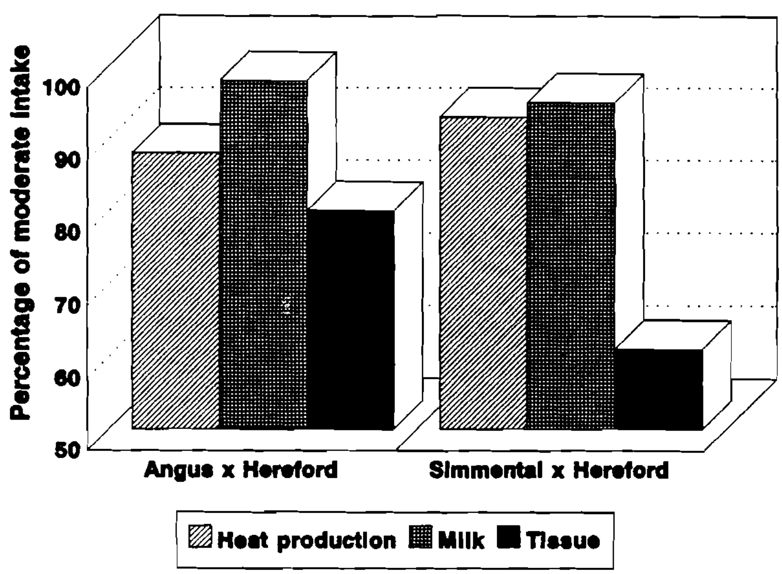

Figure 1. Energy partitioning during lactation (low relative to moderate intake).

Metabolizable energy can be used by the cow for meeting maintenance requirements, development of a fetus, production of milk or energy storage in the body (i.e., fat). If feed energy consumed is inadequate to meet all of the cows needs, adjustments are made in its partitioning among them based on priority and the ability of the animal to alter the efficiency with which energy is used for each function. Although they both maintained milk energy output at the lower intake during metabolism measurements, the AH cows did so by reducing heat production twice as much but tissue energy deposition half as much as the SH cows. The practical significance of this is that any reduction in maintenance requirements represents a true savings of feed energy, and potential improvement in production efficiency, whereas tissue energy removed or not deposited will need to be replaced at some point in the future to maintain body condition and reproductive performance. It would appear that genotypes traditionally selected for greater milk production rely more on tissue energy adjustment to support milk production than on reduction of maintenance requirements.

Evaluation of Crude Protein Sources and Levels for High Growth Potential Yearling Steers Fed High Energy Diets

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CATTLE 95-9

Summary

Feedlot cattle are now capable of growth rates that greatly exceed our descriptions for established nutrient requirements. We must now redefined the impact of sources and levels of dietary CP on growth rate and efficiency. Pursuing this question, yearling steers (n = 360 $\bar{x}$ BW = 790 ± 10) were fed various levels and sources of supplement crude protein during a 120 day finishing period. Diets were formulated to contain 12 or 13% CP. Supplemental CP was provided in the forms of urea, soybean meal, bloodmeal, and feather meal. Actual dietary CP levels of 11.8% and 12.6% were lower than formulations but still allowed for level comparisons. Higher CP levels improved feed/gain ($P<.05$) during the initial 42 days on feed in only one set of diet contrasts. CP level did not affect cumulative performance by steers. In one set of contrasts SBM supported higher ($P<.05$) ADG and a trend ($P<.15$) toward improved feed/gain over urea based supplements. In a second set of contrasts SBM tended to support higher ADG ($P<.15$) and higher DMI ($P<.10$) than urea plus escape protein liquid supplements. There were no interactions between sources and levels of supplemental CP. The apparent CP requirement of medium framed steers gaining over 4 lb per day was not greater than 11.8% of the diet.

Key Words: Steers, Feedlot, Protein

Materials and Methods

Yearling steers were acquired from various sale barns from June 9 to July 15, 1994. The experiment required 360 suitable steers (9 diets x 5 pen replicates x 8 steers) that were selected from 410 purchased animals. To accommodate problems of assembling these numbers of suitable subjects, the experiment was initiated in a staggered sequence. Block 1 (pen replicates 1 and 2) was started on test June 15; Block 2 (pen replicates 3 and 4) was started June 28; and Block 3 (pen replicate 5) was started July 18. All subsequent management steps were outlined related to the number of days the cattle were on feed rather than to a given date.

Initial processing involved ear tagging, BW measurement (for allotment), vaccination using Resvac 3/Somubac[2] (MLV for IBR, BVD, PI_3 and Haemophilus somnus) and Ultrabac 7[2] (7 clostridia sp) and parasite treatment with Ivomec pour on[3]. Cattle had access to long hay during the initial 2 to 3 days in the feedlot and a receiving diet (25% grass hay, 73.2% whole shelled corn, 1.8% supplement) was limit fed at 1.25 x maintenance from receiving until starting on experiment.

Allotment to treatments was done by first stratifying steers by BW among treatments. The BW was then stratified among pen replicates within treatments. Prior to allotment, steers of exceptionally high or low BW, of atypical breed type, or exhibiting an unthrifty appearance were deleted from the allotment pool. Steers were physically sorted to their assigned pens the afternoon prior to starting on test. Treatments were assigned to pens in a manner that balanced their distribution throughout the feedlot facility.

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Initial and all subsequent BW were determined on individuals from 0730 to 0930. This was prior to morning feeding. Feed or water were not withheld. Implanting when needed was done during the weighing procedure. The initial implant used was Synovex-S[4]. The implant used at reimplanting (41 or 42 days on feed) was Revalor[5]. Steers were shipped (75 miles) to the abattoir the afternoon following final BW measurement (119, 120, or 121 days on feed) and slaughtered 24 hours after the final BW was determined. Hot carcass weight was recorded at the time of slaughter. Longissimus area and rib fat thickness were measured on chilled carcasses. Marbling score and percentage of KPH noted by the USDA Grader on duty were recorded.

Feed schedules involved feeding the assigned diet at 1.65 x M immediately after initial BW was determined. The level of feed delivery was gradually and systematically increased to achieve expected peak DMI by 28 days without causing metabolic disorders. During the initial 21 days, feed deliveries were made once daily. Thereafter, feed was delivered twice daily in equal amounts. The quantity of feed delivered each day was based on feed calls made at 0700. Treatments were unknown to the feedcaller.

The nine supplement treatments are outlined in Table 1. Complete diet formulations are outlined in Table 2. Feed preparation was accomplished by mixing batches that would feed all five replicates within each treatment. Two batches were manufactured for each diet daily to accommodate morning and afternoon feed schedules. Feed commodity ingredients were sampled once each week and assayed for DM, CP, and ash. Roughages were also assayed for ADF and NDF content. Supplements were assayed for moisture and CP content at the time of manufacture. The diet nutrient contents were back calculated from ingredient assays and the as fed formulations used to manufacture batches of feed. This calculation was done weekly and whenever as fed formulations were adjusted for feed DM values. Means reported reflect all of these weekly composition calculations.

Table 1. Supplement characterizations

Supplement	Treatment	Form	% CP	Source
LS 40	1	liquid	53.9	Urea
DS #1	2	pellet	35.9	urea
LS 50	3,4	liquid	73.9	urea
DS #2	4,5	pellet	36.6	SBM
LS 45B	6	liquid	79.2	urea/blood meal/feather meal
LS 55B	7	liquid	87.9	urea/blood meal/feather meal
LS 460	8,9	liquid	6.4	molasses
DS 8	8	pellet	40.6	SBM
DS 9	9	pellet	42.6	SBM

[4]Roche Animal Health, Paramus, NJ.
[5]Hoechst-Roussel Agri-Vet Co., Tuttlingen, Germany.

Table 2. Basal diet formulations and CP content[a]

Ingredient	Treatment 1	2	3	4	5	6	7	8	9	SEM
Ground hay	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.01	8.00	
Whole shelled corn	43.05	39.13	42.87	41.34	37.42	43.50	43.50	39.31	38.07	
High moisture corn	43.45	39.52	43.29	41.71	37.78	43.91	43.91	39.68	38.43	
Molasses		3.59			3.57					
LS 40	5.50									
DS 1		9.76								
LS 50			5.80	3.14						
DS 2				5.80	13.23					
LS 45B						4.59				
LS 55B							4.59			
LS 460								4.00	4.00	
DS 8								9.00		
DS 9									11.50	
DM[b]	81.9	83.1	82.0	82.6	83.2	82.1	82.0	82.5	82.7	.16
CP (target CP)[b]	11.76 (12)	11.54 (12)	12.76 (13)	12.64 (13)	12.52 (13)	12.08 (12)	12.39 (13)	11.89 (12)	12.83 (13)	.063
ADF[b]	5.7	5.5	5.7	5.6	5.4	5.8	5.9	5.5	5.4	.05
NDF[b]	13.2	12.5	13.2	12.9	12.2	13.3	13.3	12.5	12.3	.03
Ash[b]	3.4	4.7	3.6	4.0	4.9	3.2	3.3	3.9	4.0	.11
NE_m, Mcal/cwt[c]	94.2	95.4	92.6	94.2	95.3	94.4	94.3	94.2	94.1	.02
NE_G, Mcal/cwt[c]	63.0	63.2	61.9	62.7	62.9	63.4	63.0	62.5	62.3	.18

[a]Percentage, DMB except when noted otherwise.
[b]Assayed values.
[c]Estimated values.

The DMI of each pen was summarized weekly based on ingredient DM and actual feed deliveries. When feed lost condition due to overfeeding or adverse weather, material was removed from the feed bunk, weighed, and sampled for DM analysis. The dry mass was subtracted from weekly total DM delivered before calculating average daily DMI per steer for the period. These weekly DMI records were used to calculate mean daily DMI during the periods corresponding to each BW determination. The pen mean BW and DMI were used in calculating feed/gain (FG) and statistical analyses.

Because of the complexity of the treatments used in this experiment it was more effective to analyze various treatment combinations as individual studies. Strategies for preplanned comparisons resulted in five separate AOV. Set 1 evaluated urea and SBM at 12 or 13% CP (TRT 1,2,3 5). Set 2 compared only urea or SBM at 13% CP (TRT 3,4,5). Set 3 compared urea with urea + escape protein at 12 or 13% CP (TRT 1,3,6,7). Set 4 compared SBM with urea + escape protein at 12 or 13% CP (TRT 2,5,6,7). Set 5 compared the value of including micro-ingredients in liquid or pelleted forms (TRT 2,5,8,9).

Statistical analyses were accomplished using the GLM procedures of SAS. Pen was considered the experimental unit for comparing feedlot performance variables. The blocks had a significant influence on BW and performance results. Therefore, block was used as a covariate in statistical analyses summarized here. Least squares means are reported in the tables.

Weekly feed records were included in the data base for each block. This resulted in repeated observations during weeks that overlapped between blocks. The repeated measures serve to weight mean feed analysis data for the number of steers consuming diets at any given time.

Carcass data were evaluated by considering individual carcasses as the experimental unit. Adjusted carcass weights were generated using initial live BW as a covariate and as such is a reflection of feedlot carcass gain. Marbling scores were indexed on a scale where 5.0 = small°, 4.0 = slight° degrees of marbling. Percentage choice carcasses among treatments were compared by Chi square analyses.

Results and Discussion

The methods used for diet analyses are quite sensitive. The least significant difference for CP generated by Duncan's New Multiple Range test was .18 units for adjacent means. Actual CP levels of 11.8% and 12.6% for the 12% and 13% CP treatments, respectively, differed ($P<.001$). Differences ($P<.05$) also occurred between diets within CP level (Table 3). No overlap in CP content existed between diets among levels. The biologically relevant differences in CP content are limited and may have compromised the potential to evaluate optimal dietary CP. Even so, some practical interpretations are still possible.

The initial BW (Table 4) was heavier than desired but necessary to meet uniformity and quality standards for this type of experiment. The experiment duration was planned for 140 days but heavy initial BW and excellent performance reduced the days on feed to 119, 120, and 121 for Blocks 1, 2, and 3, respectively. There were no protein source x level interactions evident in the data set, allowing independent discussion of each.

The level of CP did not affect performance of feedlot steers. The actual dietary CP increased 6.9% (11.80 vs 12.62%) considering all diets. A greater increase may have had an effect but in previous studies we have seen no response to elevating CP above that provided by a SBM supplemented 11.25% CP diet.

There were differences evident between CP sources. The diets supplemented with SBM tended ($P<.10$) to promote greater ADG (Tables 5, 6, and 8). Numerical advantages for SBM were evident in each phase of each comparison set used. Oftentimes these differences were not significant, but the consistency of the rankings is a relevant consideration. Considering only diets 1, 2, 3, and 5, the SBM increased ADG 5% ($P<.02$) and tended ($P=.15$) to improve F/G, although this was only a 3% response. When only the 13% CP diets were considered (Set 2; Table 6), a 5% increase ($P=.098$) in ADG occurred when SBM was fed. The 50/50 blend of urea/SBM based supplements resulted in an intermediate rate of gain.

Table 3. Duncan's New Multiple Range test of diet CP content by CP source and level

Level	12% CP				13% CP				
means[a]	11.80				12.62				
Source	Urea		SBM		Urea		SBM		Urea/SBM
means[b]	11.92		11.70		12.58		12.68		12.60
DIET	1	6	2	8	3	7	5	9	4
	11.76[d]	12.08[e]	11.50[c]	11.89[d]	12.76[hi]	12.39[f]	12.52[fi]	12.83[i]	12.60[gh]

[a]Level effect (P<.001).
[b]Source within CP level.
[c,d,e,f,g,h,i]Means without common superscripts differ (P<.05).

Table 4. Initial, interim, and final BW comparisons

	Treatment								
	1	2	3	4	5	6	7	8	9
Initial BW	787	787	784	794	787	792	791	795	788
Re-implant BW	948	964	956	972	964	971	972	972	981
Final BW	1289	1313	1293	1311	1321	1311	1301	1318	1300

	P<	
Significant diet contrasts	Re-implant BW	Final BW
Urea vs SBM (1, 3 vs 2, 5)	.1326	.0451
Urea 12% vs 13% CP (1 vs 3)	NS	NS
SBM 12% vs 13% CP (2 vs 5)	NS	NS
Urea vs urea + escape (1, 3 vs 6, 7)	.0208	NS
Dry vs liquid (2, 5 vs 8, 9)	.1266	NS

Table 5. Set 1 comparisons: Urea vs SBM and 12 vs 13% CP

	Treatment				P<[a]	
	1	2	3	5		
	Urea (12%)	SBM (12%)	Urea (13%)	SBM (13%)	Urea vs SBM	12 vs 13% CP
Initial to re-implant						
ADG	3.93	4.32	4.20	4.35	NS	NS
DMI	16.85	16.79	16.71	16.64	NS	NS
F/G	4.32	3.90	4.05	3.85	.0785	NS
Re-implant to final						
ADG	4.32	4.43	4.27	4.51	NS	NS
DMI	25.05	25.78	24.71	25.47	NS	NS
F/G	5.81	5.84	5.80	5.65	NS	NS
Cumulative						
ADG	4.19	4.39	4.24	4.46	.0201	NS
DMI	22.25	22.71	21.98	22.46	NS	NS
F/G	5.32	5.18	5.19	5.04	.1436	NS

[a]NS P≥ .15.

Table 6. Set 2 comparisons: Additive response of urea and SBM

	Treatment			P
	3	4	5	
	Urea (13%)	Urea/SBM (13%)	SBM (13%)	Urea vs SBM
Initial to re-implant				
ADG	4.20	4.36	4.35	NS
DMI	16.71	17.10	16.64	NS
F/G	4.05	3.95	3.85	NS
Re-implant to final				
ADG	4.27	4.28	4.51	.1506
DMI	24.71	25.21	25.47	NS
F/G	5.80	5.90	5.65	NS
Cumulative				
ADG	4.24	4.31	4.46	.098
DMI	21.98	22.45	22.46	NS
F/G	5.19	5.23	5.04	NS

Adding escape proteins to a urea based liquid supplement tended (P<.15) to improve steer performance during the initial feeding period (Set 3; Table 7). Performance by steers fed diet 7 was lower after reimplanting and, as a result, cumulative steer performance was not affected (P>.15) by including an escape protein. These diet comparisons should be replicated. The initial performance response to escape protein looked favorable. Further replication would help establish whether post-reimplant responses were real or if they were an artifact of this specific experiment. No mitigating circumstances were evident to explain the change in growth rate associated with diet 7. SBM caused greater ADG (P=.1096) and DMI (P=.0929) than urea + escape protein supplements. Most of this response occurred after re-implanting. When urea was fed without escape protein the SBM response existed during the initial feeding period as well. This further substantiates the evidence that there may be some advantage to including urea + escape protein.

The inclusion of microingredients in the liquid supplement depressed ADG (P=.0383) and DMI (P=.0674) after reimplanting (Set 5; Table 9). Overall DMI was depressed (P=.0552) when the liquid carrier was used. This is in direct contrast with previous research at this station. Possibilities for this outcome include reduced product mix stability or differences in actual monensin content of the diets. Unfortunately, monensin assays were not conducted on the dry and liquid supplements used.

Overall mean carcass values were dressing percent 60.5; carcass weight 792 lb; rib eye area 14.01 in.^{2}; rib fat thickness .44 in., and marbling score 5.00. We observed 51% choice carcasses. The carcass variables fit well within industry objectives. Table 10 depicts how purchase groups (blocks) affected carcass variables.

Carcass weights were greater (P<.01) when steers were fed SBM (Table 11). This confirms that the increases in ADG attributed to SBM were in fact gain and not a function of digestive tract fill. Diets had no other notable effects on carcass traits.

In previous experiments we have observed that when growth potential is high, SBM based supplements support higher ADG than urea based supplements. In most of those situations, SBM also stimulated DMI. In those experiments when the level of NPN was increased substantially, DMI was reduced with only slight decreases in ADG. This resulted in a favorable reduction in F/G as compared to lower CP, urea supplemented diets.

The conditions of this experiment substantiate the role of SBM for improving ADG although DMI was not affected. The numerical peak in performance was observed on treatment 5 which was 12.5% CP using a SBM based supplement. This level of performance was not different (P>.15) from that associated with the 11.5% CP (SBM) treatment 2.

The addition of escape proteins to urea based liquid supplements showed evidence of potential benefits, especially during the initial 42 days on feed. The change in relative performance during initial and final feeding phases for cattle fed diet 7 is unexplained. This treatment merits re-evaluation to determine if the response is in fact repeatable.

The basal diets used in this experiment could be labelled as typical, but they are not representative of all feedlot diets. Diets containing other ingredients may respond differently to these supplements. Most notably are diets containing higher protein corn co-products prevalent in this region. All high moisture corn or steam-flaked corn diets may also respond differently to the NPN based diets because of differences in ruminal starch fermentation.

Table 7. Set 3 comparisons: Urea vs urea + escape CP and 12 vs 13% CP

	Treatment				P	
	1	3	6	7		
	Urea (12%)	Urea (13%)	Urea + escape (12%)	Urea + escape (13%)	Urea vs urea + escape	12 vs 13% CP
Initial to re-implant						
ADG	3.93	4.20	4.36	4.42	.1221	NS
DMI	16.85	16.71	16.89	16.91	NS	NS
F/G	4.32	4.05	3.88	3.84	.0651	NS
Re-implant to final						
ADG	4.32	4.27	4.31	4.16	NS	NS
DMI	25.05	24.71	24.34	24.70	NS	NS
F/G	5.81	5.80	5.66	5.94	NS	NS
Cumulative						
ADG	4.19	4.24	4.33	4.25	NS	NS
DMI	22.25	21.98	21.80	22.04	NS	NS
F/G	5.32	5.19	5.05	5.19	NS	NS

Table 8. Set 4 comparisons: SBM vs urea plus escape protein

	Treatment				P	
	2	5	6	7		
	SBM (12%)	SBM (13%)	Urea + escape (12%)	Urea + escape (13%)	SBM vs urea + escape	12 vs 13% CP
Initial to re-implant						
ADG	4.32	4.35	4.36	4.42	NS	NS
DMI	16.79	16.64	16.89	16.91	NS	NS
F/G	3.90	3.85	3.88	3.84	NS	NS
Re-implant to final						
ADG	4.43	4.51	4.31	4.16	.0412	NS
DMI	25.78	25.47	24.34	24.70	.0514	NS
F/G	5.83	5.65	5.66	5.94	NS	NS
Cumulative						
ADG	4.39	4.46	4.33	4.25	.1096	NS
DMI	22.71	22.46	21.80	22.04	.0929	NS
F/G	5.18	5.04	5.05	5.19	NS	NS

Table 9. Set 5 comparisons: Dry and liquid micro-ingredient carriers

	Treatment				P<	
	2	5	8	9		
	Dry (12%)	Dry (13%)	Liquid (12%)	Liquid (13%)	Dry vs Liquid	12 vs 13% CP
Initial to re-implant						
ADG	4.32	4.35	4.35	4.73	.1414	.1341
DMI	16.79	16.64	16.86	16.24	NS	NS
F/G	3.90	3.85	3.88	3.44	.0561	.0296
Re-implant to final						
ADG	4.42	4.51	4.37	4.04	.0383	NS
DMI	25.78	25.47	24.89	24.11	.0674	NS
F/G	5.84	5.65	5.69	5.98	NS	NS
Cumulative						
ADG	4.39	4.46	4.37	4.27	NS	NS
DMI	22.71	22.46	22.15	21.43	.0552	NS
F/G	5.18	5.04	5.07	5.02	NS	NS

Table 10. Variation in carcass traits among blocks

	Least squares means		
	Block 1	Block 2	Block 3
Carcass weight, lb	763[b]	808[c]	816[c]
Dressing, %	60.0[b]	61.2[c]	60.3[b]
Rib eye area, in.^{2}	13.98	14.08	13.91
Rib fat thickness, in.	.44[b]	.43[b]	.47[c]
Marbling score[a]	5.1[b]	4.9[c]	5.0[bc]
Choice percent[d]	61.2	39.6	52.8

[a]4.0 = slight; 5.0 = small.
[b,c]Means without common superscripts differ (P<.05).
[d]Block effect (P<.001).

