1996

# 1996 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

# South Dakota BEEF Report

# 1996

Agricultural Experiment Station
Cooperative Extension Service
South Dakota State University

The following companies and individuals generously provided livestock, commercial products, equipment, grant funds, or their time in support of beef cattle research, extension, and teaching programs at South Dakota State University:

Alltech, Inc., Nicholasville, KY
American Cyanamid Co., Inc., Wayne, NJ
Elanco Products Co., Greenfield, IN
Farmland Industries, Kansas City, MO
GTA Feeds, Sioux Falls, SD
Heartland Grain Fuels, L.P., Aberdeen, SD
Hoechst-Roussel, Somerville, NJ
IBP, Luverne, MN
Land O'Lakes, Fort Dodge, IA
Mallinckrodt Veterinary, Inc., Mundelein, IL
Merck and Company, MSDAGVET, Rahway, NJ
Middle America Network, Mapleton, IA
Purina Mills, Inc., St. Louis, MO
R and L Feedyard, Kimball, SD
Roche Animal Health, Nutley, NJ
Sioux Automation, Sioux Center, IA
Sioux Falls Stockyards, Sioux Falls, SD
Southeast SD Experiment Farm Corporation
SD Cattlemen's Association
SD Corn Utilization Council
SD County Extension Agents
SD Livestock Foundation
SD Livestock Marketing Association
SD Stockgrowers Association
SD Veterinary Medical Association
SD Wheat Commission
The Upjohn Company, Kalamazoo, MI
Tri County State Bank, Kimball, SD
21st Century Genetics, Shawano, WI
USDA/NRI Competitive Grants Program
Zip Feeds Mills, Inc., Sioux Falls, SD

Published in accordance with an act passed in 1881 by the 14th Legislative Assembly, Dakota Territory, establishing the Dakota Agricultural College and with the act of re-organization passed in 1887 by the 17th Legislative Assembly, which established the Agricultural Experiment Station at South Dakota State University. SDSU is an Affirmative Action/Equal Opportunity Employer (Male/Female) and offers all benefits, services, education, and employment opportunities without regard for ancestry, age, race, citizenship, color, creed, religion, gender, disability, national origin, sexual preference, or Vietnam Era veteran status.



400 copies printed by the Department of Animal and Range Sciences, SDSU, at $1.75 each. April 1997.

South Dakota
State University

SDSU

College of Agriculture and
Biological Sciences

Department of Animal and
Range Sciences

Box 2170, SDSU
Brookings, SD 57007-0392
Phone 605-688-5165
FAX 605-688-6170

May 1997

Dear Beef Cattle Industry:

We realize this is a few months late, but here is the 1996 Beef Report. This report will give you a good overview of research in which South Dakota State University is involved that affects beef production.

As usual there is research reported on nutrition and feed management. This 1996 Beef Report contains our first report on gene mapping research and there is a summary of some of the beef cattle disease management research.

South Dakota State University research covers a wide spectrum. Our faculty, both research and extension, bring together the latest information from other universities. Our goal is to do the best job possible of serving 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

mt

List of Abbreviations

| | |
|---|---|
| ADG | Average daily gain (pounds/day) |
| ADF | Acid detergent fiber |
| ADIN | Acid detergent insoluble nitrogen |
| AI | Artificial insemination |
| BCS | Body condition score |
| BST | Bovine somatotropin (growth hormone) |
| BW | Body weight |
| CP | Crude protein |
| CV | Coefficient of variation |
| d | day |
| DM | Dry matter |
| DMI | Dry matter intake, daily pounds per head |
| EPD | Estimated progeny difference |
| F/G | Feed:gain (lb/lb) |
| FSH | Follicle stimulating hormone |
| GF | Gain:feed (lb gain/100 lb dry feed) |
| GnRH | Gonadotropin releasing hormone |
| i.m. | intramuscular |
| i.v. | intravenous |
| IVDMD | In vitro dry matter disappearance |
| KPH | Kidney, pelvic and heart fat |
| LH | Luteinizing hormone |
| ME | Metabolizable energy |
| n | Number of observations |
| $NE_m$ | Net energy for maintenance |
| $NE_g$ | Net energy for gain |
| NDF | Neutral detergent fiber |
| NRC | National Research Council |
| P | Probability |
| PG | Prostaglandin |
| r | Correlation coefficient |
| $r^2$ | Coefficient of determination |
| s.c. | subcutaneous |
| SE | Standard error |
| TDN | Total digestible nutrients |
| VFA | Volatile fatty acid |

TABLE OF CONTENTS

# Interpreting Experiment Results

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

SDSU **CATTLE 96-1**

A typical experimental format involves evaluating the response caused by application of alternative 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. Statistical procedures can be useful to determine the extent to which observed variation is due to treatment effects versus other factors.

For example, suppose that animals receiving Diet A grow faster than animals receiving Diet B. Was the observed difference in growth rates actually due to dietary differences or to other factors (e.g., genetics, age, sex, measurement error, 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 statistical analyses. A brief discussion of some of the more common statistics encountered in animal research follow.

Average or Mean. These two terms are used interchangeably. We often compare mean values of treatment groups for variables of interest. In some studies, least-squares means are reported rather than the raw means. In so-called "balanced" studies, least-squares means are often the same as raw means. However, when experimental subjects are distributed across treatment groups in an uneven or biased manner, then adjustments to the means are needed to account for the bias. Appropriate adjustments are made by the procedure of least squares.

Correlation Coefficient. This statistic is a measure of the degree of association between two variables and can range from -1 to +1. A strong positive correlation (close to +1) indicates that high values of one variable tend to occur more often than not in combination with high values of the other variable. Similarly, low values of one variable tend to be associated with low values of the other variable. In humans, for example, we generally expect a rather strong, positive correlation between height and weight. Taller individuals tend to be heavier, whereas shorter individuals tend to weigh less, on average. A strong negative correlation (near -1) indicates that high values of one trait tend to be associated with low values of the other trait. A correlation coefficient near zero indicates that the two variables are largely independent of one another.

Regression Coefficient. This statistic indicates the average change in variable Y for each one unit increase in variable X. In its simplest form (i.e., linear regression), the regression coefficient is simply the slope of a straight line. A regression equation can be used to predict the value of the dependent variable (Y) for a given value of the independent variable (X). A more complicated procedure, known as multiple regression, can be used to derive an equation which uses several independent variables to predict a singe dependent variable. An example is the USDA beef cutability equation, in which % cutability is predicted from carcass weight, external fat thickness, KPH fat, and rib-eye area.