Table 11. Carcass traits for all treatments[a]

	Diets								
	1	2	3	4	5	6	7	8	9
Carcass weight[b]	785	802	789	797	804	794	792	797	799
Dressing, %	60.3	60.6	60.5	60.6	60.3	60.4	60.7	60.2	61.0
Rib eye area, in.^{2}	13.7	14.2	13.4	14.3	13.9	14.0	13.7	14.1	14.7
Rib fat thickness, in.	.45	.48	.46	.45	.44	.44	.41	.42	.46
Marbling score[c]	4.9	4.9	5.2	5.0	5.0	5.1	5.0	4.9	4.9
Choice, %[d]	50	38	67	43	63	62	55	45	38

[a]Least squares means.
[b]1 and 3 vs 2 and 5 (P<.01).
[c]4.0 = slight; 5.0 = small.
[d]Diet effect (P=.050).

Crude Protein Content of Diet of Cattle Grazing Native and Introduced Pastures

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CATTLE 95-10

Summary

Crude protein contents of diets were compared for steers grazing introduced, high condition native and low condition native grass pastures under spring-deferment or season-long grazing systems. This study was conducted at the SDSU Cottonwood Research Station near Cottonwood, SD, in 1990, 1991, and 1992. Esophageally fistulated steers were used to obtain diet samples throughout the grazing season on all treatments. Esophageal samples were analyzed for crude protein content and data were compared among grazing treatments within each year. In all three years, cattle diets were not limiting until late summer. Contrary to what was expected, diets of cattle on introduced grass pastures were typically higher in crude protein throughout the summer than diets of cattle grazing native pastures. Average daily gains were similar for all pastures and grazing systems for all years.

Key Words: Diet Quality, Grazing System, Native Grass, Introduced Grass

Introduction

The performance of grazing livestock is a function of forage quality and quantity of intake. Quantity of grazeable forage on the grasslands of the Northern Great Plains (NGP) generally increases from early spring through summer and then begins to decline as plants mature. Forage quality decreases as the growing season progresses, however, due to relative increases in plant structural components and decreases in crude protein and metabolizable energy. Crude protein is often limiting in mature range grasses. Grazing systems can affect both quality and quantity of intake by regulating the time of year and length of time livestock are allowed to graze a pasture. Specialized grazing systems have long been promoted as limiting the impacts of livestock defoliation by controlling, both in time and space, the amount of forage demanded. A period of nonuse for uninterrupted growth during a critical phase in the development of a plant is beneficial. For cool season grasses, such as western wheatgrass (*Agropyron smithii*, Rydb.) this would occur during the spring. Spring-deferment, a commonly used grazing regime in the NGP is often prescribed to accomplish this period of nonuse. In spring, livestock are often grazed on a pasture which has been seeded with an introduced grass such as crested wheatgrass (*Agropyron cristatum* (L.)) and to a lesser extent, Russian wildrye (*Elymus junceus* Fisch). The original focus of specialized grazing systems was to improve depleted range while allowing some level of grazing. Limited emphasis has been placed on individual livestock performance.

A grazing study was initiated in 1989 in an attempt to evaluate the use of the grasslands of western South Dakota so as to benefit both vegetation and livestock. The overall objective of this study was to identify, through the examination of vegetation and cattle diet characteristics, criteria for determining when to move livestock in a grazing system on native and introduced pastures during the spring through summer grazing season. This paper addresses a portion of the larger study and looks at the percentage of crude protein available in diets harvested by steers grazing introduced pastures and native grass pastures in either high or low range condition.

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Materials and Methods

The study was conducted at the Cottonwood Range and Livestock Research Station in west central South Dakota from 1990 through 1992. The Station is located approximately 75 miles east of Rapid City, South Dakota. Climate is continental and semi-arid with hot summers and cold winters. Long-term average annual precipitation is 15.5 in., the majority of which occurs between April and September.

Experimental Pastures

Twenty pastures were used in this study. Twelve pastures were of native range and eight of introduced grasses. Six of the native pastures were in high range condition (Hi) which had dominant vegetation of western wheatgrass with an understory of blue grama (*Bouteloua gracilis* [H.B.K] Lag. ex Steud) and buffalograss (*Buchloe dactyloides* [Nutt.] Engelm). The other six native pastures were in low range condition (Lo) which is dominated by warm season shortgrasses, blue grama and buffalograss, with western wheatgrass making up a lesser component of the vegetation. All native pastures were 17 acres in size. Four of the eight introduced grass pastures had been seeded to crested wheatgrass (Ag) in 1975, and the remaining four were seeded to Russian wildrye (El) in 1979. The introduced pastures ranged in size from 25 to 42 acres. The El pastures were used in this study during 1990 only.

Grazing Treatments

Half of the native pastures of each condition (Hi and Lo) received the season-long (SL) grazing treatment and half received the spring-deferred (DF) grazing treatment. Season-long treatments occurred from early May to late August and spring-deferred treatments occurred from early June to late August in 1990, 1991, and 1992. Half of the introduced pastures of each species (Ag and El) received the same SL treatment as the native pastures. The remaining introduced pastures received a spring-only (SO) treatment which required grazing only during early May to early June, which was the spring deferment period of the native DF pastures.

Stocking Rate

Pastures were stocked with yearling steers of mixed breed, local origin, and uniform size (Table 1). Stocking rate on native pastures was 0.5 AUM/acre for both the SL and DF treatments. Stocking rate for introduced pastures (both Ag and El) was 0.5 AUM/acre in 1990, 0.7 AUM/acre in 1991, and 1.0 AUM/acre in 1992.

Diet Quality Samples

Diet quality samples were collected using esophageally fistulated steers. Samples were collected throughout the grazing season in each year on native Hi and Lo and introduced Ag and El pastures for the SL, DF, and SO grazing treatments. Samples were collected by removing the cannula from the neck of the animal, strapping a collection bag beneath the esophageal opening, and allowing the animal to graze freely for approximately 30 minutes. Bags were then removed from the animal, the cannula reinstalled, and the samples immediately bagged and frozen. Samples were later freeze-dried and analyzed for percent crude protein.

Results and Discussion

For each of the three years of the study, percent crude protein was generally not limiting in diets of steers grazing native and introduced pastures until late in the summer when it approached 6% for the native pastures (Figures 1-3). Contrary to what was expected, percent crude protein in the diet was typically higher throughout the season on introduced compared to native pastures. Overall quality of cool season plant species (e.g., crested wheatgrass and Russian wildrye in the introduced pastures and western wheatgrass in the native pastures) is known to decline markedly during summer, while warm season species (e.g., buffalograss and blue grama in the native pastures) should offer the highest quality forage at that time. Even in a hot summer (1990) steers grazing Russian wildrye, a cool season introduced grass, had diets with the highest percent crude protein (greater than 10% all season) when compared to steers on crested wheatgrass and native pastures. Both crested wheatgrass and Russian wildrye are

Table 1. Average weight (lb) of steers on turn-in date for 1990, 1991, and 1992

	Season-long[1]				Spring-only		Deferred	
Year[2]	Hi	Lo	Ag	El	Ag	El	Hi	Lo
1990	595	584	624	593	594	602	675	684
1991	626	631	611	NG[3]	609	NG	710	712
1992	699	687	688	NG	673	NG	737	753

[1]Hi = high condition native range pastures, Lo = low condition native range pastures, Ag = crested wheatgrass pastures, El = Russian wildrye pastures.
[2]Turn-in dates for 1990: season-long and spring-only = May 7; deferred = June 8. 1991: season-long and spring-only = May 2; deferred = June 7. 1992: season-long and spring-only = May 11; deferred = June 9.
[3]Russian wildrye pastures were grazed in 1990 only.

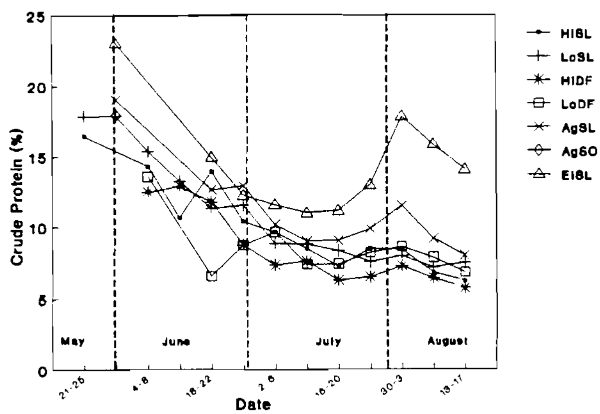

Figure 1. Crude protein content (%) of steer diets during 1990.

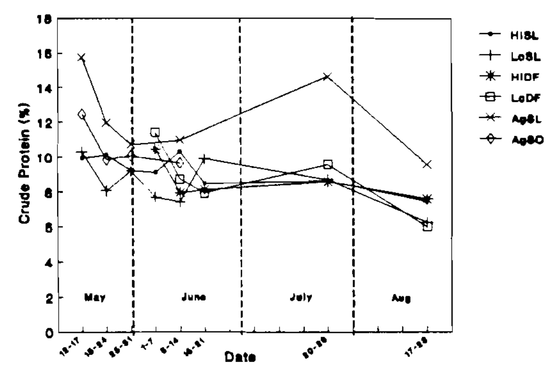

Figure 3. Crude protein content (%) of steer diets during 1992.

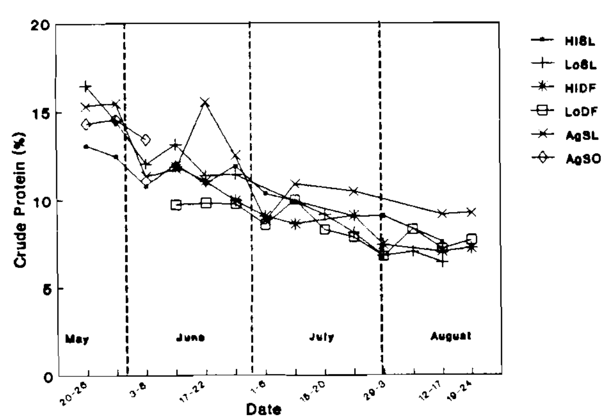

Figure 2. Crude protein content (%) of steer diets during 1991.

Grazing treatments were HiSL = season-long on native high condition pastures, LoSL = season-long on native low condition pastures, HiDF = spring-deferment on native high condition pastures, LoDF = spring-deferment on native low condition pastures, AgSL = season-long on crested wheatgrass pastures, AgSO = spring-only grazing on crested wheatgrass pastures, and ElSL = season-long on Russian wildrye pastures.

bunchgrasses that maintain a substantial mass of leaf material on the periphery of the bunch. These leaves would provide higher quality forage to grazing livestock than the stems and are readily available to grazing animals. Native grasses, both cool and warm season, typically maintain a higher stem to leaf ratio and leaves are not easily separated by a grazer from the stems. Thus, it is likely that the steers consumed a greater percentage of the lower quality stems while grazing the native pastures than did steers on introduced pastures, leading to generally lower quality diets from the native pastures.

Average daily gains (ADG, Table 2) were similar for all pastures within each year. ADG was as high on cool season, introduced pastures as on native pastures for all years even with the higher stocking rates on the introduced pastures in 1991 and 1992 (1.0 AUM/acre for introduced vs 0.5 AUM/acre for native in 1992). This is another indication that the steers grazing the introduced pastures during the entire grazing season were obtaining a diet of adequate quality and quantity for reasonable growth.

Conclusions

As long as forage quantity is not limiting, livestock can obtain forage of adequate nutritional value throughout the grazing season on cool season introduced grass pastures. Thus, it is possible to allow cattle to remain on introduced pastures much later in the season than is traditionally done without sacrificing animal weight gains. This longer deferment of use of native pastures in spring will reduce grazing pressure on important cool season grass species and would add flexibility to an operation, which is very crucial in dry years.

Acknowledgements

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Table 2. Average daily gain (lb) for 1990, 1991, and 1992

	Season-long[1]				Deferred	
Year[2]	Hi	Lo	Ag	El	Hi	Lo
1990	1.9	2.0	1.9	2.1	1.7	1.9
1991	1.8	1.8	1.8	NG[3]	1.4	1.8
1992	1.5	1.6	1.9	NG	1.4	1.2

[1]Hi = high condition native range pastures, Lo = low condition native range pastures, Ag = crested wheatgrass pastures, El = Russian wildrye pastures.
[2]Grazing season ended on August 21, 1990, August 22, 1991, and August 25, 1992.
[3]Russian wildrye pastures were grazed in 1990 only.

Effect of Anabolic Agents on Marbling in Yearling Crossbred Steers

SDSU

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CATTLE 95-11

Summary

A total of three hundred and twenty-four crossbred yearling steers were used in a two year study to determine the effects of anabolic agents on carcass characteristics. Steers were fed in a commercial feedlot for an average of 123 days, slaughtered and carcass data were collected. Implanted cattle gained significantly more weight (P<.05) than nonimplanted cattle. Steers that were implanted with Revalor-S gained weight more rapidly (P<.05) than Synovex-S implanted cattle. Implants significantly (P<.05) increased hot carcass weights and rib eye area when compared to nonimplanted cattle and Revalor implanted cattle tended (P=.0564) to have heavier hot carcass weights than Synovex implanted cattle. Implants did not significantly affect yield grades. Implanted steers had lower (P<.05) marbling scores than control steers. Steers that were implanted with Revalor showed a significant (P<.05) decrease in marbling score when compared to the Synovex groups. The percentage of choice carcasses for no implant, Revalor, and Synovex treatments were 78.85, 58.82, and 67.68, respectively.

Key Words: Implants, Marbling, Yearling Steers

Introduction

Implants are currently aggressively used in the beef industry to improve growth rates, feed conversion, and cutability. However, some studies have shown that implants may reduce marbling scores and, therefore, reduce USDA quality grades. According to the National Beef Quality Audit, $21.68/carcass is lost due to insufficient marbling scores. As the beef industry moves toward a value based marketing system, understanding factors influencing marbling score will become increasingly important.

The objective of this study was to examine the impact of implants on marbling score in yearling steers.

Materials and Methods

Three hundred and twenty-four crossbred yearling steers (770 lb) were delivered to a commercial feedlot[3] in central South Dakota. Steers had been on pasture in western South Dakota and had not been implanted during the grazing season.

At processing, cattle were weighed, vaccinated, treated for parasites with Ivomec[4] and randomly assigned to either no implant, Revalor[5] or Synovex[6] treatment groups. Implants were administered at processing using sponge and paint tray procedures to disinfect between cattle. In year 1, 84 of the heaviest conditioned steers were slaughtered after 111 days on feed. The remaining 90 steers were slaughtered after 140 days on feed. In year 2, 75 randomly selected steers were slaughtered after 114 days on feed. The remaining steers were slaughtered after 127 days on feed. Carcass data were collected

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[6]Syntex Animal Health, Des Moines, IA.

after a 24-hour chill. Final weight was determined by dividing hot carcass weight by average dressing percent for each slaughter date.

Average daily gain and carcass traits were analyzed using GLM procedures of SAS. Class variables in the model were treatment and year. Treatment means were separated using orthogonal contrasts.

Results and Discussion

Year effects and treatment by year interactions were not (P>.10) significant. Therefore, only treatment effects are shown. Table 1 shows the effect of implant on weight and average daily gain. Implants had a significant effect (P<.05) on average daily gain compared to controls. Steers implanted with Revalor had greater (P<.05) average daily gains when compared to Synovex implanted steers.

Table 2 displays carcass data for the steers. Implants significantly (P<.05) decreased marbling scores as compared to nonimplanted steers. Revalor implanted cattle had significantly lower marbling scores (P<.05) when compared to Synovex cattle. Percentage choice carcasses for control, Revalor, and Synovex were 78.85, 58.82, and 67.68, respectively. These differences were statistically significant (P<.10) as determined by Chi-square analysis.

Implants significantly increased hot carcass weight, and rib eye area when compared to nonimplanted cattle. Revalor implanted steers had a significantly larger rib eye area when compared to Synovex implanted steers. Implants had no significant effect on 12th rib fat thickness or yield grade.

These data suggest that implants reduce carcass quality. The probable method of marketing the cattle is an important consideration when designing an implant program.

Table 1. Weight and average daily gain (lb)[a]

Item	Control	Revalor	Synovex
Initial weight	767 ± 7.45	768 ± 7.33	773 ± 7.35
Final weight	1157 ± 10.44	1243 ± 10.27	1220 ± 10.29
Average daily gain[bc]	3.18 ± .068	3.88 ± .067	3.65 ± .067

[a]Means ± standard error.
[b]Implant vs control (P<.05).
[c]Revalor vs Synovex (P<.05).

Table 2. Implant effect on carcass traits[a]

Item	Control	Revalor	Synovex
Hot carcass weight, lb	760 ± 6.30	758 ± 6.19	745 ± 6.21
Fat thickness, in.	.431 ± .018	.459 ± .018	.466 ± .018
Rib eye area, in.^{2}	12.01 ± .136	12.60 ± .133	12.18 ± .134
Yield grade, units	2.81 ± .075	2.88 ± .075	2.99 ± .074
Marbling score, units[bcd]	5.39 ± .094	5.03 ± .092	5.27 ± .093
Percentage choice[e]	78.85	58.82	67.68

[a]Means ± standard error.
[b]4.00 = slight°; 5.00 = small°.
[c]Implant vs no implant (P<.05).
[d]Revalor vs Synovex (P<.05).
[e]Chi-square analysis (P<.10).

"CORRECTION"

Unfortunately, an error may be found in Table 2 on page 44. Hot carcass weight for control cattle was 706 lb not 760 lb as indicated by the table.

John J. Wagner

Dosages of Laidlomycin Propionate for Receiving and Growing Diets Fed to Steer Calves

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CATTLE 95-12

Summary

The inophore laidlomycin propionate[2] (LP) became available in 1995 to improve ADG of cattle fed in confinement. Initial efficacy studies focused on finishing diets and yearling cattle. Limited data are available to quantify the benefits of using LP in calf grower programs. To evaluate LP efficacy for calves, receiving-grower diets based on corn silage were formulated to contain 0, 5.5, or 11 g/T LP and were fed to recently weaned steer calves. Five pens of 10 steers (initial BW = 483 lb) were assigned to each diet. The grower phase was terminated after 98 days on feed. Final diet ionophore concentrations of 4.6 and 9.6 g/T were below formula specifications. Assays of supplements indicated a significant loss of ionophore during feed manufacture. The cause of this loss was not identifiable from the sampling procedures used. The higher dosage of LP reduced ($P<.05$) DMI through the initial 56 days on feed while having no effect on average daily gain. After 56 days on feed, steers fed the higher LP diet exhibited greater ($P<.05$) ADG and better ($P<.05$) feed efficiency than steers fed the low LP diet. Cumulative steer performance included an improvement ($P<.05$) in feed efficiency when LP was fed at 9.6 g/T.

Key Words: Steers, Calf, Corn Silage, Laidlomycin Propionate, Ionophore

Materials and Methods

Steer calves (287 head) were secured from two ranches in western South Dakota. They were weaned and transported to the SDSU Brookings feedlot on November 1, 1994. Upon arrival steers were gate cut into 10 head groups and allowed overnight access to long grass hay and water. The morning after arrival all calves were processed. Processing included applying individual eartags; recording BW; vaccination using Resvac 4/Somubac[3] (MLV IBR, BVD, PI_3, BRSV and Haemophilus somnus), One Shot[3] (pasteurella haemolytica bacterin-toxoid) and Ultrabac 7[3] (Cl. chauvoei, Cl septicum, Cl novyi, Cl sordellii and Cl perfringes types C & D); deworming with Synanthic[4]; and ectoparasite control with DeLice[5].

After processing steers were returned to their pens and 3.5 lb of the receiving diet (Table 1) was delivered on top the long hay. Delivery of this diet continued once daily to cattle appetite for a 7-day receiving period. Access to long hay was discontinued 72 hours after steer arrival at the feedlot. All steers were reweighed the morning of November 8 and this BW was used for allotment purposes. Any morbid steers or individuals that lost BW during the receiving period were deleted from the allotment scheme. The heaviest steers were also deleted to reduce the group to 150 steers. Ranch of origin identity was maintained and stratified in each pen. Allotment of 10 steers per pen was accomplished with a balanced weight stratification, first among treatments and subsequently among replicates within treatment. The experiment was designed for three diet treatments with five 10-head replicate pens per treatment.

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[3]Smithkline Beecham Animal Health, West Chester, PA, 19380.
[4]Syntex Animal Health, West Des Moines, IA, 50266.
[5]RXV Products, Porterville, CA, 93257.

Table 1. Receiving and grower diet formulations[a]

	Diet		
Ingredient	Receiving	Grower 1-76 days	Grower 77-98 days
Corn silage	73.23	76.38	—
Oat silage	—	—	48.49
Rolled corn	15.00	12.00	39.89
Ground corn[b]	—	—	2.11
SBM, 44%[b]	10.42	10.54	8.43
Limestone[b]	.75	.68	.68
Dicalcium phosphate[b]	.10	—	—
Trace mineralized salt[b]	.50	.40	.40

[a]%, DM basis.
[b]Included in a pelleted supplement. Complete supplement formulations are noted in Table 2.

At 0700 on November 10, 1994, steers were sorted to their assigned pens. They were then weighed and implanted with Synovex-S. This BW was used as the initial BW for the test. Feed and water had been withheld since 1600 hours the previous day to minimize BW variations due to digestive fill. After processing feed deliveries including diet treatments were made. The three treatments included 1) control, no nonnutritive additive, 2) 5.5 g laidlomycin propionate/ton, and 3) 11 g laidlomycin propionate per ton. All diets had similar formulations (Table 1) except for the additive inclusion rate in the pelleted supplement.

Bunks were reviewed daily at 0730 to make daily feed calls. Steers were fed once daily generally between the hours of 0800 to 1100. Feed ingredients were sampled each week and analyzed for DM, CP, ADF, NDF and ash. Weekly summaries of DMI were calculated from feed batch sheets and assayed DM of each ingredient. When carryover feed accumulated, the feed was removed from the bunk, weighed and sampled for DM determination. Weekly DMI summaries were corrected for this discarded feed. This system allowed a weekly estimate of diet supplement content corrected for fluctuations in feed moisture content. Each batch of supplement was assayed for ionophore concentration and when combined with actual diet supplement levels allowed accurate estimates of dietary ionophore concentration and ionophore intake. When corn silage inventories were depleted, a second grower diet was fed (77 to 98 days on feed) to complete the experiment.

Cattle were weighed at 0730 after 28, 56, 77 and 98 days on feed. Interim weights were "full." Feed and water were withheld 16 hours prior to the day 98 BW determination which was used as the final BW. Individual BW were measured and averaged for each pen. The pen mean BW was used with average daily DMI/steer in all feedlot performance variable calculations.

Steers were observed twice daily for visual signs of illness. Therapies were conducted as per established health protocols. One steer had to be removed from the experiment because of a urinary disorder. Pen mean data were corrected deleting this steer from all files used in the analysis of variance.

All performance data were analyzed on a pen mean basis using the GLM package in SAS. Mean separations tests were described with the PDIFF option to the LSMEANS calculation. This allows the reviewer to consider whichever mean comparisons are of interest but should only include pre-planned comparisons for data interpretation.

Results

Laidlomycin propionate (LP) concentrations in pelleted supplements were consistently lower than formulated values. Overall mean supplement LP concentrations of 36 and 73 grams per ton were 76 and 81% of expected values.

Because of this, the formulated diet ionophore concentrations of 5.5 and 11 g/T were actually 4.6 and 9.6 g/T (84 and 87%) of formulated concentrations (Table 2). The daily LP intake ($mg \cdot steer^{-1} \cdot d^{-1}$) was consistently two times higher for diet 3 than diet 2 although absolute LP intake amounts were lower than projected.

Range conditions were very dry during the 1994 grazing season and weaning weights of calves were about 75 lb lighter than observed in the two previous years. This probably contributed to excellent ADG on the relatively low energy grower diets fed (Table 3). The extraordinary ADG and feed/gain observed during the initial 28 days on test reflects fill effects as well as calf body condition. During this period the higher level of LP depressed DMI without compromising ADG. The higher LP treatment caused a numerical reduction in DMI during each interim period. This reduction was significant only during the initial 56 days on feed. Cumulative DMI tended (P=.07) to be reduced when the higher LP was fed.

Table 2. Diet ionophore concentration and daily ionophore intake

		Diet			
		2		3	
Week of:	Days	mg/steer	g/T	mg/steer	g/T
Nov 10	7	25	4.8	49	9.6
Nov 17	7	31	5.0	59	10.0
Nov 24	7	32	4.7	62	9.4
Dec 1	7	33	4.6	63	9.4
Dec 8	7	34	4.4	65	8.9
Dec 15	7	33	4.1	65	8.5
Dec 22	7	33	4.6	63	9.5
Dec 29	7	35	4.8	67	10.1
Jan 5	2	43	5.4	79	10.5
Jan 7	5	49	5.3	92	10.5
Jan 12	7	48	5.3	90	10.3
Jan 19	7	35	4.0	90	10.5
Jan 26	7	36	3.4	85	8.4
Feb 2	7	42	4.3	93	9.8
Feb 9	7	40	4.0	90	9.1
$\bar{X}$		36.6	4.6	74.1	9.6

Table 3. Feedlot performance variables by period

	Diet			
		Laidlomycin propionate		
	Control	5.5 g/T	11 g/T	SEM
Initial BW	483	485	485	2.6
1 to 28 days				
ADG	4.11	4.24	4.13	.121
DMI	12.54[a]	12.71[a]	12.14[b]	.156
F/G	3.06	3.00	2.96	.074
Day-28 BW	598	604	600	3.7
29 to 56 days				
ADG	2.56	2.53	2.42	.138
DMI	15.00[a]	15.09[a]	14.08[b]	.232
F/G	5.90	5.99	5.86	.247
Day-56 BW	669	675	668	4.8
57 to 77 days				
ADG	3.26[a]	3.80[b]	3.89[b]	.146
DMI	17.48	17.80	17.11	.262
F/G	5.40[a]	4.71[b]	4.42[b]	.176
Day-77 BW	734	754	750	6.9
78 to 98 days				
ADG	2.25[ab]	2.04[a]	2.35[b]	.101
DMI	20.15	20.10	19.61	.271
F/G	8.98[ab]	9.83[a]	8.39[b]	.428
Final BW	785	797	799	6.3
1 to 98 days				
ADG	3.09	3.19	3.21	.063
DMI	15.93	16.07	15.36	.211
F/G	5.17[a]	5.04[a]	4.79[b]	.053

[a,b]Means without common superscripts differ ($P<.05$).

The interim ADG were affected by diet during the 57 to 77- and 78 to 98-day periods. There were elevated ($P<.05$) ADG due to feeding LP in the 57 to 77-day period and an apparent rebound effect where the lower LP diet caused lower ($P<.05$) ADG during the 78 to 98-day period. Overall there were no differences ($P>.15$) in ADG due to diet.

Similar ADG and reduced DMI caused by feeding ionophores did improve feed conversions (F/G). The differences in F/G became evident as cattle reached heavier BW and caloric intake limitations became an important component of growth. Cumulative F/G was improved 3% ($P=.11$) for the lower LP treatment and 7.5% ($P<.001$) for the higher LP treatment. The F/G response appeared dose dependent in this experiment (Table 4). During periods when actual diet ionophore concentrations were greater, the percentage of improvement in F/G was greater. Low LP concentrations (3.9 g/T) during the final 21 days apparently minimized the F/G response for this treatment.

A primary objective of this study was to identify an appropriate LP dosage range for high roughage grower diets. Effective LP dosages slightly lower than 5 g/T were not effective in improving steer performance although consistent numerical advantages existed in the data set. An effective dosage of 9 to 10 g/T did clearly improve F/G. This was accomplished by reducing DMI without compromising ADG. The limited conclusions that can be drawn from this are that LP should be fed at levels of 9 to 10 g/T in grower diets, but that the initial 28-day LP concentration should be in the 5 to 9 g/T concentration range.

Table 4. Ionophore intake and feed conversions

	Diet					
	1		2		3	
Period	Ionophore concen-tration	Feed per gain	Ionophore concen-tration	ΔFeed per gain, %	Ionophore concen-tration	ΔFeed per gain, %
1-28	—	3.06	4.8	-1.2	9.6	-3.3
29-56	—	5.90	4.5	+1.5	9.3	-.7
57-77	—	5.40	5.0	-12.8	10.5	-18.1
78-98	—	8.98	3.9	+9.5	9.1	-6.6

Effect of a Yeast Culture Product (Yea-Sacc) on Feedlot Performance of Yearling Cattle Self-Fed an All-Concentrate Finishing Diet

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CATTLE 95-13

Summary

Seventy-two yearling steers (initial weight 793 lb) were allotted to 8 pens and self-fed a finishing diet consisting of 91% whole shelled corn and 9% pelleted supplement without or with Yea-Sacc (11 g per day). Feed was provided to each pen approximately every 3 days in amounts necessary to provide constant access during the 109-day trial. No treatment differences were detected for any of the feedlot performance or carcass characteristics measured. The occurrence of acidosis was high in both treatments as evidenced by the higher percentage of abscessed livers (40%). The feeding of Yea-Sacc did not have any beneficial effect in these circumstances.

Key Words: Yeast, Steers, Feedlot Performance, Carcass Traits

Introduction

Many direct-fed microbial products have been introduced into the market place over the past decade. Although evidence for a positive effect on animal performance has existed for many years, adoption has been slow. This is probably due to the lack of performance data indicating in which specific production situations the various products are or are not effective. A previous study at SDSU indicated that the feeding of a yeast strain specifically selected to compliment high grain diets (Yea-Sacc, Alltech, Inc., USA) was effective in improving gain of yearling steers fed a 90% concentrate, 10% roughage diet once daily.

The objective of this study was to determine if this same yeast product could positively affect feedlot performance and/or carcass characteristics of yearling steers self-fed an all-concentrate finishing diet.

Materials and Methods

Seventy-two yearling steers were selected from a larger group that had been used on a previous growing study. Additional processing was not necessary with the exception that a Revalor[3] implant was given at the beginning of the study. The steers were randomly allotted to 8 pens and fed a whole shelled corn finishing diet without (CONT) or with Yea-Sacc (YS; 11 g per day). Diet composition is presented in Table 1. The amount of the finishing diet was initially restricted to 10 lb per day and gradually increased to ad libitum over a 15-day period. Ad libitum grass hay was provided separately through day 15 and then removed. For the remainder of the study, feed was provided approximately every 3 days in amounts necessary to provide constant access to feed to simulate the use of a self-feeder. The steers were housed in semi-confinement on cement for the 109-day trial. Feed bunks were under a roof. YS was not fed from day 103 through 109 because supplies were depleted and could not readily be replaced.

Initial weights were determined after overnight removal of feed and water. The final weights were based on hot carcass weight divided by a constant dressing percent. Feedlot performance data were analyzed on a pen basis as a completely random design. Carcass data

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Table 1. Test diet composition (dry matter basis)[a]

Item	Percent
Whole shelled corn	90.90
Soybean meal	3.40
Ground corn	2.10
Limestone	1.20
Urea	.80
Trace mineral salt	.50
Potassium chloride	.50
Dicalcium phosphate	.50
Premix[b]	.10

[a]Formulated to contain 12% crude protein, .55% Ca, .42% P and .65% K.
[b]Provided 237 mg Rumensin and 43,000 IU supplemental vitamin A per day. Yea-Sacc was provided at 11 g per day to treated calves. The supplement was pelleted.

were analyzed using individual animal measurements. Percentage of choice, percentage of yield grades 1 and 2 and percentage of abscessed livers were tested by chi-square analysis.

Results and Discussion

Performance and carcass data are presented in Table 2. No treatment differences were detected for any of the feedlot performance or carcass characteristics measured ($P>.10$). The occurrence of acidosis was high in both treatments as evidenced by the percentage of abscessed livers (at least 40%). This is greater than the occurrence in the previous study (15%) in which a positive response to YS feeding was found. The feeding of YS did not have any beneficial effect in these circumstances.

Table 2. Feedlot performance and carcass data

	Treatment		
Item	Control	Yea-Sacc	SE
No. of steers	36	36	
Dry matter intake, lb/day	19.5	19.5	.20
Wt gain, lb/day	3.36	3.28	.071
Feed:gain	5.81	5.96	.127
Hot carcass wt, lb	695	690	4.6
Choice, %	71	61	
Yield 1 and 2, %	58	70	
Abscessed livers, %	40	43	

Sequencing of Feed Ingredients for Ration Mixing

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CATTLE 95-14

Summary

Alternative methods of sequencing ration ingredients into a mixer wagon were evaluated using a 13.53% roughage finishing diet. Batches A and B evaluated the addition of grass hay to a triple auger mixer either last or first, respectively. Batches C and D examined adding liquid supplement to a reel type mixer either immediately after the addition of corn or first, respectively. Three samples were obtained from each batch after 2, 4, 6 and 8 minutes. The coefficient of variation among acid detergent fiber levels at each time period for each batch was used as the criterion for determining adequacy of mix. Both batches A and B appeared adequately mixed after 6 minutes, indicating that ground grass hay could be added to a finishing diet either first or last when using a triple auger mixer. Batch C appeared adequately mixed after 4 minutes. Coefficients of variation for all mixing times were larger for batch D as compared to batch C at all mixing times, indicating that adding liquid supplement to the batch first may result in a poorer ration mix than adding liquid supplement immediately after corn.

Key Words: Mixer Wagon, Ration Quality Control

Introduction

Ration quality control is an important component of feedlot management. Providing cattle with a properly formulated and mixed diet is critical in maintaining stable feed intake patterns and optimum performance. Previous research conducted at South Dakota State University has demonstrated that optimum mixing time should be determined for specific rations and mixer wagons.

Presumably, the sequence in which feeds are added to the mixing equipment also affects mixing adequacy and time. Generally, the major feed commodities are added to the mixer in order from most dense to least dense. One objective of this research was to evaluate whether ground hay should be added to a finishing diet first or last when using a triple auger mixer (TRA). Another objective was to determine if liquid supplement could be added to a finishing diet first when using a reel type mixer (RT).

Materials and Methods

Table 1 shows the ingredient and theoretical nutrient composition of the finishing ration used in this study. For the TRA mixer[2], the feed ingredients were added in the following order: Batch A - corn, liquid supplement, soybean meal, hay; Batch B - hay, corn, soybean meal, liquid supplement. For the RT mixer[3], the feed ingredients were added in the following order: Batch C - corn, liquid supplement, soybean meal, hay; Batch D - liquid supplement, corn, soybean meal, hay. For batches A and C, liquid supplement was distributed evenly across the top of the corn. The liquid supplement was then mixed into the corn for about 30 seconds. The mixers were then stopped and the remaining ingredients added. For batch D, liquid supplement was added to the empty mixer. Then corn was added to the batch. The corn was mixed into the supplement for about 30 seconds. The mixer was then stopped and the remaining ingredients added. For batch B, all

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[3]Knight reel augie mixer.

Table 1. Finishing diet ingredient and nutrient composition

Item	Concentration[a]
Ingredient	
Rolled corn	78.82
Ground grass hay	13.53
Soybean meal	5.23
Liquid supplement	2.42
Nutrient	
Dry matter[b]	84.67
Crude protein	10.77
Acid detergent fiber	9.15

[a]Dry matter basis.
[b]As-fed basis.

feed ingredients were added to the mixer without any 30-second premix periods.

Once the last ingredient was added, the mixer was started and allowed to run for 2 minutes. The mixer was then stopped and a two quart sample was obtained off the top of the mixture from the front, middle and back of the wagon. The mixer was started again and stopped at 2-minute intervals and additional samples were obtained at each interval. Thus, three samples were obtained after 2, 4, 6 and 8 minutes of mixing. Samples were analyzed for dry matter, crude protein, acid detergent fiber (ADF), and ash according to standard wet chemistry procedures. ADF values were reported on an ash free basis.

Samples collected from the front, middle and rear of the mixer were considered replicates 1, 2 and 3 at each time period. Mean values were calculated at each time period and the coefficient of variation was used as a criterion to determine adequacy of mix.

Results and Discussion

Table 2 shows the mean and the coefficient of variation for each time period for batches A and B. Table 3 shows the mean and the coefficient of variation for each time period for batches C and D. The coefficients of variation observed for dry matter content and crude protein were generally small and of limited value in evaluating mixing adequacy.

Table 2. Mean nutrient composition and coefficients of variation for the batches mixed with the triple auger mixer

Variable	Time, min.	Batch A		Batch B	
		Mean	CV	Mean	CV
Dry matter	2	85.45	.37	85.86	.15
	4	85.28	.49	85.94	.17
	6	84.22	1.73	85.96	.10
	8	84.84	.66	85.98	.66
Crude protein	2	9.70	6.32	9.99	5.46
	4	10.01	2.41	10.18	1.48
	6	10.30	3.07	10.33	3.35
	8	9.75	7.39	10.28	.96
Acid detergent fiber	2	13.67	29.72	11.98	49.07
	4	12.19	17.70	21.84	90.07
	6	10.91	8.16	11.18	11.09
	8	15.53	39.87	12.19	18.66

Table 3. Mean nutrient composition and coefficients of variation for the batches mixed with the reel type mixer

Variable	Time, min.	Batch C Mean	Batch C CV	Batch D Mean	Batch D CV
Dry matter	2	85.71	.09	85.92	.16
	4	85.79	.06	85.80	.22
	6	85.80	.09	85.90	.64
	8	85.89	.05	86.00	.12
Crude protein	2	10.72	8.13	10.40	8.58
	4	10.96	4.04	10.24	10.29
	6	10.99	2.15	10.74	4.64
	8	10.88	3.43	10.93	1.97
Acid detergent fiber	2	12.31	17.72	14.03	50.44
	4	11.24	6.43	14.45	44.20
	6	11.53	7.80	12.31	15.09
	8	12.04	4.08	12.36	9.13

ADF values were much more variable among ingredients and are more useful in evaluating ration mix. For the TRA mixer, both batches appeared adequately mixed after 6 minutes. Additional mixing beyond 6 minutes appears to increase ADF variation and may indicate a breakdown in the ration mix. All values reported for ADF appeared greater than the theoretical value. For batch A, this may be due to adding the highest ADF feed last to the mix. It may be more difficult to obtain a uniform mix from top to bottom in the mixer. However, for batch B it is not clear why the ration at the top of the mixer should be higher in ADF content.

For the RT mixer, batch C appeared adequately mixed after 4 minutes. The coefficient of variation declined from 17.72% to 6.43%. Batch D appeared to be mixed more slowly. The coefficient variation didn't decline to below 10% until 8 minutes of mixing. Much higher coefficients of variation were observed at all mixing times for batch D as compared with batch C, indicating that adding liquid supplement first to the RT mixer resulted in a poorer ration mix.

Often the sequence of ingredients selected to add to the mixing equipment is based on convenience. It may be desirable to add one commodity first or last to the mix based on location of that feed relative to the other feeds. The data presented in this paper suggest that adequacy of ration mix can be affected by the sequence of adding feeds to the mixer. Adequacy of mix should be a major criterion for selecting the sequence used for feed mixing.

Acknowledgements

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Livestock Manure: a Nonpoint Source Environmental Hazard in South Dakota?

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CATTLE 95-15

Summary

This exploratory study shows estimated manure nutrient loadings on cropland for 78 selected feedlots in South Dakota to be 4.7 times greater than for 62 selected cow-calf operations. For 44% of feedlots studied, the estimated amounts of manure nitrogen (N) spread on cropland exceed the 75 lb/acre fertilizer N level recommended for corn with a 100 bu/A yield goal. For 40% of feedlots and 23% of cow-calf operations, amounts of manure N dropping on pasture exceed the 38 lb/A recommended fertilizer N level for pasture land. Since the design capacity of feedlots covered in the study is nearly 10 times the average for all feedlots in the state and the average size of herd for the cow-calf operators studied is 1.35 times the state average, the estimated percentages of beef cattle operations studied with potential nonpoint pollution from animal wastes are considerably greater than for beef cattle operations generally in the state.

Key Words: Manure Nutrient Loadings, Feedlots, Cow-Calf Operations, Nonpoint Source Pollution

Introduction

The National Research Council, in its recent study "Soil and Water Quality, An Agenda for Agriculture," reports that the concentration of cattle in large confinement feeding operations and the increasing regional concentration of dairy, poultry, and other animal production systems are giving rise to more manure being produced than can be used efficiently on nearby croplands. With concentrated livestock production, environmental concerns can arise in connection with (1) waste run-off from feedlots and (2) nutrients leaching into soil and water from manure in excess of the nutrients required by crops.

If management expertise is the same, possibilities for pollution are greater if cattle are fed in large feedlots. Point source pollution may increase because of the large amounts of feedlot waste available as potential run-off into surface water or leaching to groundwater in the immediate vicinity of large feedlots. Non-point source pollution may increase because the economic disincentives for transporting manure long distances from its point of origin may result in excessively heavy manure applications on farmland close to large feedlots.

In this study of livestock manure nutrient loadings on farmland for cattle feeding and cow-calf operations in South Dakota, two primary research questions are addressed:

1) Are nutrient loadings greater for feedlots or cow-calf operations? This question is significant since, on the one hand, cattle on feed are more geographically concentrated than cattle on pasture but, on the other hand, fed cattle account for only one-seventh as much as grazing cattle of the total estimated manure produced in the U.S.

2) Are nonpoint source pollution manure nutrient loadings in South Dakota environmentally dangerous? Some commentators believe that they are.

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Materials and Methods

Responses by 78 fed cattle and 62 cow-calf operators in South Dakota to questionnaires mailed during winter 1991-92 represent a main data source for this study. In each study, questionnaires were mailed by the South Dakota Agricultural Statistics Service to 500 randomly selected producers. Response rates were 42% and 26%; several respondents reported no longer producing cattle and/or backgrounding rather than finishing cattle for slaughter.

For simplicity, we assumed all spread manure to be solid raw. The amounts of solid raw manure assumed to be produced and available for land application by various species and types of livestock and poultry found on the surveyed farms are shown in Table 1. For information on the sources of these data, see Annex A of "Livestock Manure Production and Disposition: South Dakota Feedlots-Farms-Ranches," available from the author.