---

[1]Professor.

Variance. This is a measure of variation of a variable (trait). Its unit is the square of the unit of measurement (e.g., $lb^2$).

Standard Deviation. This is also a measure of variation calculated as the square root of the variance. Thus, its units are the same as the original trait.

Coefficient of Variation (C.V.). The C.V. is calculated as the standard deviation divided by the mean for a particular variable or trait. Dividing by the mean removes the effects of scale and units from the variable, which allows a comparison of the relative variation between two traits. The variance or standard deviation of different traits cannot be directly compared, but it might be appropriate to compare their C.V.'s.

Standard Error. Data presented in an experiment are normally based on a sample of experimental subjects drawn from some larger population. Hence, a statistic (parameter) calculated from the sample group is only an estimate of that parameter's value in the entire population. A value known as a standard error is often calculated for parameter estimates such as the mean, correlation, or regression coefficient. The standard error is an indication of the possible error associated with such estimates. It is calculated as a ± value (deviation).

The magnitude of the standard error depends on the animal-to-animal variation and on the number of animals in the sample from which the parameter was estimated. As sample size increases, a larger proportion of the whole population is included, and the likelihood is increased that the parameter estimated from the sample will closely approximate the overall population parameter. The standard error decreases as sample size increases.

Probability Value or Statistical Significance (P-value). Statistical comparisons will often be accompanied by a probability (P) value. Suppose, for example, a research paper indicated "calves receiving Diet A gained .35 lb per day more (P = .05), on average, than calves receiving Diet B." For practical purposes, we can interpret this statement to mean that the probability of attaining a difference of at least .35 lb/day for reasons other than dietary effect is about 5%. Such a difference may be said to be statistically significant at the .05 level of probability.

A difference larger than .35 lb/day in the example above would have resulted in a smaller P-value. A smaller P-value reflects increased confidence that there is a true underlying effect of the treatment. When differences between treatment means are relatively small—compared to differences between animals receiving the same treatment—then the P-value will be higher and we cannot confidently conclude that there was a true treatment effect. The size of difference required to achieve a given P-value varies between traits and studies. All other factors being equal, as sample size increases, a smaller treatment difference is required to achieve a given level of statistical significance.

# Effect of Increasing Levels of Condensed Corn Distillers Solubles on Performance of Growing Steers

G.A. Sharp[1] and C.P. Birkelo[2]
Department of Animal and Range Sciences

SDSU

**CATTLE 96-2**

Summary

A trial was conducted as a randomized block design to assess the effects of condensed corn distillers solubles (CCDS) on performance of steer calves (n=200) fed 40% concentrate, dry rolled corn-hay based growing diets. CCDS was included at 0 (MSBM), 5 (5CCDS), 10 (10CCDS), or 20% (20CCDS) of diet DM, replacing soybean meal, molasses, and corn. A corn silage/supplement diet was also included (SIL). Dry matter intakes at higher CCDS levels were lower than that of MSBM ($P<.05$). Average daily gain was not affected ($P>.20$) and, as a result, feed efficiency (F/G) tended to improve ($P=.14$). Steers fed SIL consumed less DM ($P<.05$), gained faster ($P<.01$), and were more efficient ($P<.01$) than all other treatments. Ruminal fluid was collected by stomach tube from steers (n=90) at -.5, +1, +4, and +7 hours from feeding. Values reported are means across sampling times. Ruminal $NH_3N$ and molar proportions of acetate decreased ($P<.05$) and propionate increased ($P<.05$) with increasing CCDS level. Despite significance, no discernable pattern was observed for ruminal fluid pH. CCDS was an effective protein and energy source in 40% concentrate corn-hay growing diets. Based on performance, maximum inclusion rate is at least 20% of diet DM.

Key Words: Condensed Corn Distillers Solubles, Growing Diets, Steers

## Introduction

The fermentation of corn grain to ethanol produces, in addition to ethanol, distillers grains and a liquid fraction called thin stillage (or "sweet water"). This liquid fraction is often condensed to a syrup which can range from 30 to 50% DM, 10 to 20% fat, and 20 to 30% protein, depending on source. The syrup is commonly referred to as condensed corn distillers solubles (CCDS).

Limited work has been conducted to determine optimum and maximum dietary levels of CCDS in feedlot diets. This study was designed to determine (1) the effects of increasing levels of CCDS on feedlot performance of steer calves fed growing diets and (2) effects of CCDS level on rumen function.

## Materials and Methods

Two hundred crossbred steer calves (initial weight 553 lb) were randomly allotted within breed type to 20 pens (10 steers/pen, 4 pens/treatment) and fed 40% concentrate diets (Table 1) containing either CCDS[3] at 0 (MSBM), 5 (5CCDS), 10 (10CCDS), or 20% (20CCDS) of the diet DM or a predominantly corn silage diet (SIL).

Diets were mixed and fed once daily at 8:30 a.m. Steers were allowed to consume feed ad libitum during the trial. The diets were formulated to contain 11.5% protein, .75% Ca, .64% P, and 1.48% K. Diets also contained 22 grams monensin per ton of diet DM. Feed ingredients were sampled weekly and stored frozen for later analysis for DM and Kjeldahl N. All steers were fed a common diet during the final 5 days of the 84-day study.

---

[1]Graduate Assistant.
[2]Associate Professor.
[3]Heartland Grain Fuels, L.P., Aberdeen, SD.