The total amounts of manure produced by various species and types of livestock and poultry on each of the 78 feedlot and 62 cow-calf operations were calculated by multiplying the data in Column 4 of Table 1 by the respective numbers of each type of livestock found in each farm operation. Percentages of these total amounts of manure assumed to drop directly on pasture land—versus to be scraped, collected, and spread on cropland—are shown in Table 2. The assumed elemental nitrogen (N), as percentages of raw solid manure applied to farmland at the time of land application, for various livestock species are as follows: poultry 1.74%, sheep .99%, beef cattle .72%, dairy cattle .49%, and hogs .42%.

Table 1. Amounts of manure produced by various species and types of livestock poultry assumed in the study

	Livestock management assumptions		Manure available for application	
Category of livestock	Body weight (lb)	Days in herd/flock	Lb/day	Tons for days in herd/flock
Beef cattle				
Brood cow	1,100	365	61	11.13
Service bull	1,700	365	94	17.16
Stockers	615	200	34	3.40
Finishing cattle	775	270	43	5.81
Dairy cow	1,300	365	93	16.97
Hogs				
Brood sow	350	365	11	2.01
Market hog	135	150	11	.83
Sheep				
Ewe	180	365	6.3	1.15
Market lamb	70	140	2.5	.18
Poultry				
Layer	7	365	.30	.055
Broiler	7	45	.40	.009

The percentages of manure dry matter, N, and losses were assumed to be the same for all beef producers in the study. Producers were assumed to follow sound management practices in their handling, storage, application, and incorporation of manure. Further, manure was assumed to be applied uniformly over all cropland receiving spread manure applications and to drop uniformly over all grazing land in the respective farming operations. We are aware that these assumptions are not entirely realistic. Without having detailed data to enable analytic attention to these issues, however, we decided to proceed with the study, and to openly acknowledge that the study results must be considered as indicative, not definitive.

Results and Discussion

Feedlots and Cow-calf Operations Studied

On average, the 78 feedlot managers operate 1,475 acres of cropland and 590 acres of pasture land. The cow-calf operations studied have only 44% as much cropland (650 acres) as the feedlot operations but 2.4 times as much pasture land (1,430 acres).

The mean design capacity of the feedlots studied is 890 head, which is nearly 10 times the state average feedlot size of 90 head. The average size of herd for the cow-calf operators is 116 head, which is 1.35 times the state average of 86.

Livestock Manure Nutrient Loadings

An estimated average of 5,370 tons of manure is produced annually by the livestock associated with each feedlot studied. The corresponding manure production for cow-calf operations is only 1,825 tons or 34% as much. Seventy-seven percent of the total manure produced on feedlots is spread on cropland, whereas only 46% of the total manure produced on cow-calf operations is spread on cropland.

Estimated annual applications of livestock manure per acre on cropland average 6.1 tons for feedlots and 1.3 tons for cow-calf operations. They range from 0.4 to 28 tons for feedlots and from 0.03 to 4.5 tons for cow-calf operations. Eight percent of feedlot operators spread more than 15 tons/A/yr.

The estimated average annual elemental nitrogen (N) application for feedlot operations is 98 lb/A (Table 3). For cow-calf operations, the average N application (21 lb/A) is only 21% as much. Nitrogen application rates for 44% of feedlots exceed 75 lb/A.

The estimated average annual amount of manure N dropping on pasture land of 33 lb/A for feedlots is significantly more ($P<.01$) than the average of 25 lb/A for cow-calf operations. The estimated amount of manure N dropping on pasture land exceeds 38 lb/A for 40% of feedlots and 23% of cow-calf operations.

Thus, although feedlots have 2.3 times as much cropland as cow-calf operations, their average cropland manure nutrient loading rates are 4.7 times as great as for cow-calf operations. Their average pasture land manure nutrient loading rates are 30-32% more than for cow-calf operations. With feedlots, manure nutrient loading rates are about 3 times as great on cropland as on pasture land. With cow-calf operations, on the other hand, manure nutrient loading rates on cropland are 15-17% less than those for pasture land.

These outcomes are associated with contrasts in (a) the average estimated total amount of manure produced by feedlot operations (5,370 tons) versus cow-calf operations (1,825 tons), (b) total manure spread on cropland as a ratio to that dropped on pasture land for feedlot operations (3.41) versus that for cow-calf operations (0.86), and (c) the cropland-pasture land mix for feedlot operations (2.5 times as much cropland as pasture land) versus cow-calf operations (only 46% as much cropland as pasture land).

Livestock Manure in South Dakota: A Nonpoint Source Environmental Hazard?

Identifying benchmarks against which the above estimated manure nutrient loadings can be evaluated is problem-prone. Maximum "environmentally safe" nutrient loadings on farmland depend—among many factors—on site-specific soil N levels, soil properties and

Table 2. Percentages of total manure produced assumed to drop directly on pasture land[a]

Category of livestock[b]	Feedlots	Cow-calf operations
Beef		
Service bulls	80	100
Brood cows	80	Actual
Stockers	80	80
Backgrounded cattle	n/a	80
Replacement heifers	n/a	60
Finishing cattle	Actual	0
Breeding ewes	80	80
Dairy cows	80	80

[a]The term "actual" reflects the numbers of days that producers reported cattle to graze on pasture land as percentages of 365 in the respective feedlot and cow-calf operations,.
[b]None of the manure produced by brood sows, market hogs, market lambs, layers, and broilers for either type of operation was assumed to drop on pasture land.

Table 3. Levels of elemental nitrogen (N) from livestock manure spread on cropland and dropped on pasture land, 78 feedlots and 62 cow-calf operations

Type of farmland and cattle operation	Estimated nutrient loading (lb N/acre/yr) Range	Mean[a]
Cropland		
Feedlots	6-507	97.7
Cow-calf operations	1-65	20.9
Pasture land		
Feedlots	0-117	33.2
Cow-calf operations	3-91	25.2

[a]In each paired comparison, the mean nutrient loading for feedlots is significantly greater than for cow-calf operations ($P<.01$).

condition, aquifer depths, distance from surface water, crop nutrient requirements, and weather at the time of manure application. Nevertheless, we established general benchmarks for maximum recommended amounts of manure N for application to cropland and pasture land in S.D. as follows.

South Dakota State Law requires agricultural waste plans to be developed for new feedlots with a capacity for more than 1,000 head and for any existing feedlot which has been shown to be the source of water pollution. The waste utilization plan requires annual soil tests with subsequent manure application based on crop nitrogen requirements. The crop nitrogen requirement for corn, for example, is calculated as (1.45 * yield goal) - 20. The actual fertilizer recommendation is determined by subtracting the NO_3-N in a 2-ft soil sample from the nitrogen requirement.

The average corn yield in South Dakota is 80 bu/A. The fertilizer recommendation for a farmer with a 100 bu/A yield goal and a 50 lb/A NO_3-N soil test would be 75 lb/A. Nitrogen recommendations for grass are based on (25 * yield in tons) -soil NO_3-N to a 2-ft depth. If grass production is 3.5 tons/A, a typical fertilizer recommendation would be 38 lb/A.

Based on these manure N benchmarks, 44% of feedlots exceed the recommended 75 lb/A fertilizer N level for corn raised on cropland and 40% exceed the 38 lb/A recommended fertilizer N level for pasture land. Further, 23% of cow-calf operations exceed the 38 lb/A manure N benchmark level for pasture land. In interpreting these outcomes, however, it should be remembered that (1) the design capacity of the feedlots covered in the study is nearly 10 times the average for all feedlots in South Dakota and (2) the average size of herd for the cow-calf operators is 1.35 times the state average.

Conclusions

What conclusions can be drawn from the study? First, it would appear that the soil and water associated with substantial proportions of the South Dakota feedlots studied, and even for a minority of cow-calf operations studied, is potentially vulnerable to pollution from animal waste. We have determined through multiple regression analysis that the relationship between estimated manure nutrient loadings and feedlot size in this study is direct and statistically significant ($P<.01$). Further, the average design capacity for feedlots which have cropland manure N loadings exceeding 75 lb/A (1,332 head) is 2.4 times that of feedlots with cropland manure N loadings of less than 75 lb/A. Thus, animal waste from the vast majority of South Dakota feedlots of an average size or smaller is unlikely to pose a nonpoint source environmental hazard.

Second, findings from the study raise a question about the potential for soil and water pollution in states with cattle populations which are much more dense than those in South Dakota. For example, the average number of fed cattle marketed per feedlot in the nine major cattle feeding states in the Southern and Central Plains, Southwest, and Northwest ranges from 7 to 284 times that in South Dakota (see Table 2 of CATTLE 95-24).

In further exploring the issues raised in this research, we would encourage empirical research to (1) estimate amounts and nutrient content of manure produced in feedlots representing various conditions, (2) determine relationships among (a) manure production from feedlots of different sizes, (b) cropland areas required for environmentally safe distribution of that manure, and (c) distances that manure can economically be transported, and (3) explore alternative means for handling animal waste.

Evaluation of Hoof Circumference to Predict Birth Weight

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CATTLE 95-16

Summary

Records from 81 calves showed that hoof circumference is an unreliable predictor of birth weight. A hoof tape predicted only 25.9% of birth weights within 2 lb of actual birth weight. For 29.6% of the calves the error in predicting birth weight was over 10 lb.

Key Words: Hoof Circumference, Birth Weight, Calves

Introduction

Birth weights and Expected Progeny Differences (EPDs) calculated from birth weights are important bull selection tools to reduce the risk of excessive calving difficulty. For convenience, hoof tapes are sometimes used as a method to estimate birth weights in place of weighing calves with a scale. Due to questions about the accuracy of hoof tapes, we evaluated the accuracy of hoof circumference compared to birth weights measured with a scale.

Materials and Methods

Records from 81 Angus, Simmental, and Angus-Simmental crossbred bull and heifer calves born in 1995 at the SDSU Cow-Calf Teaching and Research Unit were analyzed (Table 1). Within 24 hours of birth, calves were weighed with a hanging spring scale and hoof circumference was measured with a commercially available flexible hoof tape. Hoof circumference was measured on a front foot at the hairline. The tape was marked in centimeters on one side and calibrated on the other side to estimate birth weight based on the second equation in Table 2.

A linear prediction equation was calculated with hoof circumference used as the independent variable and actual birth weight measured with a scale used as the dependent variable.

Results and Discussion

The calculated prediction equation is similar to the calibration on the hoof tape (Table 3). The low R^2 (.46) indicates hoof circumference does a poor job of predicting birth weight. The hoof tape predicted only 25.9% of the birth weights within 2 lb. The error in predicting birth weight was over 10 lb for 29.6% of the calves. Using the prediction equation that we calculated did not improve the accuracy of using hoof circumference to estimate birth weight.

This information shows that hoof circumference is not a reliable method to estimate birth weight. It is sometimes reasoned that hoof circumference could be a better indicator of potential calving difficulty than birth weight. However, several research projects have failed to show any body measurements of newborn calves that can predict calving difficulty as accurately as birth weight.

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Table 1. Data used to calculate prediction equation

	Hoof circumference, cm	Actual birth weight, lb
No. calves	81	81
Mean	18.9	88.3
Standard deviation	.9	12.6
Minimum	16.0	58.0
Maximum	20.8	118.0

Table 2. Equations to predict birth weight (lb) from hoof circumference (cm)

	Intercept	Standard error	Slope	Standard error	R^2
Calculated prediction equation	-90.9	9.27	9.48	1.15	.46
Calibration on hoof tape	-100.0	—	10.0	—	—

Table 3. Error in estimating birth weight from hoof circumference

	Based on tape reading	Based on calculated prediction equation
Range in error, lb	-19.0 to 21.0	-19.8 to 19.4
Distribution of error, %		
Less than 2 lb	25.9	21.0
2.1-5.0 lb	17.3	19.8
5.1-10 lb	27.2	28.4
Greater than 10 lb	29.6	30.9

Effects of Melengestrol Acetate (MGA) and Prostaglandin on Blood Serum Progesterone, Luteinizing Hormone, and Reproductive Performance in Beef Cows

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CATTLE 95-17

Summary

A study utilizing 64 Angus and Simmental multiparous beef cows was conducted to evaluate the administration of MGA-PGF on the onset of estrus, conception rate, and to determine blood serum hormone profiles (P_4 & LH). Cows utilized were at least 30 days postpartum and stratified by age, breed, and days postpartum into two groups: a treatment group (n=32) which received MGA orally for 14 days and a control group (n=32) which did not receive MGA. Cows in the study were bled weekly for 9 weeks to monitor serum P_4 levels. Cows with serum $P_4 \geq 1$ ng/mL were considered to have cyclic activity. Cows in both groups were injected with $PGF_{2\alpha}$ 17 days after the last MGA feeding date and bred AI following observed estrus. The number of days from the start of MGA feeding to first detected estrus was lower for treated compared to control cows (19.50 ± 3.70 and 34.31 ± 3.28, respectively, P<.01). The average number of julian days to first estrus was lower for treated compared to control cows (143.81 ± 2.46 and 154.34 ± 3.25, respectively, P=.01). Conception date in julian days was also lower for the treated animals compared to control cows (156.46 ± 2.98 and 166.55 ± 3.21, respectively, P=.01). Treatment animals had a higher level of progesterone from the start of MGA feeding until the end of the bleeding period compared to the control animals (.41 ± .04 and .19 ± .04, respectively, P<.001). The average progesterone hormone level in treated cows was higher 48 hours before injecting $PGF_{2\alpha}$ compared to the control animals (1.59 ± .12 vs 0.33 ± .12, P<.001). Blood serum analyzed for LH concentration was collected 3 days prior to $PGF_{2\alpha}$ injection (Period 1) and 4 days following the $PGF_{2\alpha}$ injection (Period 2). Mean LH levels between treatment and control groups were not different for the 7 days (1.58 ± .07 ng/mL and 1.70 ± .07 ng/mL, respectively, P=.25). When analyzed by periods, mean LH levels for Period 1 were lower (1.44 ± .08 ng/mL) than mean LH levels for Period 2 (1.84 ± .07 ng/mL, P<.01). Results from the present study suggest that MGA decreased days to first detected estrus, resulted in earlier conception, increased conception rate, increased progesterone hormone levels, and increased cyclic activity.

Key Words: MGA, Prostaglandin, LH, Postpartum, Beef Cows

Introduction

In production systems where estrous synchronization is a viable alternative for use in postpartum beef cows, specific treatments or combination of treatments can be used to shorten the effective breeding season and take advantage of the possible stimulatory effect of a progestogen. Melengestrol acetate (MGA) may be used as a management tool to enhance cyclic activity and reproductive performance in postpartum cows. This should result in earlier postpartum conception and increased reproductive performance in beef cattle. Melengestrol acetate is an orally active progesterone that effectively synchronizes estrus in beef heifers and hastens the onset of puberty. Initial studies resulted in a decreased conception

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rate when heifers were bred to the MGA synchronized estrus. Later studies utilizing MGA feeding followed by prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) synchronization of the estrus after the MGA induced estrus resulted in no decrease in reproductive performance. At the present time MGA-$PGF_{2\alpha}$ administration for estrous synchronization works well for the beef heifer. However, very little research data are available for MGA or MGA-$PGF_{2\alpha}$ administration in the suckled beef cow. Since MGA appears to hasten the onset of puberty in the prepuberal beef heifer, it may also have an effect on earlier return to cyclicity in the postpartum beef cow.

The following study was conducted to determine the effect of MGA-$PGF_{2\alpha}$ on conception rate and increasing cyclicity in anestrous beef cows, as well as to evaluate hormone profiles of progesterone and luteinizing hormone in animals following MGA-$PGF_{2\alpha}$ administration.

Materials and Methods

Sixty-four suckled Angus and Simmental multiparous cows from the Cow-Calf Teaching and Research Unit at South Dakota State University were selected to be in the study. The animals were stratified by age, breed, and days postpartum into one treatment (n = 32) and one control group (n = 32). All animals in the study had to be 30 days postpartum to the first day of MGA feeding. Only cows in the treatment group were fed MGA for 14 days. Animals were group fed receiving a supplement containing MGA, approximately .4 mg of MGA per head per day. Treatment and control cows were separated for the 14-day feeding period. All animals in the study received a ration of corn silage prior and during the study. All cows in the study were bled weekly for 9 weeks to monitor serum progesterone levels. Cows in both groups were injected with $PGF_{2\alpha}$ (25 mg of Lutalyse, I.M.) 17 days after the last MGA feeding date. Twenty animals in each group were bled 3 days before $PGF_{2\alpha}$ injection (Period 1) and 4 days after the $PGF_{2\alpha}$ injection (Period 2) to monitor serum LH and progesterone levels. All cows were observed for estrus during daylight hours and inseminated 12 hours after observed estrus. Detection of estrus began immediately after the first injection of $PGF_{2\alpha}$. All cows were inseminated by the same technician using frozen semen. Eleven days after the first $PGF_{2\alpha}$ injection all animals that failed to exhibit estrus within 6 days after the 1st injection were given a second injection of $PGF_{2\alpha}$. After the AI period, all cows were exposed to an Angus bull for a 40-day natural service period.

Blood serum progesterone concentrations were analyzed using a solid-phase radioimmunoassay for all blood samples. Blood serum LH concentrations were analyzed using a monoclonal, double antibody radioimmunoassay and blood for Periods 1 and 2 were analyzed.

Progesterone and LH levels were analyzed using the GLM procedure of completely randomized block design of SAS and least means squares were used for prediction. Categorical data were analyzed using Chi-square analysis. Data were analyzed to determine any hormonal differences between treatments and periods.

Results and Discussion

Reproductive Data

Reproductive data are presented in Table 1. Cows that were treated with MGA resulted in lower number of days from the start of MGA feeding to the first detected estrus compared to the control animals (19.50 ± 3.70 vs 34.31 ± 3.28 days, $P<.01$). Also, the average number of julian days to the first detected estrus was lower in the treatment group compared to the control cows (143.81 ± 2.46 and 154.34 ± 3.25 days, $P<.01$).

Conception date in julian days was significantly lower in the treatment animals (156.46 ± 2.89) compared to the control group animals (166.55 ± 3.21, $P<.01$; Table 2). Conception rate is presented in Table 3 and was higher in the treatment group compared to the control group. Nineteen animals conceived at the first AI period in the treatment group compared to 9 animals in the control group during the same AI period. Seven animals in the control group conceived within the time frame when the clean-up bull was present compared to 3 animals in the treatment group. Two cows remained open at the end of the 90-day breeding

Table 1. Days to estrus, conception date, days from calving to conception, and average calving date

No. of days	Control group (days)	Treatment group (days)	P-value
Days to 1st estrus from start of MGA feeding	34.31 ± 3.28	19.50 ± 3.7	<.01
Julian days to 1st detected estrus	154.34 ± 3.25	143.81 ± 2.46	<.01
Conception date in julian days	166.55 ± 3.21	156.46 ± 2.89	<.01
Days from calving to conception	104.34 ± 4.59	97.6 ± 4.62	=.30
Average 1995 calving date	84.66 ± 3.45	76.44 ± 3.07	=.08

Table 2. Reproductive data

Conception rate	Control group (n=32)	Treatment group (n=32)
First AI service	9 (28%)	19 (59%)
Second AI service	13 (40%)	8 (25%)
Clean-up bull	7 (21%)	3 (9%)
Open	3 (9%)	2 (6%)
Cyclic activity[a]	9	21

[a]From the start of MGA feedinq until the first injection of $PGF_{2\alpha}$ determined by P_4 assay.

season in the treatment group vs 3 animals in the control group. This shows that MGA helped to increase conception from the first AI service, as more animals conceived during this particular time period than animals that were not fed the MGA. These results do agree with recent studies done in Kentucky, reporting that MGA improves conception rate in multiparous animals. Days from calving to conception was not different between the two groups for treatment group (97.6 ± 4.62 days) and the control group (104.34 ± 4.59 days; P=.30). The average 1995 calving date was not significantly different between treatment and control groups (76.44 ± 3.07 vs 84.66 ± 3.45 days, respectively, P=.08; Table 1).

The number of days from $PGF_{2\alpha}$ injection to the first AI service was not different between treatment and control groups (3.77 ± .59 and 5.43 ± .84 days, P=11). Progesterone blood serum levels indicate that 21 cows in the treatment group exhibited cyclic activity from the start of MGA feeding until the end of the study compared to 9 animals in the control group. Treatment with MGA improved estrous response after the first injection of $PGF_{2\alpha}$ in this study. This can be attributed to the improved synchronization of estrous cycles before $PGF_{2\alpha}$ treatment that resulted in more cows with a CL that were more responsive to $PGF_{2\alpha}$ at the time lutalyse was administrated. Results of this study demonstrated improvement in fertility as measured by conception rate and cyclicity of cows that received MGA prior to $PGF_{2\alpha}$. Also, 85% of the cows treated with MGA became pregnant during the first 2 weeks of the breeding period compared to 68% of the control cows (Table 2), illustrating the significant influence of progestogens on improving fertility in the postpartum cow.

Progesterone Data

Treatment animals had a higher level of progesterone from the start of MGA feeding until the end of the bleeding period compared to the control animals (.41 ± .04 ng/mL and .19 ± .04 ng/mL, P<.001). Progesterone levels over the bleeding period are shown in Figure 1.

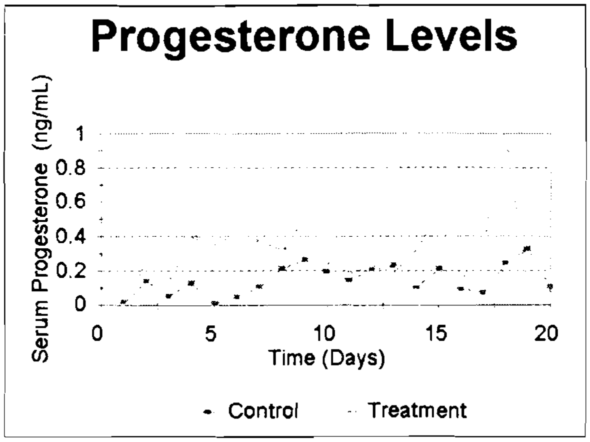

Figure 1. Average progesterone levels during the bleeding period.

Average serum progesterone levels in the treatment group were higher during the bleeding period compared to the control animals. The graph shows that cows treated with MGA had elevated concentrations of progesterone, which indicates a higher number of functional CL and an increase in cyclic activity in the MGA group. Blood serum analyzed for LH and progesterone concentration was collected 3 days prior to $PGF_{2\alpha}$ injection (Period 1) and 4 days following the $PGF_{2\alpha}$ injection (Period 2). The average progesterone hormone level (Figure 2) in treated cows was higher 48 hours before injecting $PGF_{2\alpha}$ compared to the control animals (1.59 ± .12 ng/mL and .33 ± .12 g/mL, $P<.001$). There were significant differences in levels of progesterone in Period 2 in which treated animals had a lower serum progesterone being secreted than the control animals. This shows

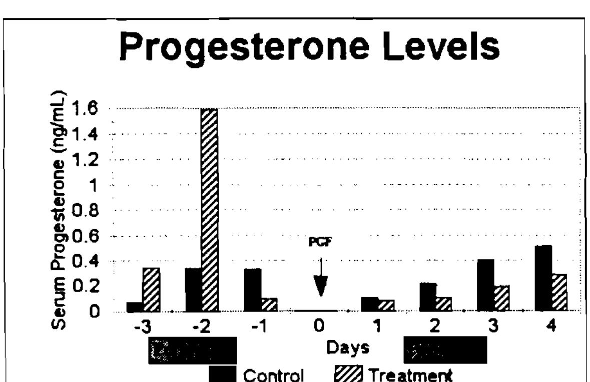

Figure 2. Progesterone levels during the two periods.

that after the $PGF_{2\alpha}$ injection more animals in the treatment group had a functional CL and regression of the CL occurred. Therefore, a lower level of progesterone was secreted from these animals compared to the control animals.

Luteinizing Hormone Data

Luteinizing hormone data is presented in Figure 3. Mean LH levels between treatment and control groups were not different for the 7 days (1.58 ± .07 ng/mL and 1.70 ± .07 ng/mL, respectively, $P=.25$). When analyzed by periods, mean LH levels for Period 1 were lower (1.44 ± .08 ng/mL) than for Period 2 (1.84 ± .07 ng/mL, $P<.01$) for all cows. Treated cows in Period 1 had lower LH levels than treated cows in Period 2 (1.35 ± .11 ng/mL vs 1.80 ± .10 ng/mL, $P<.01$). The treatment cows were administrated MGA which acts like an exogenous progestogen. Cows that have a high level of exogenous progestogen have a negative feedback on LH levels which results in lower levels of LH being secreted.

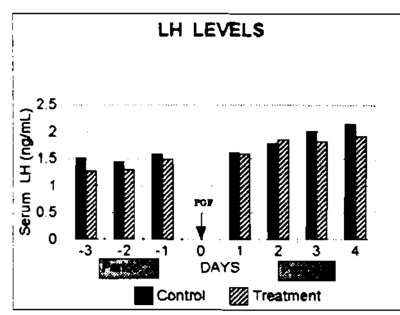

Figure 3. Luteinizing hormone levels during the two periods.

In summary use of MGA-$PGF_{2\alpha}$ in multiparous cows is a practical method of synchronization of estrous cycles in beef cows. This method effectively groups cattle into a stage of the estrous cycle for maximum effect of $PGF_{2\alpha}$ and improves conception rate, decreases days to first detected estrus, increases progesterone levels, and increases cyclic activity.

Effects of MGA on Prepubertal Crossbred Beef Heifers

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CATTLE 95-18

Summary

A study was conducted using 55 prepubertal replacement crossbred beef heifers to determine the effect of feeding MGA to prepubertal heifers on age at puberty. No difference (P=.65) was detected between MGA treated heifers versus control heifers for age at puberty. There was no difference (P=.80) in age at conception to AI for the two groups.

Key Words: MGA, Beef Heifers, Puberty, Fertility

Introduction

It is beneficial for producers to breed heifers early in the breeding season. If bred early in the breeding season, they are allowed a longer postpartum interval. This is needed so heifers can be bred with the cow herd after they calve. Breeding heifers early increases the economic value of the heifer, because she has the opportunity to wean a heavier calf. Many heifers cannot be bred early because they have not obtained sexual maturity prior to the breeding season. Progesterone like compounds can be used to induce puberty in heifers. Melengesterol acetate (MGA) is a progestin which is used in cycling feedlot heifers to suppress estrus. Once MGA feeding is stopped, these animals will exhibit estrus. It has also been shown that MGA can be used to induce puberty in beef heifers.

The purpose of this study was to determine the effects of MGA on induction of puberty in prepubertal crossbred beef heifers.

Materials and Methods

This study utilized 55 crossbred beef heifers (Angus, Hereford, Simmental, and Tarentaise) housed in dry lot at the Beef Breeding Unit at SDSU. Heifers were allotted to a control group (n=28) and a treatment group (n=27). All heifers received a cracked corn-alfalfa pellet concentrate. They had access to grass hay free choice. During the treatment period, the treatment heifers received .4 mg MGA per head per day for 14 days. The treatment period was started late January 1995 approximately 102 days before the breeding season. The average age and weights of the control and MGA heifers are shown in Table 1.

Table 1. Age and weight at start of treatment

Treatment	Age (days)	Weight (lb)
Control	302	622
Treatment	302	634

Cyclicity was determined by the collection of weekly blood samples. Samples were collected by jugular venipuncture. Upon centrifugation, blood sera was assayed for progesterone by a one step radioimmunoassay method. Samples containing 1 ng/ml or greater

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of progesterone were used to indicate the presence of a functional corpus luteum.

The breeding season was initiated in early May. The artificial insemination (AI) period lasted for 10 days. On day 7, the heifers received an injection of Lutalyse to synchronize estrus. Heifers were placed in a grass pasture with a clean-up bull for 53 days. Blood samples were collected for four weeks post-AI to determine if heifers conceived to AI. Indications of conception were three or more consecutive elevated progesterone levels. Pregnancies will be determined in August, approximately 35 days after the clean-up bull is removed using B-mode real time ultrasound.

Age and weights were analyzed using GLM procedure of SAS. Pregnancy data will be analyzed by Chi-square.

Results and Discussion

At the start of the study, the heifers were of similar age and weight (Table 1). None of the heifers showed signs of estrus. Based on progesterone levels in the blood, at the start of the breeding season 19 heifers had not displayed elevated levels of progesterone indicative of cyclic activity. At the end of blood collection period only 2 heifers had not displayed elevated progesterone levels and were not used in the analysis of days of age to first estrous.

No difference was detected between treatment groups for condition score (P=.88). The condition score of the treatment and control groups were 3.4. Condition scores are lower than what is preferred at the start of the breeding season. This may be due to the unusually wet weather experienced in the spring of 1995. The lot the heifers were housed in was extremely muddy. This could explain the low gains present from the start of the study to the beginning of the breeding season.

Weight at the start of the breeding season was not significantly different (P=.57). The mean weight for the control group was 709 lb and for the treatment group it was 721 lb. It would appear that the heifers were near 65% of the mature body weight at the beginning of breeding season.

Conception age to AI was not different (P=.80) between the control and treatment group (Table 2). The mean age at conception was 419 days for the control group and 418 days for the treatment group. Progesterone levels indicate 17 of 29 heifers inseminated had 3 or more consecutive elevated progesterone levels. Of the 17, 10 were treatment heifers and 7 were control heifers. The response to the Lutalyse appeared low (29 of 55). This may have been due to lower body condition scores and poor lot conditions.

Table 2. Condition score, weight at breeding, and age at AI

Treatment	Condition score	Weight (lb)	Age (days)
Control	3.4	709	419
Treatment	3.4	721	418

Under the conditions of this study the results are inconclusive as to whether MGA induced puberty in heifers. Further research is needed to give a better indication of whether MGA will be an effective tool to induce puberty in beef heifers.

Can Beef Tallow Make a Comeback?

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CATTLE 95-19

Summary

A study was conducted to evaluate the use of soybean oil (SBO), beef tallow (TAL) and a 50% SBO 50% TAL blend (50/50) in frying three fast-food type products (french fries, chicken nuggets, and beef fingers). Frying french fries in SBO resulted in higher cooking yields ($P<.05$) than frying in 50/50 or TAL. No differences among oils were seen ($P>.05$) in color development during frying french fries. Consumer taste panelists preferred the flavor and overall acceptability ($P<.05$) of french fries fried in SBO and 50/50 over those fried in TAL. The cooking yield of chicken nuggets was highest ($P<.05$) for SBO followed by 50/50 ($P<.05$) followed by TAL. Chicken nuggets fried in 50/50 were darker ($P<.05$) than those fried in SBO. Consumer taste panelists could not distinguish ($P>.05$) between oil types for flavor, crispness, or overall acceptability of chicken nuggets. Beef fingers fried in 50/50 were the most red in color ($P<.05$) followed by TAL ($P<.05$) followed by SBO. Consumer taste panelists were unable to differentiate between oils ($P>.05$) for flavor, crispness, or overall acceptability of beef fingers.

Key Words: Beef Tallow, Soybean Oil, Fried Foods

Introduction

Fats and oils have universal appeal. To date no other food product can match the functionality and versatility of fats and oils. Foods fried in oil offer special properties, including a smooth mouthfeel, pleasant flavor, and desired texture. Recent consumer trends toward fat reduction in the diet have put pressure on processors to reduce the fat in the final product. Despite such trends, fried foods have held a constant place in the American diet. Even with some fried food containing as much as 45% fat, consumers seem to enjoy them and keep them as part of their diet. Yearly per capita consumption of fats and oils is estimated at 62.7 lb in the United States. This has remained fairly constant despite healthy trends. This per capita consumption far exceeds the Dietary Guidelines recommended by the National Research Council. It seems that consumers are concerned about fat, but they are not willing to sacrifice the enjoyment they get from consuming fried foods.

Traditionally fried foods were cooked in a variety of oil types including those from animal sources. With the linking of dietary cholesterol to an increased risk of coronary heart disease, many fast-food restaurants and snack food companies opted to use vegetable oils to avoid the cholesterol debate. In an effort to improve the perceived healthiness, some of the flavor and functionality of the oils was lost. Due to stability problems with unsaturated fatty acids in most vegetable oils, hydrogenation became popular.

Hydrogenation of vegetable oils adds to the stability of the oil. It also increases the saturation of the fatty acids and shifts natural *cis* bonds (hydrogen atoms on the same side of the carbon-carbon bond) to the *trans* configuration (hydrogen atoms on opposite sides of the carbon-carbon bond). Due to the structural change in the molecule, the fatty acids will pack together tighter creating a solid rather than a liquid oil. A shift in the bond structure causes a number of responses in the body. The body perceives *trans* fatty acids as saturated. The result is an increase in low density

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lipoprotein cholesterol and a decrease in high density lipoprotein cholesterol levels in the blood. Both of these conditions have been linked to an increased risk of coronary heart disease. Recent publicity of the health problems associated with hydrogenated oils coupled with the hypothesis that consumers like foods fried in animal fats has opened a window of opportunity for the beef tallow industry.

The objectives of this study were to compare the color, flavor, and cooking performance of three products (french fries, chicken nuggets, and beef fingers) in three cooking oils (100% beef tallow, 100% soybean oil, and a 50% beef tallow 50% soybean oil blend).

Materials and Methods

Oils used in this study were 100% beef tallow, 100% soybean oil, and a 50% beef tallow 50% soybean oil blend. Oils were obtained from the Cargill Oil Division (Chicago, IL). Oils were formulated to contain 150 ppm Tennox 20 (a commercial antioxidant).

Products fried in this study were french fried potatoes (similar to those in fast-food restaurants), breaded chicken nuggets, and breaded beef fingers. All products were obtained from Harkers Distribution (LeMars, IA). All products were produced in the same plant from common raw materials.

Products were fried in commercial type fryers to a constant endpoint (preliminary tests determined the time and temperature for optimum performance of each product). Products were fried on three consecutive days. Five batches (1 lb each) of each product in each oil were prepared for a total of 45 lb of each product in each oil.

Color was measured on each cooked product using a Minolta hand held spectrophotometer programmed to measure L*, a*, and b* values. This color system is used to measure sample lightness/darkness (L*), redness (a*), and yellowness (b*). A series of five measurements was taken per cooked batch. A consumer taste panel was conducted on each product. Each panel ran three consecutive days with a minimum of 60 participants per day. Factors evaluated included flavor, crispness, and overall acceptability. Panelists were seated in individual stalls and presented samples of products fried in each oil. Random three digit numbers were used to mask the identity of each sample. Panelists were given a response sheet with a series of boxes ranging from dislike extremely to like extremely and asked to check the box that best described the sample presented. A number was later assigned to each box to create a nine-point hedonic sensory scale. All panel stalls were under red lighting to mask perceived color differences.

Data were analyzed using the GLM procedure of SAS as appropriate for a randomized complete block design. Mean separation was accomplished using individual contrasts.

Results and Discussion

Frying french fries (Table 1) and beef fingers (Table 3) in SBO resulted in higher cooking yields ($P<.05$) than frying in 50/50 or TAL. The cooking yield of chicken nuggets was the highest ($P<.05$) for SBO followed by 50/50 ($P<.05$; Table 2).

Color (L*, a*, b*) values were similar ($P>.05$) between all oil types when frying french fries (Table 1). As shown by the L* values, chicken nuggets fried in 50/50 were darker ($P<.05$) than chicken nuggets fried in SBO (Table 2). No differences were found ($P>.05$) for a* (redness) and b* (yellowness) values in chicken nuggets (Table 2). Beef fingers fried in 50/50 were the most red ($P<.05$) in color followed by TAL ($P<.05$), followed by SBO (Table 3). Oil type had no effect ($P>.05$) on lightness (L*) or yellowness (b*) of beef fingers (Table 3).

The consumer taste panels represented a cross-section of the university, city, and rural communities. A minimum of 60 panelists per day participated. An approximately equal distribution of sex and age of the panelists was obtained. Panelists preferred the flavor ($P<.05$) and overall acceptability ($P<.05$) of french fries fried in SBO and 50/50 over that of french fries cooked in TAL (Table 4). Oil type had no effect

Table 1. Cooking yield and color analyses of french fries

Variable	Treatment SBO	50/50	Tallow	SE
Cooking yield, %	58.27[a]	56.80[b]	57.40[b]	.17
L*[c]	63.43	62.95	62.96	.18
a*[d]	2.41	2.69	2.67	.14
b*[e]	26.81	27.73	27.32	.29

[a,b]Means within a row lacking common superscripts differ ($P<.05$).
[c]A higher L* number equals a lighter sample.
[d]A higher a* number equals a more red sample.
[e]A higher b* number equals a more yellow sample.

Table 2. Cooking yield and color analyses of chicken nuggets

Variable	Treatment SBO	50/50	Tallow	SE
Cooking yield, %	80.32[a]	79.36[b]	78.75[c]	.09
L*[d]	48.71[a]	47.66[b]	48.29[ab]	.25
a*[e]	12.38	12.61	12.69	.14
b*[f]	34.17	33.76	34.34	.46

[a,b,c]Means within a row lacking common superscripts differ ($P<.05$).
[d]A higher L* number equals a lighter sample.
[e]A higher a* number equals a more red sample.
[f]A higher b* number equals a more yellow sample.

Table 3. Cooking yield and color analyses of beef fingers

Variable	Treatment SBO	50/50	Tallow	SE
Cooking yield, %	82.40[a]	81.50[b]	81.82[b]	.09
L*[d]	43.30	42.11	42.80	.40
a*[e]	10.29[a]	11.28[b]	10.80[c]	.10
b*[f]	26.67	26.59	26.47	.16

[a,b,c]Means within a row lacking a common superscript differ ($P<.05$).
[d]A higher L* number equals a lighter sample.
[e]A higher a* number equals a more red sample.
[f]A higher b* number equals a more yellow sample.

Table 4. Consumer taste panel analyses of french fries

Variable	Treatment			SE
	SBO	50/50	Tallow	
Flavor[c]	5.92[a]	6.02[a]	5.38[b]	.12
Crispness[c]	6.43	6.43	6.12	.12
Overall acceptability[c]	6.19[a]	6.29[a]	5.67[b]	.13

[a,b]Means within a row lacking a common superscript differ ($P<.05$).
[c]1 = dislike extremely; 9 = like extremely.

($P>.05$) on the crispness of french fries (Table 4). Panelists could not distinguish between oil types for flavor, crispness, or overall acceptability ($P>.05$) of chicken nuggets (Table 5). No differences ($P>.05$) were found for flavor, crispness, and overall acceptability of beef fingers across oil types (Table 6). Both the chicken nuggets and the beef fingers were breaded products that contained spices in the breading. The french fries were raw potato strips with no salt or spices added. It seems the panelists were able to pick up the flavors of the oils more on the french fries than from the breaded products. They seemed to find an unfamiliar flavor in the TAL fries but not in the 50/50 fries. The spices in the breaded products may have made it more difficult for panelists to distinguish flavors produced by the oils.

Conclusions

Oils containing up to 50% beef tallow could be used for frying these types of fast-food products with no adverse effects on color or consumer acceptability. Soybean oil has been used exclusively by the fast-food industry for some years now. The flavors associated with animal based frying oils may be unfamiliar to some consumers. Comments were taken from each of the panelists and revealed some interesting trends. Review of the comments led us to believe that the flavor of TAL fried foods may not have been objectionable to the consumers as much as it was unfamiliar. The transition from frying oils of a vegetable base to those of an animal base may take some adjustment by the consumer.

Future Research

Work is currently being conducted in our lab to reveal the chemical composition of these oils and the products fried in these oils. The *cis/trans* bond makeup of the oils and the cooked products will be of great interest to health wise consumers. Further work on the economic feasibility and the possibility of animal vegetable blends should be conducted.

Acknowledgements

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Table 5. Consumer taste panel analyses of chicken nuggets

Variable	Treatment			SE
	SBO	50/50	Tallow	
Flavor[a]	6.62	6.33	6.41	.22
Crispness[a]	6.53	6.75	6.39	.11
Overall acceptability[a]	6.48	6.80	6.44	.18

[a]1 = dislike extremely; 9 = like extremely.

Table 6. Consumer taste panel analyses of beef fingers

Variable	Treatment			SE
	SBO	50/50	Tallow	
Flavor[a]	6.15	6.46	5.93	.20
Crispness[a]	7.07	7.15	6.89	.08
Overall acceptability[a]	6.43	6.68	6.25	.17

[a]1 = dislike extremely; 9 = like extremely.

Survey for Verotoxic *Escherichia coli* in Preharvest Beef Production Environments in South Dakota

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CATTLE 95-20

Summary

Evaluation of fecal swabs from 140 slaughter beef animals in South Dakota in the months of July through September 1993 and 1994 did not yield any *Escherichia coli* O157:H7. In like manner, the evaluation of 126 ground beef samples was negative for this microorganism. Fecal swabs and ground beef samples were obtained from all sections of the state. The slaughter facilities were inspected by the South Dakota Department of Agriculture's Animal Industries Board. There were 167 isolates of strains of *E. coli* with the gene for production of verotoxins. The significance of these organisms to cattlemen and consumers is not known.

Key Words: *Escherichia coli* O157:H7, Verotoxin, Beef

Materials and Methods

A survey was initiated in the summer of 1993 and finished in the summer of 1994 for the prevalence of *E. coli* O157:H7 and other verotoxigenic *E. coli* serotypes. Four quadrants of South Dakota were surveyed by obtaining at least 30 fecal swabs and 30 ground beef samples from each quadrant. The summer months were chosen because the literature indicates a higher incidence of human disease from *E. coli* O157:H7 during these months. Ground beef samples were either purchased at retail or were received from samples sent to the Animal Disease Research and Diagnostic Laboratory, South Dakota State University by the SD Animal Industries Board Inspectors in the Residue Monitoring program.

The procedures approved by the US Department of Agriculture (Revision 3 of Laboratory Communication #38-*Escherichia coli* O157:H7) were used for the isolation of *E. coli* from the fecal swabs and ground beef. The 3M™ Petrifilm™ Test Kit-HEC was the key analytical device used to select stains typical of *E. coli* O157:H7. Testing with specific antisera for the O157 somatic antigen and the H7 flagellar antigen was accomplished on suspect isolates.

Probes were constructed to detect the genes coding for the two Shiga-like toxins (SLT) SLT I and SLT II) commonly found in verotoxic *E. coli*. These were constructed by the ADRDL, SDSU.

Verotoxin production by the isolates carrying the SLT I or SLT II genes is currently being determined.

The statistical evaluation for the prevalence of *E. coli* O157:H7 in South Dakota slaughter cattle and ground beef was performed by evaluation of a binomial distribution at the 95% confidence level.