Table 1. Grower trial diet composition (% DM)

| Ingredient | MSBM | 5CCDS | 10CCDS | 20CCDS | SIL |
|---|---|---|---|---|---|
| Dry rolled corn | 25.12 | 26.94 | 23.71 | 17.06 | — |
| Grass hay | 30.00 | 30.00 | 30.00 | 30.00 | — |
| Oat hay | 30.00 | 30.00 | 30.00 | 30.00 | — |
| Soybean meal | 6.16 | 4.75 | 3.38 | .84 | 11.87 |
| Molasses | 5.00 | — | — | — | — |
| CCDS | — | 5.00 | 10.00 | 20.00 | — |
| Limestone | .54 | .83 | 1.05 | 1.50 | .18 |
| Dical phosphorus | 1.70 | 1.20 | .80 | — | 1.78 |
| Potassium chloride | .88 | .68 | .46 | — | .45 |
| Trace mineral salt | .50 | .50 | .50 | .50 | .50 |
| Premix | .10 | .10 | .10 | .10 | .10 |
| Corn silage | — | — | — | — | 85.12 |
| Chemical analysis | | | | | |
| DM, % | 85.84 | 78.65 | 71.86 | 61.80 | 55.49 |
| CP, % | 10.78 | 10.70 | 10.57 | 10.40 | 11.57 |

Initial and final shrunk weights were determined after withholding feed and water overnight. All steers were vaccinated for IBR, BVD, PI3, BRSV, and black leg and received ivermectin and an estradiol implant. One steer died 37 days into the study due to causes not related to treatment.

Ruminal fluid was collected by stomach tube from nine animals per treatment on day 23 and day 58 of the trial. Samples were collected .5 hours before and 1, 4, and 7 hours after feeding, strained through cheesecloth, analyzed immediately for pH, and then acidified and frozen for later analysis for VFA and $NH_3N$. Means reported are across sampling times.

Performance variables were analyzed as a randomized block design using the GLM procedures of SAS. Variables were tested for linear, quadratic, and cubic effects of CCDS level. Treatment means were separated by the PDIFF option of LSMEANS when F was significant. Block represented pen type (confinement vs open, dirt lots). Mean ruminal pH, $NH_3N$, and VFA concentrations were analyzed as a completely random design using GLM procedures.

## Results and Discussion

Dry matter intake at higher CCDS levels were lower than that of the MSBM diet ($P<.05$; Table 2). Average daily gain was not affected and, as a result, feed efficiency (F/G) tended to improve with increasing CCDS level ($P=.14$). Steers fed SIL consumed less DM ($P<.05$), gained faster ($P<.01$), and were more efficient ($P<.01$) than all other treatments.

Despite statistical differences ($P<.05$) between growing diets (Table 3), there was no discernable pattern in mean ruminal fluid pH. However, ruminal $NH_3N$ and molar proportions of acetate decreased ($P<.05$) and propionate increased ($P<.05$) with increasing CCDS level when averaged across sampling times.

CCDS used in this study was an effective protein and energy source in a 40% concentrate growing diet. When replacing soybean meal, molasses and corn, CCDS apparently results in similar gain, lower intake, and a trend toward improved feed efficiency. Based on performance, maximum inclusion rate of CCDS is at least 20% of DM in a dry rolled corn-hay based growing diet.

Table 2. Performance data

| Item | MSBM | 5CCDS | 10CCDS | 20CCDS | SIL |
|---|---|---|---|---|---|
| DMI, lb/day | 16.67[a] | 15.94[ab] | 15.08[bc] | 15.06[bc] | 13.89[c] |
| CPI, lb/day | 1.79 | 1.70 | 1.59 | 1.57 | 1.61 |
| ADG, lb/day | 2.09[d] | 2.14[d] | 2.03[d] | 2.09[d] | 2.38[e] |
| F/G | 7.94[d] | 7.52[d] | 7.46[d] | 7.25[d] | 5.81[e] |

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

Table 3. Rumen fermentation data[a]

| Item | MSBM | 5CCDS | 10CCDS | 20CCDS | SIL |
|---|---|---|---|---|---|
| pH | 6.68[de] | 6.74[de] | 6.62[ef] | 6.81[d] | 6.54[f] |
| $NH_3N$[b] | 4.99[e] | 3.80[e] | 4.71[e] | 2.26[d] | 4.06[e] |
| Acetate[c] | 64.87[e] | 64.20[e] | 61.97[d] | 61.17[d] | 63.61[e] |
| Propionate[c] | 21.22[de] | 20.87[d] | 21.59[de] | 24.15[f] | 22.35[e] |
| Butyrate[c] | 10.76[d] | 11.55[d] | 13.00[e] | 11.70[d] | 10.74[d] |

[a]Means across sampling times.
[b]mg/dl.
[c]Molar percent.
[d,e,f]$P < .05$.

# Effect of Increasing Levels of Condensed Corn Distillers Solubles on Performance of Finishing Steers

G.A. Sharp[1] and C.P. Birkelo[2]
Department of Animal and Range Sciences

SDSU

**CATTLE 96-3**

Summary

A trial was conducted as a randomized block design to assess the effects of condensed corn distillers solubles (CCDS) on performance and carcass merit of yearling steers (n = 216) fed 90% concentrate finishing diets. CCDS was included at 0 (MSBM), 5 (5CCDS), 10 (10CCDS), or 20% (20CCDS) of diet DM, replacing soybean meal, molasses, and corn. Average daily gain increased ($P < .05$) for steers fed CCDS but, along with a numerical trend ($P = .14$) of increasing DMI, resulted in no improvement in F/G ($P > .20$). Steers were harvested on day 108. Carcass weight and dressing percent for steers fed CCDS were greater than control steers ($P < .01$). Other carcass characteristics did not differ by treatment ($P > .20$). Ruminal fluid was collected by stomach tube from steers (n = 72) at -.5, +1, +4, and +7 hours from feeding. Values reported are means across sampling times. Ruminal fluid pH was higher for CCDS fed cattle than MSBM ($P < .05$). Butyrate increased with increasing CCDS level ($P < .05$). Differences in acetate, propionate, and $NH_3N$ were not significant ($P > .20$). The CCDS was an effective protein and energy source in 90% concentrate corn-based finishing diets. Based on performance, maximum inclusion rate is at least 20% of diet DM.

Key Words: Condensed Corn Distillers Solubles, Finishing Diets, Steers

## Introduction

The fermentation of corn grain to ethanol produces, in addition to ethanol, distillers grains and a liquid fraction called thin stillage (or "sweet water"). This liquid fraction is often condensed to a syrup which can range from 30 to 50% DM, 10 to 20% fat, and 20 to 30% protein, depending on source. The syrup is commonly referred to as condensed corn distillers solubles (CCDS).

Limited work has been conducted to determine optimum and maximum dietary levels of CCDS in feedlot diets. This study was designed to determine (1) the effects of increasing levels of CCDS on feedlot performance and carcass characteristics of cattle fed finishing diets and (2) effects of CCDS level on rumen function.