Results and Discussion

No *E. coli* O157:H7 were isolated from more than 2,700 organisms isolated in this survey.

There were 167 cultures of verotoxigenic *E. coli* strains isolated. There were 12 strains that had the SLT I gene and 155 strains that had the SLT II gene and 2 strains that had both SLT I and SLT II genes. Due to the selection of multiple cultures from each fecal swab and ground beef sample, there were four cattle

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positive for the SLT I genotype and 36 cattle positive for the SLT II genotype. For ground beef, there were three samples positive for the SLT I genotype and 32 positive for the SLT II genotype.

Based on the lack of isolation of *E. coli* O157:H7 from 140 slaughter beef animals, the level of this organism in South Dakota beef cattle is low at any point in time. If one positive in the 140 head had been found, an infection rate of 0% to 2.1% could be expected at the 95% confidence level. The projected low infection rate of South Dakota beef cattle is in line with studies being conducted in other parts of the United States.

The level of contamination of ground beef available to consumers in South Dakota is low also. Even if one sample had been found positive, a contamination level that is between 0 and 2.3%, with a 95% confidence level, can be calculated.

Acknowledgement

The funding of this study by the South Dakota Beef Industry Council is gratefully acknowledged.

South Dakota Retained Ownership Demonstration

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CATTLE 95-21

Summary

Three hundred seventy-four calves representing 44 cow-calf producers were consigned to a custom feedlot. Steer calves (254 head) consigned in October weighed 522 lb initially, gained 2.91 lb per head daily, and averaged 1,100 lb at slaughter after an average of 200 days on feed. Average cost of gain and profitability were $48.94 per cwt and -$12.03 per head, respectively. Steers consigned in January weighed 711 lb initially, gained 3.07 lb per head daily, and averaged 1,135 lb at slaughter after 141 days on feed. Average cost of gain and profitability were $43.59 per cwt and -$64.22 per head, respectively. Losses observed for 1994-95 were due to low carcass beef prices relative to the price of feeder cattle in fall of 1994 and January of 1995. As in previous years, average daily gain, days on feed, and quality grade appear related to differences in profit between cattle.

Key Words: Retained Ownership, Feedlot Performance, Feedlot Profitability

Introduction

Retained ownership of feeder calves has been shown to improve profitability of cow-calf operations when examined over many years. Average profit for cattle enrolled in October the first 3 years of the South Dakota Retained Ownership Demonstration were about $50 per head. Profits for cattle consigned in the fall of 1993 averaged -$86.61 per head. The range in profitability throughout the first 4 years for all of the groups of five calves was from -$173.03 to $177.36. An understanding of the factors influencing the profitability of retained ownership is essential in order to successfully use retained ownership as a market alternative.

The objective of this multi-year program is to evaluate retained ownership as a marketing alternative for cow-calf producers. This report summarizes data from the fifth year of the project.

Materials and Methods

Twenty-six cow-calf producers consigned 254 steer calves to a custom feedlot[6] in mid-October of 1994. Nineteen cow-calf producers consigned 120 steer calves to the feedlot at the end of January 1995. Cattle that were placed in January had been weaned in the fall and backgrounded at home prior to feedlot arrival.

Processing procedures included weighing, measuring hip height, and ultrasound[7] determination of initial fat thickness and rib eye area at the 12th rib for all steers arriving in the fall or winter. All cattle were treated for parasites, vaccinated, implanted and started on feed in the same manner as described in Beef Report articles from previous years describing the Retained Ownership Demonstration. Individual feed, yardage and veterinary bills were

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also allocated as described in previous years. Cattle were sold as individuals on a grade and yield basis as each calf appeared to reach .4 in. rib fat.

Results and Discussion

A wide variety of cattle types were represented in the program. Initial weight, hip height, rib fat, and rib eye area are displayed in Table 1. Cattle placed on feed in October averaged 522 lb and ranged from 308 to 802 lb. Steers placed in January averaged 711 lb, were 46.86 inches tall at the hip, carried .19 in. of backfat, and had an average rib eye area of 8.20 inches.

Feedlot performance information is shown in Table 2. Cattle were weighed full the day prior to slaughter. Slaughter weight for each steer was computed by applying a 4% pencil shrink to this full weight. Slaughter weight was greater for the January steers as compared with October steers (1135 vs 1100 lb). Average daily gain was also greater for January steers than for the October steers (3.07 vs 2.91 lb per head daily). January steers were fed fewer days than October steers (141 vs 200 days).

Average dry matter intake was 19.23 and 20.29 lb per head daily for the October steers and January steers, respectively. Feed to gain ratios were 6.63 and 6.69 lb dry matter per pound gain for the October steers and January steers, respectively. Performance observed for the October calves was greater this year than in 1993-94 and similar to the first 3 years of the project. Feed to gain and average daily gain for the January steers were poorer this year than in previous years.

Table 1. Initial data for retained ownership cattle

	Weight, lb	H.p height, in.	Initial fat, in.	Initial rib eye area, $in.^2$
October steers				
Average	522	44.10	.15	7.36
Range	308-802	38.50-50.00	.01-.28	4.91-9.93
Standard deviation	62	1.86	.03	.87
Range (5 head)	414-682	42.00-47.10	.11-.23	6.30-8.16
January steers				
Average	711	46.68	.19	8.20
Range	512-1055	43.00-52.50	.03-.41	5.81-10.67
Standard deviation	108	1.89	.06	.99
Range (5 head)	579-1019	44.10-49.20	.14-.34	6.93-9.56

Table 2. Feedlot performance for retained ownership cattle

	Slaughter weight, lb	Average daily gain, lb	Days fed
October steers			
Average	1100	2.91	200
Range	862-1432	1.51-4.04	166-227
Standard deviation	90	.41	23
Range (5 head)	943-1259	2.43-3.59	171-227
January steers			
Average	1135	3.07	141
Range	874-1392	.97-4.33	97-155
Standard deviation	94	.53	19
Range (5 head)	999-1300	2.52-3.73	104-155

Table 3 shows carcass data collected for the cattle. Carcasses of the January steers were heavier than carcasses of the October steers. Percentage choice carcasses for the October and January steers were 62.95 and 43.70, respectively. Both sets of carcasses were somewhat leaner than the target fat thickness of .4 inch. This reflects our desire to market these cattle prior to a greater reduction in the carcass beef price that the industry expected.

Table 4 shows the feeding period costs for the cattle. Feed and yardage expenses were greater for the October steers than the January steers due to additional time on feed. Veterinary and death loss costs were much higher for the October steers than for the January steers. January cattle were backgrounded at the home ranch and probably experienced additional death loss and veterinary expenses at home prior to feedlot arrival. Feed and total cost of gain are expressed on an initial weight to slaughter weight basis. Feed cost of gain was similar for both sets of steers, yet total cost of gain was greater for the October steers than that observed for the January cattle. Break-even sale prices were $65.93 and $68.04 per cwt for the October and January steers, respectively.

Table 5 shows the initial and sale values and profitability of cattle fed in the program. Initial price for the October steers was established by using numerous sale barn reports for the last 3 weeks in October and regressing price on pay weight (Figure 1). The same technique was used for predicting the January prices (Figure 2). Equations predicting price are displayed in Table 6. No attempt was made to adjust the initial prices for breed type, frame size, initial condition, or location.

All cattle were sold on a grade and yield basis. Table 7 displays the steer carcass prices that were obtained for the cattle. A seasonal decline in the base choice price and a widening of the choice-select spread was observed. A greater number of the October steers were sold at the earlier marketing dates, resulting in a higher price being paid for these cattle as compared with the January steers. A higher percentage of the October steers graded low choice or higher as compared with the January cattle. This also contributed to a higher carcass price for the October steers as compared with the January steers.

Profits, excluding calf interest and trucking to the lot, were -$12.03 and -$64.22 per head for the October and January steers, respectively. The variability in profitability between individual cattle and between groups of five head was tremendous (Table 8). The poorest profitability group of five cattle among the October calves lost $181.80 per head. The most profitable group of five cattle made $33.74 per head. Annual return on investment for all of the groups of five ranged from -77.82 to 16.39%.

Table 3. Carcass data for retained ownership cattle

	Hot carcass wt, lb	Dressing percent	Fat thickness, in.	Rib eye area, in.^{2}	Kidney, heart, and pelvic fat, %	Calculated yield grade, units	Marbling score, units[a]	Percent choice
October steers								
Average	686	62.34	.37	12.23	2.23	2.55	5.10	62.95
Range	524-893	57.33-69.09	.10-.90	9.30-17.00	.00-4.00	1.00-4.15	3.40-7.50	
Standard deviation	59	1.81	.15	1.30	.81	2.55	.67	
Range (5 head)	587-805	60.69-64.32	.14-.57	10.78-14.40	1.4-2.8	1.68-3.44	4.23-5.99	0-100
January steers								
Average	704	62.03	.33	12.43	2.17	2.46	4.83	43.70
Range	548-888	52.50-68.60	.10-.70	10.0-16.4	.00-4.00	.99-3.72	3.80-6.00	
Standard deviation	61	1.98	.12	1.32	.62	.52	.47	
Range (5 head)	613-810	60.08-64.23	.20-.51	10.76-14.92	1.5-2.5	1.88-3.11	4.44-5.47	0-80

[a]4.00 = Slight°, 5.00 = Small°.

Table 4. Feeding period costs[a]

Item	October steers	January steers
Feed	216.05	154.28
Yardage	30.17	20.73
Veterinary	13.87	8.42
Interest[b]	6.24	3.13
Trucking[c]	7.70	7.94
Marketing	1.47	1.47
Death loss	6.25	5.74
Total	281.75	201.71
Feed cost of gain[d], $/cwt	37.44	36.54
Total costs of gain[d], $/cwt	48.94	43.59
Break-even sale price, $/cwt	65.93	68.04

[a]Average dollars per head.
[b]Interest on feed, yardage, and veterinary expenses only.
[c]Trucking to packing plant only.
[d]Initial weight to slaughter weight basis.

Table 5. Profitability of retained ownership steers and heifers

Item	October steers	January steers
Initial pay weight, lb	544	740
Price, $/cwt	81.73	77.28
Initial value, $	442.82	570.21
Hot carcass wt, lb	686	704
Carcass price, $/cwt	103.94	100.56
Sale value, $	712.54	707.70
Profit, $/head[a]	-12.03	-64.22
Annual return on investment, %	-3.93	-29.93

[a]Excludes calf interest and trucking to the feedlot.

Table 6. Equations predicting initial price

Cattle	n	Equation[a]	R^2	Sy.x
October steers	2386	$123.6763 - .10855 \times lb + .000057 \times lb^2$	.7319	3.27
January steers	470	$153.624 - .18265 \times lb + .000105 \times lb^2$	.8117	3.11

[a]Weight = pay weight in lb.

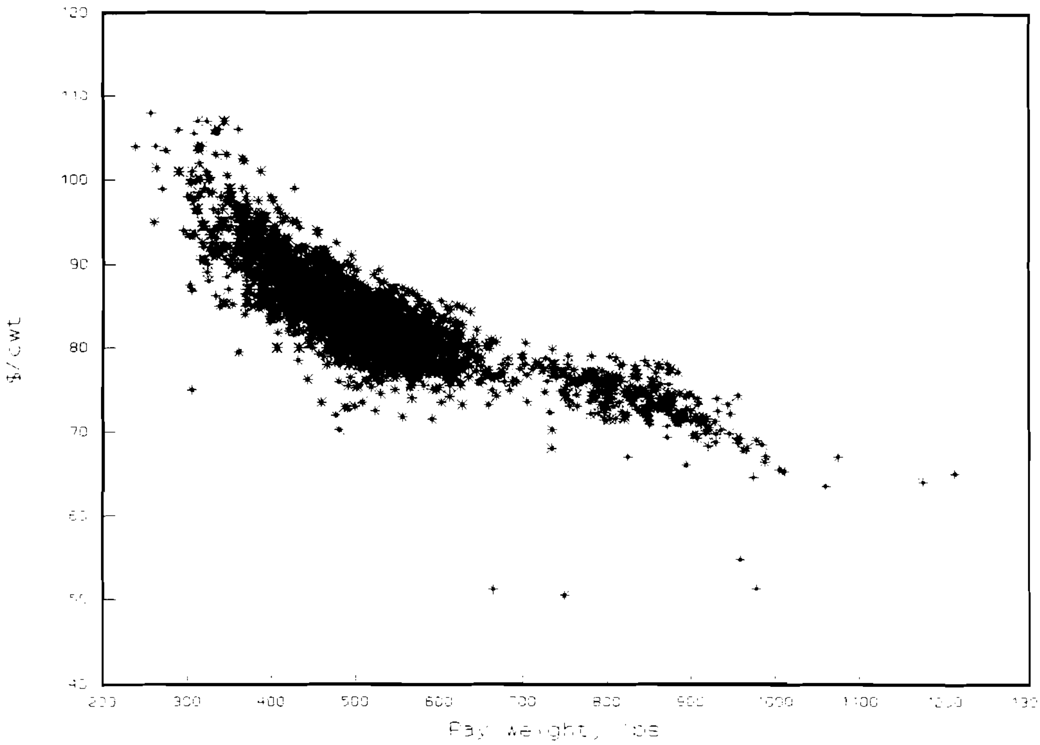

Figure 1. Relationship between price and pay weight of steers for late October 1994.

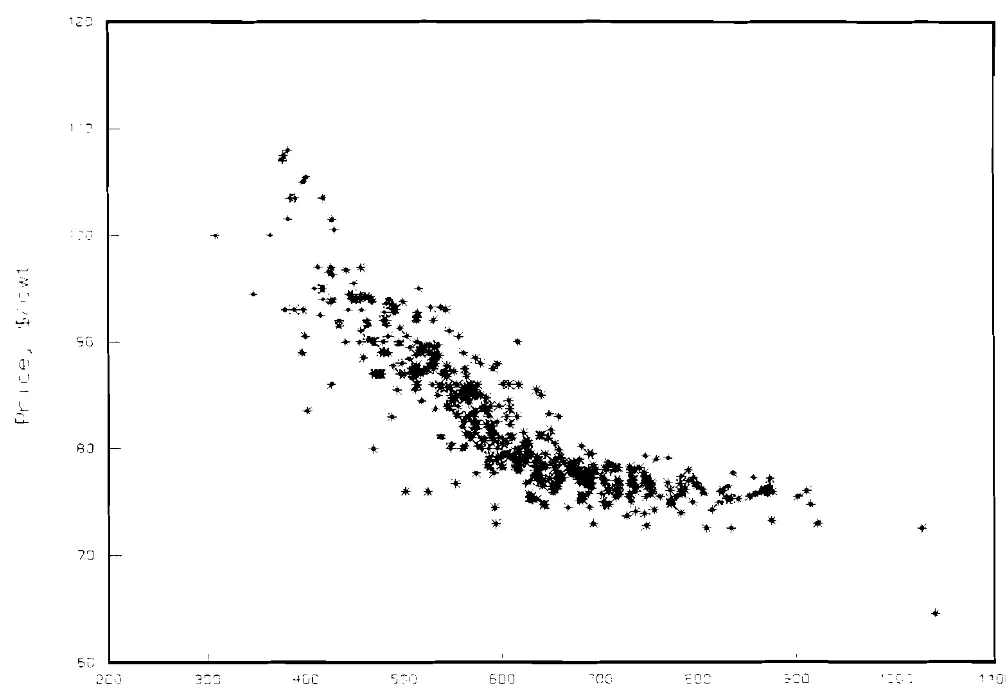

Figure 2. Relationship between price and pay weight of steers for late January 1995.

Table 7. Market dates of the cattle and carcass prices paid for cattle

Market date	Number of cattle sold: October steers	January steers	Base choice price[a]	Select discount[a]
March 30	45	—	111.00	4.00
April 27	113	16	107.00	4.00
May 31[b]	93	31	104.00	10.00
June 21[c]	—	72	106.00	9.00

[a]$ per cwt carcass.
[b]One carcass was discounted $22/cwt for weighing <550.
[c]One stag carcass discounted $28/cwt.

Table 8. Variation in profitability

	Profit, $/head	Annual return, %	Initial calf value, $/cwt
October steers			
Average	-12.03	-3.93	79.49
Range	-292.17-88.49	-100.73-39.99	29.78-101.02
Standard deviation	46.30	18.13	8.99
Range (5 head)	-115.10 - 33.74	-40.32 - 16.39	60.27-89.59
January steers			
Average	-64.22	-29.93	68.88
Range	-278.06 - 36.87	-119.45 - 16.59	47.22-84.06
Standard deviation	52.56	23.81	6.89
Range (5 head)	-181.80 - -25.24	-77.82 - -9.37	61.07-75.49

Another way to express retained ownership profitability is to use slaughter value and feedlot costs to back calculate the value of the calves when they entered the feedlot. October and January steers were worth $712.54 and $707.70 per head at slaughter, respectively. Total feeding costs were $281.75 and $201.71 per head for the October and January steers, respectively. Therefore, the calves were worth $430.79 and $505.99 at feedlot arrival for the October and January steers, respectively. Average pay weights on the calves were 544 and 740 lb for the October and January steers, respectively. Thus, October steers were worth $79.49 per cwt and the January steers were worth $68.88 per cwt. These calf values represent no interest charge on the calf and no feedlot profit. If one assumes calf interest at 9.5%, breakeven calf values are $75.37 and $66.37 per cwt.

Tables 9 and 10 show the value of select variables for low, middle, and high profitability groups for the October and January steers, respectively. Average daily gain, days on feed, and percentage of choice appear to be important factors determining profitability for cattle placed on feed in October. High profit cattle had lower cost of gain than low or middle profit cattle ($46.93 vs $50.54 and $49.32 per cwt, respectively).

For the January steers, high cost of gain appeared to sort cattle into the low profit group. Cattle in the high profit group appeared to be of higher quality. Over 97% of the cattle in the high profit group graded low choice or higher as

Table 9. Value of select variables for low, middle, and high profit groups of October placed calves

Variable	Profit group Low 1/3	Mid 1/3	High 1/3
Profit, $/head	-62.15	-4.92	31.50
Average daily gain, lb	2.65	2.87	3.21
Initial weight, lb	522	530	514
Finished weight, lb	1082	1102	1116
Dressing percent	61.87	62.32	62.83
Days fed	212	200	188
Total cost of gain, $/cwt	50.54	49.32	46.93
Percentage choice	24.81	79.8	85.5
Dry matter intake[a]	17.86	19.19	20.68
Feed/gain	6.76	6.68	6.43

[a]Calculated from body weight and gain using net energy relationships.

Table 10. Value of select variables for low, middle, and high profit groups of January placed steer calves

Variable	Profit group Low 1/3	Mid 1/3	High 1/3
Profit, $/head	-120.98	-60.67	-12.42
Average daily gain, lb	2.94	3.22	3.05
Initial weight, lb	783	661	691
Finished weight, lb	1154	1117	1133
Dressing percent	61.28	62.01	62.79
Days fed	130	145	148
Total cost of gain, $/cwt	47.49	40.87	42.49
Percentage choice	15.4	17.5	97.5
Dry matter intake[a]	20.86	20.20	19.83
Feed/gain	7.28	6.28	6.52

[a]Calculated from body weight and gain using net energy relationships.

compared with 15.4 and 17.5% for the low and middle profit groups, respectively.

Acknowledgements

Support for this project was contributed by Purina Mills, Inc., MSD AGVET, and Syntex Animal Health. The time and effort contributed by numerous private industry personnel who served on the project steering committee are also greatly appreciated. They included John McGee, Chamberlain; Ron Bauer, Platte; Art Winsky, Kimball; John Heiberger, Bridgewater; Ed Blair, Vale; Rod Larsen, Kimball; Dr. Bruce Naasz, Kimball; Dr. Arnie Fleck, Sioux City, IA; Jim Honomichl, Mitchell; and Ron Frederick, Selby. Appreciation is also expressed to numerous SDSU faculty, graduate students, staff, and extension agents who contributed to the project.

Strict Enforcement of Zero Tolerance: Effect on Carcass Weight and Dressing Percent

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CATTLE 95-22

Summary

Strict enforcement of "Zero Tolerance" regulations in the beef industry is a concern to producers and beef packers. Data on over 1,500 steers, fed and slaughtered over a four period, as part of the South Dakota Retained Ownership Demonstration Project were used to estimate the cost to producers of zero tolerance enforcement. Regression analysis was used to estimate hot carcass weight and dressing percent using the first three years data (time period prior to zero tolerance enforcement). Hot carcass weight and dressing percent were then predicted for year four. On average 13.8 lb of additional hot carcass weight was predicted compared to actual hot carcass weight. If this is due to the additional trimming associated with the enforcement of zero tolerance, then the loss to producers would have averaged $15.73 per head in 1994.

Introduction

The USDA began a program of strict enforcement of "Zero Tolerance" in the beef packing industry following the E. coli 0157:H7 outbreak in the Pacific Northwest in 1993. The regulations require beef packers to trim away large parts of a carcass if any fecal contamination occurs. The results of this enforcement are likely to be increased costs to beef packers, decreased revenue to cattle producers, and increased costs to consumers and society.

Those involved in the beef industry are not opposed to "zero tolerance." However, the present regulations are opposed by those who feel there are alternative, more cost effective methods of controlling E. coli and other contaminants. In addition, many feel that the beef industry is being forced to operate under stricter guidelines than the poultry industry, creating an unfair advantage for the poultry industry. According to one major beef packing firm, the current inspection differences (zero tolerance and other regulations) amount to about $43 per market steer subsidy to the poultry industry.

The objective of this paper is to determine the average amount of additional carcass weight that is being trimmed off and lost under the present regulations. The value of this lost carcass weight, or cost to producers, will then be estimated.

Materials and Methods

South Dakota State University has conducted a steer feeding and marketing demonstration the last four years. There has been 1,164 steers that have been placed on feed in October and fed an accelerated finishing ration at the same feedlot. The steers were marketed and slaughtered at one beef packing plant with the same slaughter endpoint (market when the estimated fat cover over the 12th rib is .4 inch). Detailed data have been collected at slaughter on these steers (Table 1).

In years three and four of the demonstration, there also has been 365 steers and 154 heifers placed on feed in January and fed a finishing ration. These cattle were marketed at the same slaughter endpoint as the 1,164 steer calves. Slaughter data on these steers and heifers are presented in Table 2.

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Table 1. Means and standard deviations on slaughter data of 1,164 steer calves fed an accelerated finishing ration

Variable	Units	Year 1 n=250	Year 2 n=350	Year 3 n=150	Year 4 n=414
Slaughter weight	lb	1146.91^{a}	1124.54^{b}	1148.38^{a}	1152.99^{a}
		(99.080)	(106.905)	(97.064)	(102.069)
Hot carcass weight	lb	733.58^{a}	718.75^{b}	724.48^{ab}	722.81^{ab}
		(69.533)	(77.021)	(64.641)	(69.751)
Dressing percent	%	63.94^{a}	63.87^{a}	63.07^{b}	62.67^{c}
		(1.904)	(2.002)	(1.818)	(1.948)
Days on feed	days	195.70^{a}	189.41^{b}	182.31^{c}	207.01^{d}
		(17.006)	(16.402)	(23.529)	(25.981)
Fat over 12th rib	inches	.42^{a}	.45^{b}	.39^{a}	.40^{a}
		(.152)	(.160)	(.145)	(.143)
Rib eye area	sq. in.	12.84^{a}	12.33^{b}	12.69^{a}	12.36^{b}
		(1.555)	(1.678)	(1.225)	(1.332)
Kidney, heart & pelvic fat	%	2.47^{a}	2.38^{ab}	2.71^{c}	2.34^{b}
		(.600)	(.558)	(.570)	(.525)

Note: Means with different superscripts in the same row are significantly different at the $\alpha = .05$ level.

Table 2. Means and standard deviations on slaughter data of 365 steers and 154 heifers fed a winter finishing ration

		Steers		Heifers	
Variable	Units	Year 3 n=169	Year 4 n=196	Year 3 n=65	Year 4 n=89
Slaughter weight	lb	1244.76^{a}	1196.01^{b}	1122.49^{y}	1063.14^{z}
		(105.669)	(106.685)	(84.234)	(99.669)
Hot carcass weight	lb	792.47^{a}	740.45^{b}	711.49^{y}	651.56^{z}
		(70.157)	(71.444)	(58.855)	(61.544)
Dressing percent	%	63.67^{a}	61.90^{b}	63.39^{y}	61.31^{z}
		(2.008)	(1.888)	(2.200)	(1.897)
Days on feed	days	142.18^{a}	136.84^{b}	131.00^{y}	122.03^{z}
		(12.980)	(20.265)	(21.672)	(21.087)
Fat over 12th rib	inches	.41^{a}	.35^{b}	.42^{y}	.39^{y}
		(.163)	(.131)	(.173)	(.132)
Rib eye area	sq in	13.16^{a}	13.04^{a}	12.63^{y}	12.27^{y}
		(1.438)	(1.647)	(1.208)	(1.206)
Kidney, heart & pelvic fat	%	2.49^{a}	2.11^{b}	2.70^{y}	2.35^{z}
		(.555)	(.492)	(.514)	(.556)

Note: Means with different superscripts in the same row are significantly different at the $\alpha = .05$ level. Means for steers versus heifers are not compared.

The data for the first three years of the accelerated feeding program and for year three for the winter feeding program, the time period prior to the current enforcement of regulations on zero tolerance, were used to explain variations in hot carcass weight and dressing percent. Two specific equations were estimated using ordinary least squares regression:

$$Hot\ Carcass\ Weight = b_0 + b_1 * Slaughter\ Weight + b_4 * KHP + b_5 * Days + e$$

and

$$Dressing\ Percent = b_0 + b_1 * Slaughter\ Weight + l + b_4 * KHP + b_5 * Days + e$$

where **Fat** is the fat over the 12th rib, **REA** is the rib eye area, **KHP** is the kidney, heart and pelvic fat, **Days** is the number of days on feed, and **e** is the random or unexplained error.

Using these two equations and the data for the fourth year on slaughter weight, fat, REA, KHP, and days on feed, predictions were made for hot carcass weight and dressing percent. The actual values for hot carcass weight and dressing percent were then subtracted from the predicted values and these residuals were analyzed. If the changes in enforcement of regulations have not effected carcass trimming procedures, then the residuals should be centered around zero. However, if more trimming is taking place as a result of the zero tolerance regulations, then the residuals will on average be positive. In other words, there will be more predicted than actual hot carcass weight and the predicted dressing percent will be greater than the actual dressing percent

Results and Discussion

The results of estimating the two equations for the three separate data sets are contained in Tables 3 and 4.

Depending upon the data set, between 85 and 93% of the variation in hot carcass weight is explained by the other independent variables. All of the independent variables are significant with the exception of fat thickness for the heifers. Only 24 to 36% of the variation in dressing percentage were explained by the regression equation. However, all of the independent variables are significant, with the exception of slaughter weight and fat thickness for the heifer data set.

Table 3. Regression results for explaining variations in hot carcass weight

	Accelerated steer calves	Winter steers	Winter heifers
Intercept	-126.4463**	-136.4536**	-119.0404*
	(10.1821)	(26.5587)	(48.9982)
Slaughter weight	.5840**	.5703**	.5786**
	(.0087)	(.0154)	(.0385)
Fat	36.2348**	23.3908*	-14.0011
	(4.9161)	(10.6310)	(20.2555)
REA	7.8264**	9.6733**	7.6512*
	(.5950)	(1.2296)	(3.0537)
KHP	6.1600**	10.7173**	18.2313**
	(1.2261)	(2.8476)	(5.7630)
Days	.3063**	.3899**	.3139*
	(.0388)	(.1200)	(.1356)
Adjusted R^2	.9339	.9212	.8523
F-stat	2110.550**	393.987**	74.861**

Note: Standard errors are in parentheses and a single asterisk and a double asterisk denote significance at the .05 and .01 level, respectively.

Table 4. Regression results for explaining variations in dressing percent

	Accelerated steer calves	Winter steers	Winter heifers
Intercept	52.5243**	52.1156**	53.1300**
	(.8874)	(2.1666)	(4.1659)
Slaughter weight	-.0045**	-.0056**	-.0048
	(.0008)	(.0013)	(.0033)
Fat	3.2334**	1.8467*	-1.1222
	(.4285)	(.8672)	(1.7222)
REA	.6842**	.8176**	.6542*
	(.0519)	(.1003)	(.2596)
KHP	.5683**	.8648**	1.6018**
	(.1068)	(.2323)	(.4900)
Days	.0262**	.0341**	.0265*
	(.0033)	(.0098)	(.0115)
Adjusted R^2	.3087	.3602	.2361
F-stat	67.620**	19.917**	4.956**

Note: Standard errors are in parentheses and a single asterisk and a double asterisk denote significance at the .05 and .01 level, respectively.

The regression equations estimated for each data set were used to predict hot carcass weight and dressing percentage in year four. The actual, predicted and residual differences for hot carcass weight and dressing percentage are shown in Table 5. The regression equations on average predicted 13 to 15 lb more hot carcass weight than the actual hot carcass weight. The prediction for dressing percentage averaged 1.11 to 1.37% over the actual dressing percentage. These residual differences are all significantly different than zero. This would indicate that there has been a structural change in cattle slaughtering and that more carcass weight is being trimmed off following the implementations of the strict regulations on zero tolerance.

Table 5. Actual, predicated, and residual hot carcass weight and dressing percentage

	Accelerated steers		Winter steers		Winter heifers	
	HCW	DP	HCW	DP	HCW	DP
Actual	722.81	62.67	740.45	61.90	651.56	61.30
Predicted	735.91	63.78	755.67	63.23	665.52	62.67
Residual	13.10**	1.11**	15.22**	1.33**	13.96**	1.37**

Note: Double asterisk denotes that the residuals are significantly different from zero at the α.05 level.

The weighted average hot carcass weight residual is 13.8 pounds. How much does this lost carcass weight cost producers? How much does it cost beef packers? If the average carcass price paid to producers was $114 per cwt. for 1994, then producers lost an average of $15.73 (13.8 * $1.14) per head. Total steer and heifer slaughter for 1994 was 33.5 million head, so that the total cost to cattle producers from lost revenue was $527 million.

This $527 million would be a reduction in beef packers' cost of purchasing cattle. However, they have incurred additional costs in meeting the zero tolerance regulations, and they also would have experienced a reduction in revenue since the trimmed off carcass cannot be sold as carcass or boxed beef. Additional research is needed to determine the costs beef packers have incurred in meeting the zero tolerance guidelines.

Structural Changes in Fed Cattle Industry: South Dakota vs. United States

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CATTLE 95-23

Summary

Between 1973 and 1993, there has been a major shift of fed cattle production in the United States from the Midwest and Southwest to the Central and Southern Plains. Average marketings per feedlot per year in the nation's 13 major cattle feeding states have more than doubled; average marketings per feedlot in AZ, CA, and WA are now 15,000 head or more. The degree to which the concentration has taken place in different states and regions is highly variant. South Dakota's average fed cattle marketings per feedlot have doubled over the past two decades. However, growth in fed cattle marketings in South Dakota has been limited to feedlots with a one-time capacity of 1,000 to 4,000 head, not in "mega-feedlots" as in the nation's four major cattle feeding states. The pattern of moderately-sized and relatively widely-dispersed feedlots in South Dakota confers to the state a major comparative advantage—relative to possible soil and water pollution from animal wastes.

Key Words: Fed Cattle, Concentration

Introduction

The United States fed cattle industry has become more geographically concentrated during the past two decades. Many commentators believe that the nature and degree of increased concentration is the same throughout the nation's major cattle feeding areas.

The purpose of this article is to show that this belief is false. In fact, the pattern of change over the past two decades in fed cattle concentration in South Dakota differs greatly from patterns of change in the United States' other 12 major cattle producing states.

Materials and Methods

Each quarter, the USDA reports data on numbers of (1) feedlots and (2) fed cattle marketed in each of the United States' 13 major cattle producing states [data on the tonnage of beef marketed, however, are unavailable]. These USDA data are taken into account in reports by the Livestock Marketing Information Center (LMIC) in Denver. [LMIC was earlier known as the Western Livestock Marketing Information Project.] The findings reported in this article are based on LMIC's fed cattle marketing data between 1973 and 1993 for the nation's 13 major cattle feeding states. Collectively, these 13 states account for 85% of the cattle and calves on feed nationally.

Results and Discussion

Regional Concentration in Fed Cattle Production

The total number of cattle fed in the United States' 13 major cattle feeding states has remained essentially unchanged over the past two decades at around 22.5 million (Table 1). Among regions, however, changes have been dramatic. From 1973 to 1993, the number of cattle fed in the five Central and Southern Plains major cattle feeding states has increased by 4.2 million or 32%. The largest increases have been in KS and NE, although TX continues to be the nation's leading cattle feeding state.

The increase in fed cattle marketings in the Central and Southern Plains, and to a lesser extent in the Northwest, has been at the expense of cattle feeding in the Southwest and

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[1]Professor.

Table 1. Changes in total number of fed cattle marketed, 1973 to 1993

Region/state	Number of fed cattle marketed per year ('000 head) 1973	1993	Change from 1973 to 1993 No. of head '000	Percent
Central and Southern Plains				
Texas	4,412	5,290	+ 878	+ 20
Nebraska	3,607	4,790	+ 1,183	+ 33
Kansas	2,500	4,160	+ 1,660	+ 66
Colorado	2,144	2,340	+ 196	+ 9
Oklahoma	564	835	+ 217	+ 48
Subtotal	13,227	17,415	+ 4,188	+ 32
Northwest				
Idaho	395	625	+ 230	+ 58
Washington	367	453	+ 86	+ 23
Subtotal	762	1,078	+ 316	+ 41
South Dakota	559	485	- 74	- 13
Southwest				
California	1,942	585	- 1,357	- 70
Arizona	919	378	- 541	- 59
Subtotal	2,861	963	- 1,898	- 66
Midwest-heartland states				
Iowa	3,389	1,445	- 1,944	- 57
Minnesota	875	485	- 390	- 45
Illinois	945	445	- 500	- 53
Subtotal	5,209	2,375	- 2,834	- 54
Thirteen state total	22,618	22,316	- 302	- 1

the Midwest. For example, the numbers of cattle fed in the Southwest's major cattle feeding states (CA and AZ) have dropped by 1.9 million or 66% and in the Midwest-heartland states (IA, MN, and IL) by 2.8 million or 54%.

Individual Feedlot Concentration

Between 1973 and 1993, the average number of fed cattle marketed per feedlot in the United States' 13 major cattle feeding states more than doubled to 504 head per year (Table 2). Again, patterns of change in average marketings per feedlot vary much among regions.

Absolute changes in marketings per feedlot have been greatest in AZ (an increase of over 15.2 thousand head per feedlot) and WA (13.1 thousand), followed by TX (5.4 thousand) and CO (4.4 thousand). On the other hand, average

Table 2. Changes in average number of fed cattle marketed per feedlot, 1973 and 1993

Region/state	Average number of fed cattle marketed per feedlot		Change from 1973 to 1993	
	1973	1993	Number of head	1993 as a multiple of 1973
Southwest				
California	10,729	15,000	+ 4,271	1.40
Arizona	19,146	34,364	+ 15,218	1.79
Northwest				
Idaho	695	4,464	+ 3,769	6.42
Washington	1,973	15,100	+ 13,127	7.65
Central and Southern Plains				
Texas	2,878	8,266	+ 5,388	2.87
Colorado	3,521	7,932	+ 4,411	2.25
Oklahoma	1,000	3,884	+ 2,884	3.88
Kansas	385	1,733	+ 1,348	4.50
Nebraska	210	798	+ 60	3.80
South Dakota	61	121	+ 6	1.98
Midwest-heartland states				
Iowa	100	94	- 6	.94
Illinois	63	62	- 1	.98
Minnesota	74	61	- 13	.82
Thirteen state total	232	504	+ 272	2.17

marketings per feedlot in the three Midwest-heartland states have decreased slightly.

Relative changes in marketings per feedlot have been greatest in the Northwest followed by the Central and Southern Plains and the Southwest. The states experiencing the greatest relative increases are WA (a 7.7-fold increase), ID (6.4 times), KS (4.5 times), OK (3.9 times), and NE (3.8 times).

South Dakota's Unique Fed Cattle Industry Structure

South Dakota usually ranks 8th to 10th nationally in total number of fed cattle marketed. In 1993, 485 thousand fed cattle were marketed in the state (Table 1). Over the past two decades, the number of cattle fed in South Dakota has remained more stable than that in any other state except CO.

The average number of 121 fed cattle marketed per feedlot per year in South Dakota in 1993—which has doubled since 1973—is not greatly different from the average marketings per feedlot in the Midwest-heartland (Table 2). However, it is only a tiny fraction (ranging from 1/7th to 1/284th) of the average marketings per feedlot in the nation's other major cattle feeding states.

The number of fed cattle marketed from feedlots in South Dakota with under a 1,000 head capacity grew 24% from 376 thousand in 1973 to 466 thousand in 1981 (Figure 1). By 1993, however, the number of fed cattle marketed from feedlots with under a 1,000 head capacity (120 thousand) had dropped to only about one-fourth of the number in 1981. The main reason for this striking decrease was closure of small feedlots.

The number of fed cattle marketed from feedlots with over a 4,000 head capacity has fluctuated a great deal from year to year over the past two decades. Numbers increased from 100 thousand in 1973 to a peak of 300 thousand in 1985. By 1993, however, they fell to 180 thousand.

The numbers of fed cattle marketed in two intermediate size-of-feedlot categories, however, have shown sustained increases. For feedlots with a 1,000 to 2,000 head capacity, numbers increased from 50 thousand in 1973 to 71 thousand in 1993. For feedlots with a 2,000 to 4,000 head capacity, the increase was from 32 thousand to 114 thousand.

The pattern of growth in feedlot sizes in South Dakota is greatly different from that in the nation's four largest cattle producing states. In those states, by far the largest growth in fed cattle production over the past two decades has been in feedlots with a one-time capacity of >32,000 head ("mega-feedlots"). Fed cattle marketings from mega-feedlots in TX (3.1 million cattle or 58% of the state's total fed cattle marketings) are more than double those in any other state (Table 3). Since 1973, the number of fed cattle marketed from mega-feedlots in TX has increased by 38%. In KS, CO, and NE, relative increases in mega-feedlot marketings have been greater, ranging from 1.9 to 3.2 times.

Conclusion

The strong trends toward greater concentration of fed cattle regionally in the United States and in individual feedlots are the source of environmental concern to many citizens and policy-makers. Since fed cattle are still relatively widely-dispersed in South Dakota, however, the chances of animal wastes contributing to possible soil and water pollution are much less here than in the states further south and west (except for NE) where mega-feedlots dominate fed cattle production.

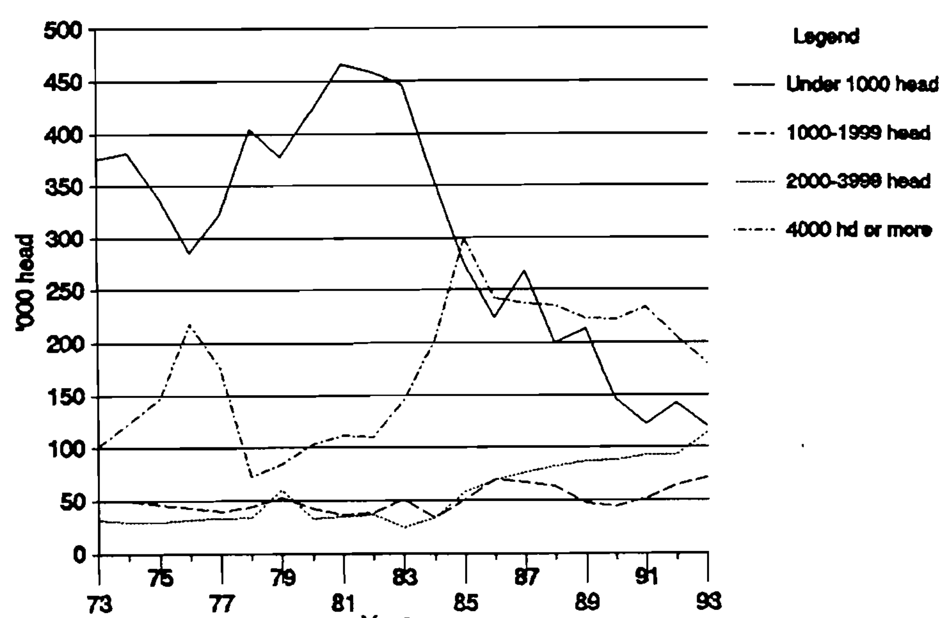

Figure 1. Fed cattle marketed by size-of-feedlot category, South Dakota, 1973-1993.

Table 3. Cattle marketed from feedlots with a capacity of >32,000 head, 1973 and 1993

	1973		1993		
	No. head ('000)	Percent of state total	No. head ('000)	Percent of state total	1993 as a multiple of 1973
Central and Southern Plains					
Texas	2,221	50.3	3,070	58.0	1.38
Kansas	450	18.0	1,450	34.9	3.22
Colorado	594	27.7	1,125	48.1	1.89
Nebraska	220	6.0	430	9.0	1.95
Southwest					
California	625	32.2	313	53.5	.50
Arizona	546	59.4	257	68.0	.47
Thirteen state total	4,656	20.6	7,838	35.1	1.68

Studying Virus Cell Interactions: Finding New Ways to Prevent Infectious Bovine Rhinotracheitis in Cattle

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CATTLE 95-24

Summary

Infectious Bovine Rhinotracheitis (IBR; bovine herpesvirus 1 (BHV-1); Rednose) is one of several cattle respiratory viruses that plays a large role in the shipping fever complex. One of the major problems with IBR is that like other herpesviruses, once animals are infected they carry the virus for life. Investigations in our laboratory have been aimed at understanding how the IBR virus gets into cells. By understanding the mechanism that the virus uses we hope to develop strategies to prevent IBR infection. Our investigations indicate that IBR grows only in actively growing cells like those found in the upper respiratory tract of cattle. We also know that IBR does not grow well in slow growing cells like those found in the brain.

Key Words: IBR, Bovine Herpesvirus 1, Rednose

Introduction

Infection of cattle with BHV-1 (IBR virus) results in two major clinical syndromes: infectious bovine rhinotracheitis (IBR) and infectious pustular vulvovaginitis (IPV). IBR is an infection of the epithelial cells of upper respiratory tract. IBR is seen throughout the world and is the most common form of BHV-1 infection in the U.S. It was first described in the U.S. in the 1950's. The disease is characterized by a 5- to 10-day incubation period with clinical signs that include fever (40.5 to 42°C), harsh cough, inappetence, depression, and a loss of milk production in lactating animals. A serous nasal discharge is present early in disease but progresses to a mucopurulent discharge. The animals may also develop a conjunctivitis. In animals that are under low stress, recovery is uneventful with animals returning to normal 5 to 10 days after onset of signs. However, in cattle that are stressed, the immunosuppressive effect of BHV-1 on the bacterial defense mechanisms of the lungs frequently results in lung complications due to secondary opportunistic bacterial infections. The most common and severe complication is the bovine respiratory disease complex commonly known as shipping fever. This complex results in a severe bronchopneumonia characterized by high morbidity and frequent mortality. Another frequent complication of IBR infection in pregnant cattle is abortion. Abortion occurs 3 to 6 weeks following infection mainly in cows between the 5th and 8th month of pregnancy and can result in an abortion rate of up to 25% of pregnant cattle.