## Materials and Methods

Two hundred sixteen crossbred yearling steers (initial weight 858 lb) were randomly allotted within breed type to 24 pens (9 steers/pen, 6 pens/treatment) and fed 90% concentrate diets (Table 1) containing CCDS[3] at 0 (MSBM), 5 (5CCDS), 10 (10CCDS, or 20% (20CCDS) of the diet DM.

Diets were mixed and fed once daily at 8:30 a.m. Steers were allowed to consume feed ad libitum during the trial. A receiving diet was fed prior to and for the first 2 days of the trial. Four step-up diets were fed for 5 days each. The finishing diets were formulated to contain 12.5% protein, .70% Ca, .65% P, and 1.08% K. Diets also contained monensin at 28 grams per ton of diet DM. High moisture corn was replaced with dry corn starting on day 59 because supplies were depleted. Feed

[1]Graduate Assistant.
[2]Associate Professor.
[3]Heartland Grain Fuels, L.P., Aberdeen, SD.

Table 1. Finishing trial diet composition (% DM)

| Ingredient | MSBM | 5CCDS | 10CCDS | 20CCDS |
|---|---|---|---|---|
| Dry rolled corn | 38.00 | 38.89 | 37.29 | 32.58 |
| High moisture corn | 38.00 | 38.89 | 37.29 | 32.58 |
| Alfalfa hay | 10.00 | 10.00 | 10.00 | 10.00 |
| Soybean meal | 5.30 | 3.90 | 2.52 | — |
| Molasses | 5.00 | — | — | — |
| CCDS | — | 5.00 | 10.00 | 20.00 |
| Limestone | .16 | .45 | .70 | 1.15 |
| Dicalcium phosphorus | 1.70 | 1.25 | .80 | .80 |
| Potassium chloride | .90 | .70 | .50 | — |
| Urea | .35 | .35 | .35 | .35 |
| Trace mineral salt | .50 | .50 | .50 | .50 |
| Premix | .09 | .07 | .05 | 2.04 |
| Chemical analysis | | | | |
| DM, % | 82.02 | 75.96 | 70.09 | 61.37 |
| CP, % | 12.59 | 12.58 | 12.52 | 12.42 |

ingredients were sampled weekly and stored frozen for later analysis for DM and Kjeldahl N.

Initial and final shrunk weights were determined after removal feed and water overnight. All steers were vaccinated for IBR, BVD, PI3, BRSV, and black leg and received ivermectin and a trenbalone acetate-estradiol implant. One steer died 32 days into the study due to causes not related to treatment.

Ruminal fluid was collected by stomach tube from nine animals per treatment on day 69 and day 70 of the trial. Samples were collected .5 hours before and 1, 4, and 7 hours after feeding, strained through cheesecloth, analyzed immediately for pH, and then acidified and frozen for later analysis for VFA and $NH_3N$. Values reported are means across sampling times.

Performance and carcass variables were analyzed as a randomized block design using the GLM procedures of SAS. Variables were tested for linear, quadratic, and cubic effects of CCDS level. Treatment means were separated by the PDIFF option of LSMEANS when F was significant. Block represented pen type (confinement vs open, dirt lots). Mean ruminal pH, $NH_3N$ and VFA concentrations were analyzed as a completely random design using GLM procedures.

The steers were fed for a total of 108 days. They were harvested 1 day after the off-test weight was taken. Carcass data were collected for determination of quality and yield grades.

## Results and Discussion

Average daily gain was greater ($P<.05$) for steers fed CCDS (Table 2) but, along with a numerical trend ($P=.14$) of increasing DMI, resulted in no improvement in feed efficiency ($P>.20$). Adjustment of daily gain for differences in dressing percent accentuated treatment differences and did not alter conclusions drawn from the unadjusted data.

Mean ruminal fluid pH (Table 3) was higher for cattle fed finishing diets containing CCDS than MSBM ($P<.05$). Molar proportion of butyrate increased with increasing CCDS level ($P<.05$), but differences in acetate, propionate and $NH_3N$ were not significant ($P>.20$).

Carcass weight and dressing percent for steers fed CCDS were greater than control steers ($P<.10$). Other carcass characteristics (Table 4) did not differ by treatment ($P>.20$).

CCDS used in this study was an effective protein and energy source in a 90% concentrate, corn-based finishing diets. When replacing soybean meal, molasses and corn, CCDS apparently results in increased gain, a trend toward greater intake, similar feed efficiency, and increased dressing percent. Based on performance, maximum inclusion rate is at least 20% of diet DM.

Table 2. Feedlot performance data

| Item | MSBM | 5CCDS | 10CCDS | 20CCDS |
|---|---|---|---|---|
| DMI, lb/day | 20.81 | 21.63 | 22.24 | 21.58 |
| CPI, lb/day | 2.62 | 2.71 | 2.78 | 2.67 |
| ADG, lb/day | 3.48[a] | 3.68[b] | 3.81[b] | 3.70[b] |
| F/G | 5.95 | 5.88 | 5.81 | 5.85 |

[a,b]$P<.05$.

Table 3. Rumen fermentation data[a]

| Item | MSBM | 5CCDS | 10CCDS | 20CCDS |
|---|---|---|---|---|
| pH | 5.75[d] | 6.07[ef] | 6.18[e] | 5.99[f] |
| Mean $NH_3N$[b] | 4.18 | 3.01 | 2.87 | 1.57 |
| Acetate[c] | 52.18 | 51.65 | 50.87 | 49.71 |
| Propionate[c] | 34.63 | 36.74 | 35.23 | 34.86 |
| Butyrate[c] | 9.13[ef] | 7.50[d] | 9.96[ef] | 11.11[f] |

[a]Means across sampling times.
[b]mg/dl.
[c]Molar percentage.
[d,e,f]$P<.05$.

Table 4. Carcass data

| Item | MSBM | 5CCDS | 10CCDS | 20CCDS |
|---|---|---|---|---|
| Carcass wt, lb | 780[b] | 802[c] | 818[c] | 820[c] |
| Dressing percent | 63.0[b] | 63.8[c] | 64.0[c] | 65.0[d] |
| Rib fat, in. | .44 | .48 | .45 | .48 |
| Rib eye area, $in.^2$ | 14.04 | 14.17 | 14.19 | 14.11 |
| Kidney, pelvic, heart fat | 1.94 | 2.11 | 2.16 | 2.07 |
| Yield grade | 2.47 | 2.64 | 2.62 | 2.73 |
| Quality grade[a] | 5.11 | 5.22 | 5.01 | 5.03 |

[a]5.00 = low choice.
[b,c,d]$P<.01$.