IPV is the disease caused by BHV-1 in the reproductive tract of cows. Its counterpart in bulls is infectious balanoposthitis (IBP). IPV/IBP was first described in Europe over 150 years ago but was not identified as being caused by a herpesvirus until the late 1950's. This disease occurs 1 to 3 days following mating and results in a severe inflammatory reaction of the genital mucosa including edema, hyperemia, small pustules (1-2 mm in diameter) and a mucopurulent discharge. This disease frequently results in secondary bacterial infections. The acute phase of the disease lasts 2 to 4 days and is usually resolved by 10 to 14 days following onset. Another reproductive consequence of

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BHV-1 infection is infertility resulting from ovarian infection.

A third syndrome seen following BHV-1 infection is encephalitis. This is a rare disease of younger cattle that has been reported worldwide. This neurological disease results in signs that include incoordination, muscular tremors, recumbency, ataxia, and blindness that invariable leads to death. This neurogenic BHV-1 is genetically and antigenically related to the BHV-1 responsible for IBR and IPV. However, due to the serologic, genetic, and clinical differences, the name bovine herpesvirus 5 (BHV-5) has been suggested for this BHV-1-like agent.

BHV-1 establishes latent infections in cattle resulting in a lifelong carrier state. Reactivation and shedding of the virus can occur following stress (transport, parturition, etc.) or immunosuppression with glucocorticoids. The reactivation of the virus in the infected host results in inapparent clinical disease but serves as a source of infection for naive animals. We have been studying the interaction of BHV-1 and bovine cells to understand the mode the virus infects cells. An increased understanding of these interactions can be used to prevent infections and shedding of the virus.

Materials and Methods

The goal of this study was to investigate the cellular changes that occur when bovine herpesvirus 1 (BHV-1) interacts with target cells. This research project pursued three questions. First, do virus-host cell interactions trigger a cellular signal transduction cascade that involves changes in cytoplasmic $[Ca^{2+}]$ or pH? Second, does virus infection alter host cell DNA synthesis? Third, is the efficiency of BHV-1 replication dependent on the cell cycle?

For the first question we used fluorescent probes to examine the possibility that interactions between BHV-1 and cellular receptors induce a signal transduction cascade that results in changes in intracellular Ca^{2+} and pH.

For the second question we measured the effect of BHV-1 on BT cell DNA utilizing the incorporation of (methyl-^{3}H) thymidine as an indicator of DNA synthesis. The use of UV inactivated BHV-1 (UV BHV-1) and quiescent cells makes these studies unique.

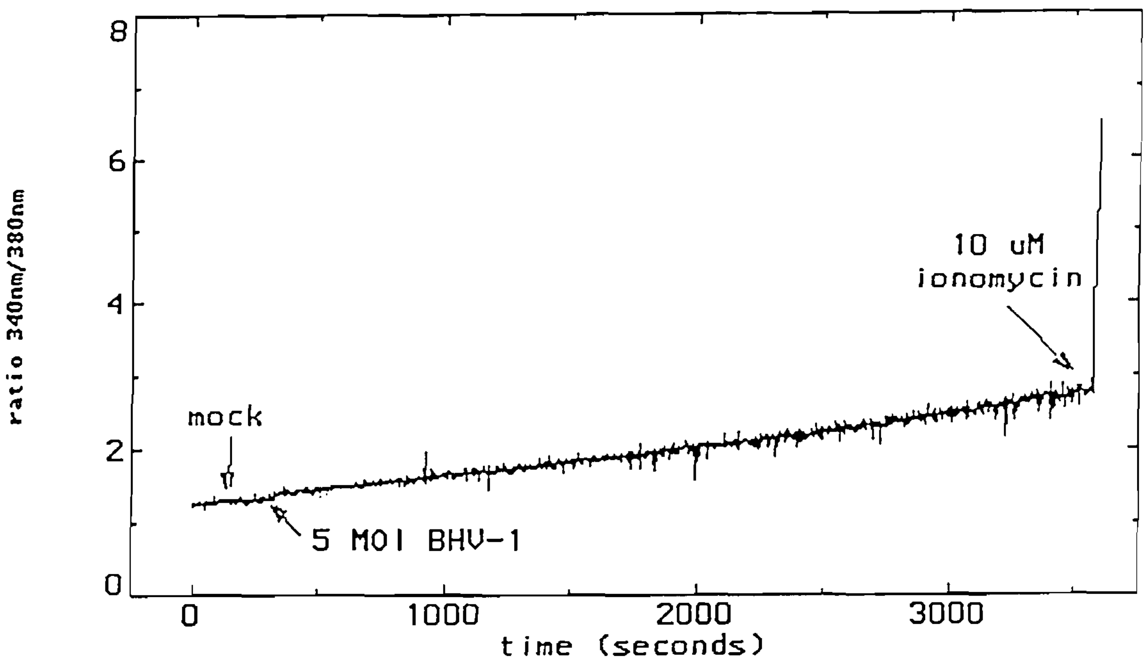
For the third question we compared BHV-1 replication in actively dividing and quiescent primary bovine turbinate (pBT) cells.

Results and Discussion

The results showed that BHV-1 does not stimulate changes in either cytoplasmic Ca^{2+} concentration (Figure 1) or pH (data not shown). A variety of cell types, probe loading procedures, and analysis techniques were used to measure the effect of BHV-1 on these two parameters of cell signaling. With these methods, a change in cytoplasmic free calcium concentration ($[Ca^{2+}]_i$) was detected following treatment of bovine turbinate cells (BT) and peripheral blood lymphocytes with growth factors. A change in cytoplasmic pH could not be detected in BT or Madin Darby bovine kidney cells treated with growth factors. These findings become important when interpreting the effect of BHV-1 on cell signaling. Growth factor stimulated changes in $[Ca^{2+}]_i$ provide a biological control for Ca^{2+} influx. The results with BHV-1 indicate that virus interactions with host cells do not trigger a Ca^{2+} dependent cell signaling pathway. This same interpretation cannot be made with cytoplasmic pH since the expected change in pH was not detected in cells treated with growth factors. This implies that either the probe, equipment, or some other factor was not functioning properly resulting in an undetected pH change. Assuming an undetected pH change did occur, the effect of BHV-1 on cytoplasmic pH can only be speculated.

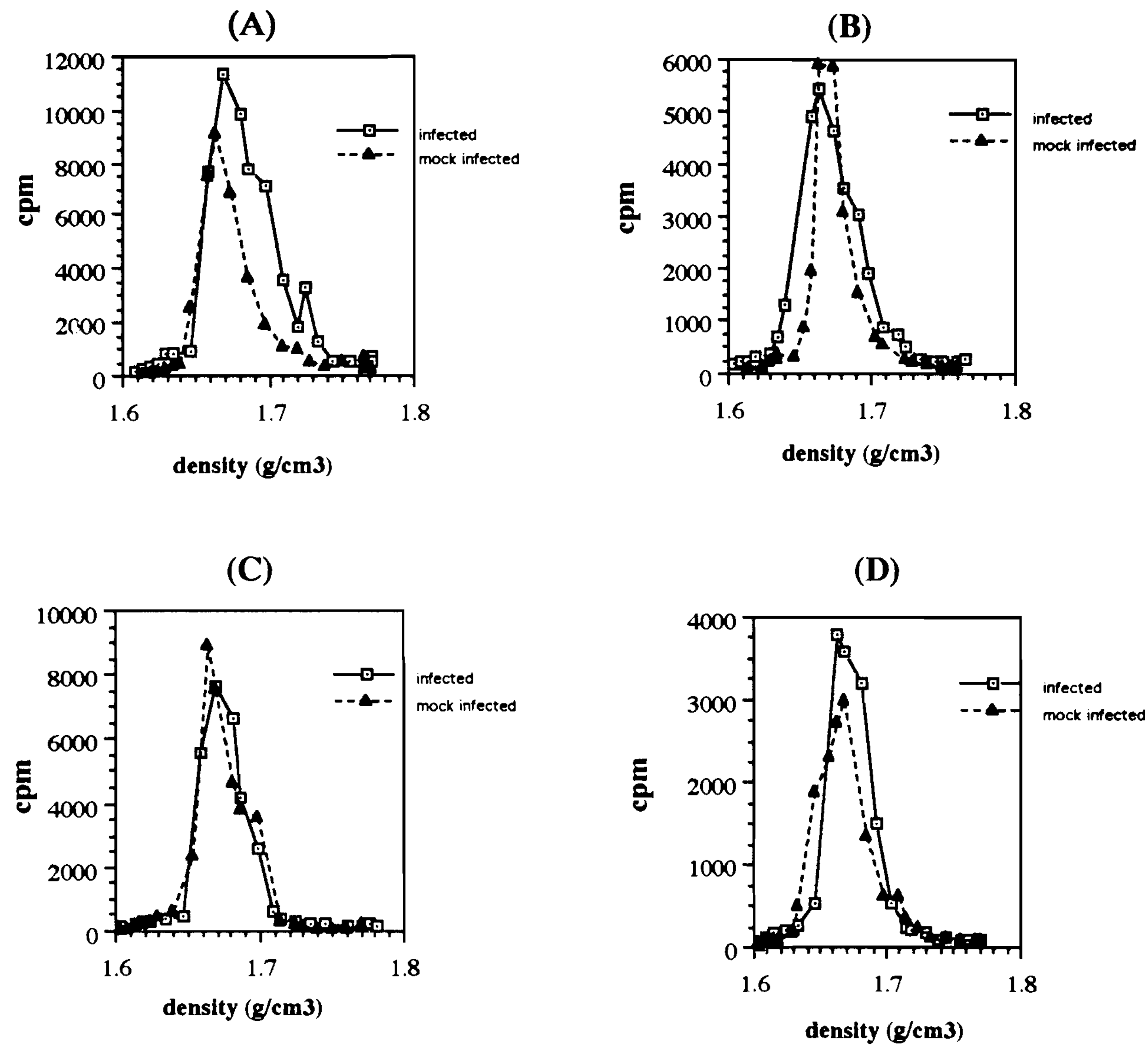
Neither BHV-1 nor UV BHV-1 stimulated cellular DNA synthesis in actively dividing or quiescent cells (Figure 2). Our studies demonstrated that BHV-1 infection of actively dividing cells did not completely inhibit host cell DNA synthesis. Interestingly, we could not detect viral DNA synthesis in BHV-1 infected quiescent cells. This was an important observation because it suggested that BHV-1 replication is cell cycle dependent.

Figure 1



PBL were loaded with 5 μM of fura-2 AM. 5 x 10^6 PBL were placed in a cuvette an mock infected with MEM followed by 5 MOI of BHV-1. Fluorescence measurements were made by alternating the excitation wavelength between 340 and 380 nm and collecting the emissions at 510 nm. 10 μM ionomycin was added at the end of the experiment to saturate the probe with Ca^{2+}. Additions are indicated on the graph with arrows and text.

Figure 2



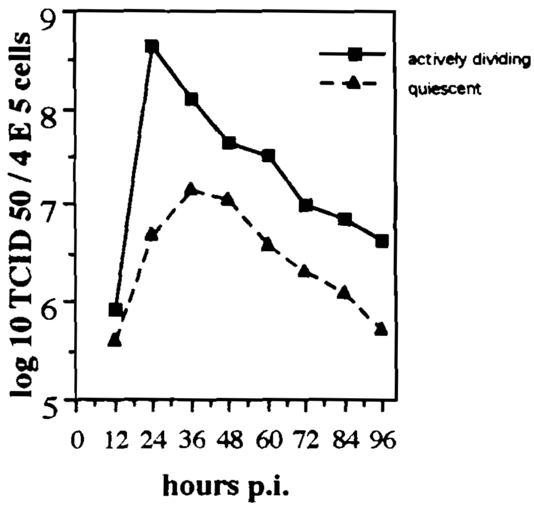
Actively dividing (A) and quiescent (B) BT cells were infected with 0.3 MOI of BHV-1 and treated with 1 mCi of (methyl-3H) thymidine for 24 hours. Actively dividing (C) and quiescent (D) BT cells were treated with UV inactivated BHV-1 and (methyl-3H) thymidine as described above. Total cellular DNA was isolated and isopycnic centrifugation in CsCl was used to separate virus and cellular DNA. The density of each fraction was determined using a refractometer and the radioactivity measured with a scintillation counter. Thymidine incorporation is expressed in counts per minute (cpm). The clear squares represent virus infected cell DNA and solid triangles represent mock infected cell DNA.

Higher virus yields (Figure 3) and more viral protein synthesis (data not shown) occurred in cells that were undergoing active DNA synthesis. These differences were not due to a reduced amount of BHV-1 virions attaching to or infecting the quiescent cells. This suggests that a factor associated with the quiescent cells is limiting BHV-1 gene expression and replication. Viral gene expression and replication in the quiescent cells may have been limited by a decreased supply of cellular machinery such as RNA polymerase II and transcription factors. Quiescent cells would have a decreased quantity of these proteins compared with cells that were actively dividing.

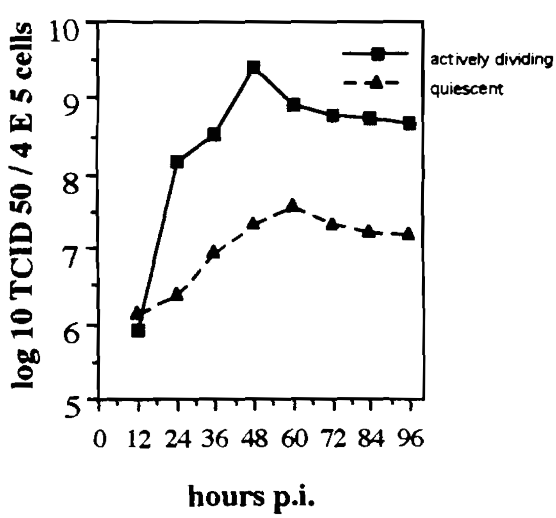
The co-evolution of a pathogen with its host leads to the development of some interesting relationships. Through selective pressure, viral phenotypes adapt and become better able to modify and use the host cell. This research represents a component of a model that envisions early virus-host cell interactions as a means for viruses to alter host cell physiology by triggering different signaling cascades. These cascades serve the virus by modifying the intracellular environment in a way that promotes viral synthetic events. Present data suggest that BHV-1 does not activate quiescent cells and that it replicates more efficiently in actively dividing cells.

Figure 3

(A)



(B)



Actively dividing and quiescent pBT cells were infected with 5 MOI of BHV-1 and the TCID50 of each cell associated (A) and cell free (B) virus sample was measured. Solid squares represent actively dividing cells infected with BHV-1 and solid triangles represent infected quiescent cells. Titers are expressed as the log10 TCID50 per 4 x 105 cells. Each data point is the average of triplicate samples.

The faculty members of the **Animal and Range Sciences Department** are always ready to answer your questions. Our Brookings phone number is (605) 688-5166. Staff members in Rapid City (RC) may be reached at (605) 394-2236. Please feel free to give any one of us a call.

FACULTY

	SPECIALTY	RESPONSIBILITY
BIRKELO, Carl P.	Ruminant Nutrition	Research, Teaching
BOGGS, Donald L.	Beef Cattle Nutrition and Management	Extension
BRUNS, Kelly	Livestock Judging Team Coach	Teaching
COSTELLO, William J.	Meat Science	Teaching, Research
GARTNER, F. Robert (RC)	Range Science	Research, Teaching
GEE, Dan H.	Evaluation/Marketing	Teaching
HAMILTON, C. Ross	Swine Nutrition	Research, Teaching
HELD, Jeffrey E.	Sheep Nutrition and Production and Management	Extension
INSLEY, Larry W.	Beef Cattle Management and Nutrition/Horse Production	Extension, Teaching
JOHNSON, James R. (RC)	Range Science	Extension, Research
JOHNSON, Patricia S.	Range Science	Research, Teaching
KRONBERG, Scott	Range Science	Research, Teaching
LIBAL, George W.	Swine Nutrition and Management	Research, Teaching
MALES, James R.	Ruminant Nutrition	Department Head
MARSHALL, Donald M.	Animal Breeding	Research, Teaching
MCFARLAND, Douglas C.	Monogastric Nutrition and Muscle Biology	Research, Teaching
MILLER, Herley L.	Reproductive Physiology	Research, Teaching
PRITCHARD, Robbi H.	Ruminant Nutrition	Research, Teaching
PRUITT, Richard J.	Cow-Calf Management	Teaching, Research
ROMANS, John R.	Meat Science	Research, Teaching
SLYTER, A. Lowell	Reproductive Physiology/Sheep Production and Management	Research, Teaching
THALER, Robert C.	Swine Nutrition	Extension
WAGNER, John J.	Ruminant Nutrition	Extension, Research
ZALESKY, Douglas D. (RC)	Beef Cattle Management	Extension

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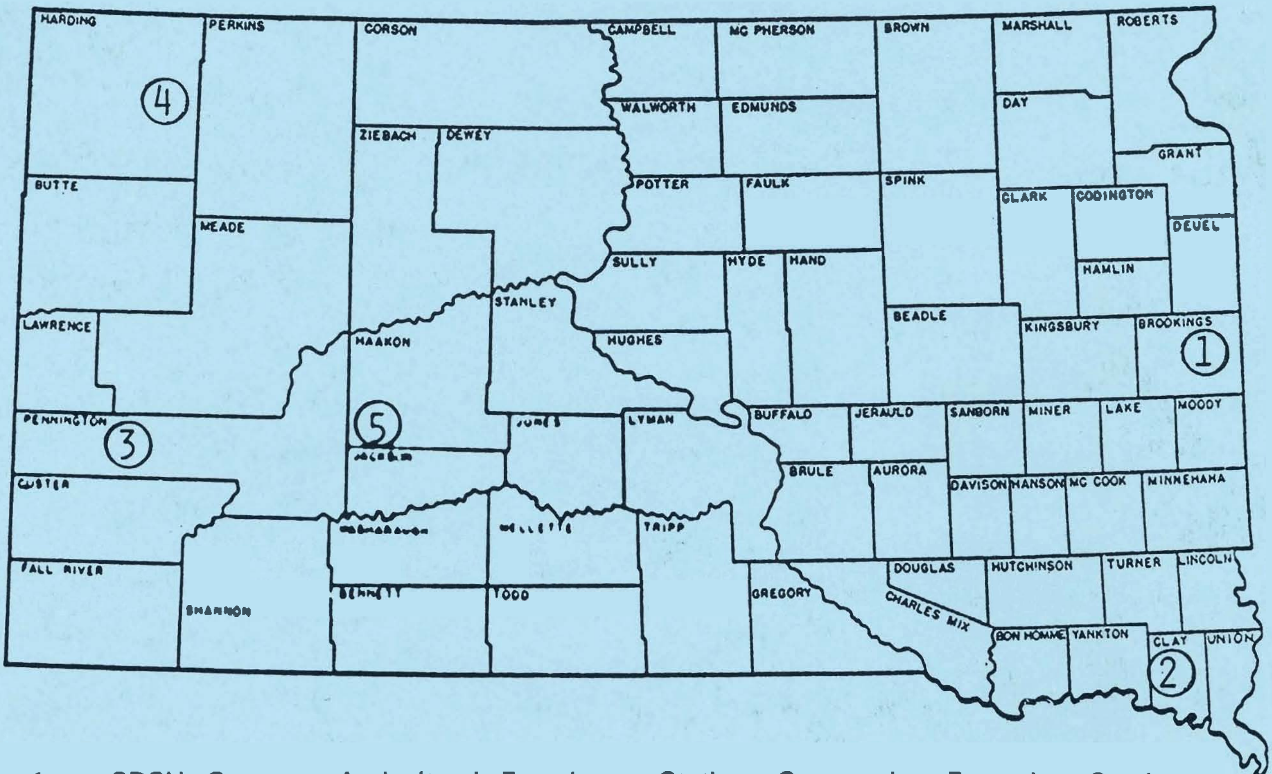
ANIMAL AND RANGE SCIENCES
RESEARCH AND EXTENSION UNITS



1. SDSU Campus, Agricultural Experiment Station, Cooperative Extension Service, Brookings.

2. Southeast South Dakota Research Farm, Beresford
   Beef cattle nutrition * Swine nutrition and management.

3. West River Agricultural Research and Extension Center, Rapid City
   Professional research and extension staff in Animal and Range Sciences, Plant Science, Economics, 4-H, and Extension Administration.

4. Antelope Range Livestock Station, Buffalo
   Beef cattle breeding * Range beef herd management * Sheep nutrition, management, and breeding.

5. Range and Livestock Research Station, Philip
   Range beef nutrition * Herd management * Range management.

These research and extension units are geographically located in South Dakota to help solve problems, bring the results of livestock and range research to the user, enhance the statewide teaching effectiveness of the Animal and Range Sciences Department staff, and maintain a close and productive relationship with South Dakota producers and our agri-business community.

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