# Ionophore Programs for Finishing Yearling Steers

R.H. Pritchard[1]
Department of Animal and Range Sciences

SDSU **CATTLE 96-4**

Summary

The relative effectiveness of three ionophore feeding strategies was compared in yearling steers. Six pens of 8 steers were assigned to each of the following treatments: A) no ionophore fed, B) lasalocid (33 g/T) fed for 28 days and then replaced with laidlomycin propionate (11 g/T) for the balance of time on feed; C) monensin (28 g/T) fed throughout, and D) laidlomycin propionate (11 g/T) fed throughout. A five diet step-up program was used that culminated in a final diet based on cracked and high moisture corn and 7% ground hay. Ionophores increased (P<.05) ADG (3.9%) and carcass weight and lowered (P<.05) feed/gain 4.5% during the 135-day feeding period. Among ionophore treatments, monensin resulted in a lower (P<.05) cumulative ADG and carcass weight than diets containing laidlomycin propionate. Three of the four steers removed from the trial due to metabolic disorders were from the no ionophore treatment.

Key Words: Steer, Feedlot, Ionophore

## Introduction

There are currently three ionophores available for use in feedlot cattle finishing diets. Properties of lasalocid, laidlomycin propionate, and monensin differ and affect how these products are used in feeding programs. Lasalocid has little effect on DMI and adaptation appears to be easily accommodated by cattle. It is approved for use in finishing diets by virtue of its favorable effects on ADG and gain efficiency. Laidlomycin propionate has similar characteristics but has been interpreted to be a more potent effector of ADG. Its relative suitability in receiving diets has not been thoroughly evaluated. Monensin has DMI depressing characteristics that result in increased gain efficiency. It is also credited with reducing digestive problems in cattle on high grain diets. Because of its potent effect on DMI, an ionophore step-up program is recommended when adapting cattle to diets containing monensin.

The differences in these ionophores affect their suitability in any given situation. It may be possible to enhance production efficiencies by the timing of use of a product to match a stage of the feeding program. This experiment was designed to measure the efficacy of three ionophore strategies for finishing yearling steers.

## Materials and Methods

Research subjects (192 head) were selected from a group of 233 yearling steers. The steers were predominately Limousin crosses reared on one ranch. The group was backgrounded at a feedlot 70 miles from the research feedlot. The 677-lb mean purchase weight represented yearlings with minimal flesh. Upon arrival at the feedlot, steers were tagged, weighed, vaccinated (Resvac 3, Ultrabac 7), and treated for internal parasites (Synanthic paste) and ecto parasites (Synergized DeLice) according to label instructions. Cattle of odd type were noted for deleting from the sample population.

The experiment involved four treatments and six pen replicates of eight steers per treatment. Diet treatments included A) no ionophore, B) lasalocid (33 g/T DMB) for 28 days followed by laidlomycin propionate (LP; 11 g/T DMB), C) monensin (MON; 28 g/T DMB), and D) LP (11 g/T DMB) throughout. The complete diets and component supplements are outlined in Tables 1, 2, and 3. To accommodate adaptation to monensin, supplements for

[1]Professor.

Table 1. Diet formulations

| | % DM basis | | | | | |
|---|---|---|---|---|---|---|
| Ingredient | Step 1 | Step 2 | Step 3 | Step 4 | Step 5 | Step 5A |
| Ground hay | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 | 7.00 |
| Rolled corn | 30.90 | 30.90 | 40.90 | 45.90 | 48.90 | 78.90 |
| High moisture corn | 5.00 | 20.00 | 25.00 | 28.00 | 30.00 | — |
| Liquid supplement[a] | 4.50 | 4.50 | 4.50 | 4.50 | 4.50 | 4.50 |
| Dry supplement[b] | 9.60 | 9.60 | 9.60 | 9.60 | 9.60 | 9.60 |
| Oat silage | 43.00 | 28.00 | 13.00 | 5.00 | — | — |
| Days fed | 1 to 2 | 3 to 4 | 5 to 7 | 8 to 11 | 12 to 108 | to finish |
| DM | 50.5 | 58.1 | 69.2 | 77.6 | 82.9 | 86.3 |
| CP, % | 14.0 | 13.6 | 13.2 | 12.9 | 13.0 | 13.4 |
| NDF, % | 32 | 25 | 18 | 15 | 13 | 13 |
| Ash, % | 6.8 | 5.5 | 4.1 | 3.4 | 2.9 | 2.9 |
| $NE_m$, Mcal/cwt[c] | 77.6 | 83.5 | 89.6 | 92.4 | 94.4 | 96.3 |
| $NE_g$, Mcal/cwt | 46.9 | 52.6 | 58.3 | 61.0 | 62.6 | 64.0 |
| Laidlomycin propionate, g/T[d] | 11.5 | 11.5 | 11.5 | 11.4 | 10.8 | 11.5 |
| Monensin, g/T[d] | 14.5 | 14.5 | 14.5 | 28.9 | 29.6 | 28.2 |

[a]See Table 2 for formulation.
[b]See Table 3 for formulation.
[c]Based upon tabular feed values.
[d]Only one ionophore used in diets as assigned by treatment.

Table 2. Custom liquid mixes

| | LS O | | LS O |
|---|---|---|---|
| DM, % | 68.35 | Zn, ppm | 433 |
| CP, % | 7.71 | NaCl, % | 6.95 |
| Ca, % | 12.76 | I, ppm | 7.20 |
| P, % | .60 | Fe, ppm | 1273 |
| K, % | 9.26 | Se | 5.16 |
| Mg, % | .39 | Vitamin A, IU | 39,886 |
| S, % | .36 | Vitamin D, IU | 9,964 |
| Mn, ppm | 267 | Vitamin E, IU | 379 |
| Co, ppm | 1.9 | $Ne_m$ | 49.92 |
| Cu, ppm | 93 | $Ne_g$ | 33.29 |

Table 3. Dry supplement formulations

| | %, DM basis |
|---|---|
| Soybean meal, 44% | 80.20 |
| Urea | 4.17 |
| Wheat midds | 15.63 |
| | g/T as fed basis |
| Bovatec 68 | 1170 |
| Cattlyst 50G | 945 |
| Rumensin 80 | 1477 |

treatments A (control) and C (monensin) were used in a 1:1 ratio to produce a 14 g/T diet for the initial 7 days. Cattle were fed twice daily. The feed for the six pen replicates in each treatment was mixed in a single batch at each feeding. To facilitate allotment of steers, processing weights were arranged by increasing BW. Extremely light or heavy BW steers were deleted. Steers were randomly allotted to treatments A to D and subsequently to replicates 1 to 6. Within 40 hours of arrival at the feedlot, steers were sorted into assigned pens. Steers were fed 12 lb of a nonmedicated receiving diet for the next 4 days (June 9 to 12). Initial test BW was the mean of BW determined the mornings of June 12 (day 0) and 13 (day 1). This corresponded to days 3 and 4 of fixed DMI. Synovex-S was administered to all steers during the second initial BW measurement.

Individual BW were determined on day 0, 1, 28, 56, 84, 112, 136, and 137. Revalor implants were administered on day 56. Animals were observed twice daily for health problems. When health problems were noted, steers were generally removed to a hospital pen for closer observation. The home pen diet was fed to hospitalized steers and upon recovery steers were returned to their original pen. If normal appetite and well-being were not reestablished while in the hospital, steers were removed from the test. When steers were removed, their contribution to pen mean BW was deleted from the data set. Those steers were assumed to consume feed at the pen mean level except while in the hospital where individual DMI was known. Feed records were adjusted accordingly.

Feed bunks were managed to allow cattle access to as much feed as they could apparently metabolize based on feed carryover and animal behavior. Dramatic fluctuations in feed delivery were minimized. During the aggressive step-up phase, true ad libitum DMI was not allowed. Increases in feed deliveries were restricted when most of the steers in a pen exhibited diarrhea. Because of this approach, differences in DMI reflect the influence of treatment on the onset of gastrointestinal upset rather than the DMI depression resulting from acute digestive upset.

Diet commodity ingredients were sampled each week. Corn was analyzed for DM, CP, and ash content. Hay was analyzed for DM, CP, ADF, NDF, and ash content. Dry supplements were sampled when delivered and analyzed for DM, CP, ash, and ionophore content. Diet composition was calculated based on batch sheet ingredient inclusion and analyzed composition of ingredients. Tabular values were used for corn and dry supplement fiber content. Specification values were used for the nutrient content of liquid supplements. Data reported in Table 1 reflect weekly calculations.

To verify mix integrity, bunk samples were obtained during the afternoon feeding on days steers were weighed. Sampling was accomplished by placing a 5" x 11" x 13" dishpan midway along the bunk as each pen was fed. Feed contained in this pan after feed delivery was retained. The supplement and bunk samples were submitted to analytical labs for ionophore assay.

The evening after the final BW determination, steers were co-mingled and shipped to the abattoir and harvested the next morning. Carcasses were identified at exsanguination to accommodate evaluation 24 hours later. Carcass weight, rib fat thickness, and rib eye area were measured. Marbling score and percentage of KPH were estimated by the federal grader on duty.

All feedlot performance data were evaluated on a pen mean basis. Steers were not deprived of feed or water prior to any BW measurements. The final BW was shrunk 3%

only to calculate cumulative ADG and dressing percentage. Carcass data were evaluated on an individual steer basis. All data were analyzed using procedures in SAS that are appropriate for a completely random design experiment. To test treatment means, orthogonal contrasts were established. These contrasts included control vs ionophores (A vs B, C, D), lasalocid-laidlomycin propionate vs laidlomycin propionate (B vs D), and lasalocid-laidlomycin propionate + laidlomycin propionate vs monensin (B, D vs C). Probabilities for contrasts are noted in tables of results.

## Results

Four steers were removed from the experiment and subsequently deleted form the data set. One steer was removed from Trt B on day 21 because of a stifle injury. Two steers were removed from Trt A and one steer from Trt B because of persistent bloat problems. These removals caused the effect of treatment on initial BW depicted in Table 4.

Diets were formulated to contain 11 g LP/T or 28 g MON/T. Bunk samples collected on days 29, 57, 85, and 113 averaged 10.6 g LP, 29.3 g MON, and 10.2 g LP/T for treatments B, C, and D, respectively (Table 4).

### Control vs Ionophores

Use of restricted feeding 12 lb per head per day pretrial allowed only partial fill. The influences of fill and condition of the steers resulted in extraordinary performance during the initial 28 days on feed. During this phase ionophores affected ($P=.1075$) feed efficiency in spite of remarkably low feed/gain values for control steers (Table 4). The only other period where ionophores improved feed/gain over controls was from 57 to 84 days ($P<.001$). Despite the lack of consistent interim influence from ionophores, cumulative 135-day data showed a 4.5% improvement ($P=.0169$) in feed/gain when ionophores were fed.

From 29 to 56 and 85 to 112 days, ionophores tended ($P=.15$) to depress ADG. In contrast, from 57 to 84 and 113 to 135 days ionophores increased ADG ($P<.01$). Overall, ionophores increased ADG 3.9% ($P<.01$). The effect of ionophores on ADG was related to influences of ionophores on DMI only during the period 29 to 56 days. That was the only period in which ionophores affected (depressed) DMI ($P<.01$).

### Laidlomycin Propionate vs Monensin

Steers fed LP tended to consume more feed ($P=.1011$) than steers fed MON from 29 to 56 days. This was largely due to the increase in DMI that occurred for steers switched from lasalocid to LP at day 29 (Trt B). During the 85- to 112-day period, dry corn replaced high moisture grain. In this period the ADG of control steers increased over previous 28-day intervals of performance and ADG of steers fed MON decreased. The formulation change occurred at day 108 and two pens on treatment C responded adversely, becoming diarrhetic and experiencing depressed appetites. The ADGs of steers on treatment C rebounded during day 113 to 135, but overall LP caused a 4.4% greater ADG ($P=.0177$) than MON.

### Lasalocid Start-up

Treatment B tended to cause higher ADG ($P=.1196$) and DMI ($P=.0877$) over treatment D during the 29- to 58-day period. This corresponds to the time when treatment B was switched from lasalocid to LP. It should be noted that 1 to 28-day ADG was also numerically higher when LP was fed. These data suggest a positive gain response associated with ruminal adaptation to LP whether it is during receiving or as a substitute for a previous ionophore. These episodes of increased ADG associated with adapting to LP contributed to the LP gain response over MON.

### Carcass Traits

Feeding ionophores increased ($P<.05$) hot carcass weight and dressing percent over controls. Feeding LP increased hot carcass weight ($P=.04$) and dressing percent ($P=.06$) over MON (Table 5).

Treatments did not influence quality or yield grades of carcasses. The percentage of choice

was lower than is typical for this facility when we meet carcass criteria of .4 in. rib fat. Quality grades may have been influenced by several factors including genetics and weather (heat stress). Cattle performance had diminished markedly in the 112- to 135-day period, suggesting further days on feed were not appropriate.

## Conclusions

These data support previously documented influences of LP on feedlot cattle performance. They also indicate that LP can be used in start-up diets without adverse effects. The data do suggest a favorable ADG response during adaptation to LP when introduced on day 1 or day 28. This phenomenon should be further explored.

Table 4. Feedlot performance summary

| Item | Treatment A[a] | B[b] | C[c] | D[d] | P< A vs B,C,D | B vs D | C vs B,D |
|---|---|---|---|---|---|---|---|
| Initial BW | 683 | 686 | 689 | 689 | .0700 | NS[e] | NS |
| | | | 1 to 28 days | | | | |
| BW 28 | 844 | 850 | 857 | 861 | .0285 | .1010 | NS |
| ADG | 5.74 | 5.88 | 5.98 | 6.13 | NS | NS | NS |
| DMI | 18.13 | 18.12 | 17.98 | 17.98 | NS | NS | NS |
| F/G | 3.18 | 3.09 | 3.03 | 2.95 | .1075 | NS | NS |
| | | | 29 to 56 days | | | | |
| BW 56 | 971 | 976 | 974 | 977 | NS | NS | NS |
| ADG | 4.55 | 4.51 | 4.20 | 4.15 | .1503 | .1196 | NS |
| DMI | 24.20 | 23.42 | 22.10 | 22.42 | .0033 | .0877 | .1011 |
| F/G | 5.33 | 5.23 | 5.31 | 5.42 | NS | NS | NS |
| | | | 57 to 84 days | | | | |
| BW 84 | 1083 | 1112 | 1115 | 1115 | .0009 | NS | NS |
| ADG | 3.98 | 4.85 | 5.01 | 4.92 | .0026 | NS | NS |
| DMI | 24.81 | 25.85 | 24.76 | 25.15 | NS | NS | NS |
| F/G | 6.43 | 5.34 | 4.94 | 5.15 | .0010 | NS | NS |
| | | | 85 to 112 days | | | | |
| BW 112 | 1219 | 1245 | 1227 | 1251 | .0052 | NS | .0105 |
| ADG | 4.85 | 4.77 | 4.01 | 4.89 | .0744 | NS | .0002 |
| DMI | 26.35 | 27.03 | 26.28 | 26.72 | NS | NS | NS |
| F/G | 5.52 | 5.68 | 6.57 | 5.48 | NS | NS | .0049 |
| | | | 113 to 135 days | | | | |
| BW 135 | 1286 | 1318 | 1298 | 1325 | .0058 | NS | .0208 |
| ADG | 2.92 | 3.14 | 3.08 | 3.20 | NS | NS | NS |
| DMI | 24.51 | 24.60 | 24.29 | 25.00 | NS | NS | NS |
| F/G | 8.73 | 8.27 | 8.05 | 8.37 | NS | NS | NS |
| | | | 1 to 135 days[f] | | | | |
| BW 135[g] | 1247 | 1278 | 1259 | 1285 | .0058 | NS | .0208 |
| ADG | 4.18 | 4.39 | 4.22 | 4.42 | .0244 | NS | .0177 |
| DMI | 23.57 | 23.77 | 23.04 | 23.40 | NS | NS | NS |
| F/G | 5.65 | 5.42 | 5.47 | 5.30 | .0169 | NS | NS |

[a]Control.
[b]Lasalocid-laidlomycin propionate.
[c]Monensin.
[d]Laidlomycin propionate.
[e]P>.15.
[f]Based on shrunk final BW (day 135).
[g]BW 135*.97.

Table 5. Carcass traits[a]

| | Treatment | | | | P< | | |
|---|---|---|---|---|---|---|---|
| Item | A[b] | B[c] | C[d] | D[e] | A vs B,C,D | B vs D | C vs B,D |
| HCW | 783 | 812 | 791 | 814 | .0274 | NS[f] | .0411 |
| Dressing % | 62.75 | 63.54 | 62.83 | 63.35 | .1209 | NS | .0657 |
| Adj. HCW[g] | 785 | 813 | 789 | 813 | .0163 | NS | .0055 |
| Rib fat, in. | .395 | .427 | .379 | .402 | NS | NS | .0899 |
| Rib eye area, in.$^2$ | 13.59 | 13.97 | 13.69 | 14.02 | NS | NS | NS |
| KPH, % | 2.03 | 2.10 | 2.04 | 2.16 | NS | NS | NS |
| Marbling[h] | 4.83 | 4.73 | 4.74 | 4.79 | NS | NS | NS |
| Choice, % | 21 | 15 | 16 | 22 | NS | NS | NS |
| Yield grade | 2.52 | 2.60 | 2.48 | 2.55 | NS | NS | NS |

[a]Least squares means.
[b]Control.
[c]Lasalocid-laidlomycin propionate.
[d]Monensin.
[e]Laidlomycin propionate.
[f]P<.15.
[g]Corrected using initial BW as covariate.
[h]4.0 = slight°, 5.0 = small°.

# Effect of Feed Delivery Management on Yearling Steer Performance

S.J. Bierman[1] and R.H. Pritchard[2]
Department of Animal and Range Sciences

SDSU

**CATTLE 96-5**

Summary

Gain efficiency by cattle fed high grain diets can be affected by feed delivery management (FDM). Restricted or limit feeding improves feed efficiency but can reduce ADG. This experiment was designed to evaluate if feeding near ad libitum intake while reducing the amount of variation between daily feed deliveries could provide feed efficiency advantages over unrestricted access to feed without restricting ADG. The FDM strategies for the 121-day feeding period included prescription intakes (PI) where variability between day to day feed deliveries were minimized or ad libitum intake (ALI) where feed was always available. Crossbred yearling steers (n = 76, initial BW 866 lb ± 6.72) of mixed origin were stratified by BW and randomly assigned to one of two treatments then to one of five pens within a treatment. The 92% concentrate, 63 Mcal $NE_g$/cwt diet, was fed to the PI group throughout the 121-day study. Four step-up diets were fed over 12 days to adapt the ALI group to the 92% concentrate diet. Feed was delivered daily at 0730 and 1630. The bunks were slick for the PI treatment at 0700 69% of the days on feed and 40% for the ALI treatment ($P<.01$). The PI fed steers consumed less DM ($P<.001$) during interim periods days 1 to 29 and 58 to 85 ($P<.05$). The PI steers were more efficient days 1 to 29 ($P<.03$) and overall ($P<.10$). Carcass variables associated with yield grade were not affected ($P>.10$) by FDM and PI caused higher marbling scores (5.67 vs 5.31; $P<.085$), while percent choice did not differ, 74 vs 79% for the PI and ALI treatments, respectively. The PI treatment lowered ($P<.05$) feed cost $5.30/cwt gain. This experiment indicated that FDM can influence DMI and feed efficiency without compromising ADG.

Key Words: Feed management, Beef, Feedlot

## Introduction

Proper feed delivery management may increase profitability by reducing the amount of feed wasted and improving cattle performance. An integral part of FDM is how cattle are started on feed. Many feedlots use a step-up system of decreasing roughage in the ration over a period of 14 to 21 days. Another approach is feeding the finishing ration on day 1 but at a restricted level of intake and then systematically increase feed deliveries until ad libitum intake is achieved. These two systems were compared in this experiment.

The most common FDM system has been to provide continuous access to feed. Today, a clean bunk management system is gaining popularity. This system restricts feed deliveries to ensure that feed bunks are empty at least once each day. Thus, the objective of the experiment was to evaluate if a clean bunk management system allowing minimal variation between daily feed deliveries could provide feed efficiency advantages without restricting ADG over allowing unlimited access to feed.

## Materials and Methods

Crossbred steers (n = 76) were stratified by BW and randomly assigned to one of two treatments and then to one of five pens within a treatment. Treatment 1 was the prescription (PI) feeding system. The steers were started on a 63 Mcal $NE_g$/cwt finishing ration at a restricted

[1]Research Associate.
[2]Professor.

DMI. On day 1 the cattle received 15 lb DM per head of diet 5 (Table 1). The bunks were managed so the cattle consumed all their feed each day. By day 29 the cattle were consuming 19.8 ± .34 lb DM per head per day. Treatment 2 was the ad libitum (ALI) feeding system. The steers received four step-up diets over 11 days and on day 12 were fed diet 5. The bunks for ALI treatment were managed to contain feed at all times. Bunk space was limited to 1 foot per head for both treatments.

The steers were used for the SDSU feedlot short course so they had previously been vaccinated against IBR, BVD, BRSV, Hemophilus, and $PI_3$, deloused, and implanted with Revalor-S[3]. Allotment weights were taken after the feedlot short course and the steers were stratified by weight into the two treatments and then into five replicate pens of seven or eight steers per pen. Two days prior to starting the trial the cattle were fed grass hay only. Feed and water were withheld from all steers 24 hours prior to start of the experiment. The steers were weighed on August 28, 1995, and test pens received experimental diets on that day and continued through December 27, 1995.

Diet ingredients were sampled weekly to determine dry matter, crude protein, and ash content. Feed bunk conditions were scored daily. Feed calls were made at 0700 for both treatments and ALI bunk scores were noted at 1300 to determine if the cattle required more feed. The cattle were fed at 0730 and 1630 daily.

Individual body weights were determined at 0700 after 0, 29, 57, 85, and 121 (final weight) days on feed. Feedlot performance was evaluated by experimental units represented by pen mean data. Cumulative data were based on a 3% shrink applied to final body weight (day 121).

Steers were harvested 24 hours after final BW were determined and hot carcass weights were recorded. After a 24-hour chill, rib fat and rib eye area were measured. Marbling score and percentage of kidney, pelvic, and heart fat were determined by a federal grader.

An economic analysis of breakeven and feed cost/cwt gain were determined for each pen and treatment means were statistically compared.

## Results and Discussion

Feed delivery management did not ($P>.10$) affect ADG (Table 2). Cumulative DMI was reduced ($P<.01$) by the PI treatment. However, the difference in DMI can be attributed to roughage intake. Evaluation of roughage intake indicates that 81% of ALI roughage consumption occurred during the step-up period (days 1 to 29). During interim periods, PI steers consumed 20, 8, 11, and 5% less DM than the ALI steers. The PI steers had improved feed efficiency ($P<.09$) over the ALI steers throughout the trial. The improved feed efficiency was likely due to DMI. Also, the ALI steers may have experienced intermittent episodes of subacute acidosis due to the availability of feed, whereas the PI steers were prevented from overeating by virtue of FDM.

Feed bunks were slick at 0700 69.3% of the days on feed for PI and 39.7% for ALI treatments ($P<.01$). An objective of PI feeding was to reduce variation in daily feed deliveries. Over the entire feeding period, the average variance in daily feed deliveries per pen for ALI and PI treatments were 11.8 lb ± 3.1 and 5.6 lb ± 1.0, respectively ($P<.01$). During interim periods where DM consumption was different, the variation in feed delivered was also different ($P<.01$).

Carcass data are shown in Table 3. Carcass variables associated with yield grade were not affected ($P>.10$) by FDM. Mean marbling scores for PI steers were greater (5.67 vs 5.31; $P<.085$) than ALI steers, but percent choice did not differ, 74 vs 79%.

Economically, the PI treatment had lower feed cost/cwt gain and breakeven. Feed cost included the cost of ration ingredients ($3.04/bu WSC and $3.39/cwt ground grass hay) plus dry and liquid supplements. The feed cost per cwt

[3]Hoescht Roussel Agri-Vet Company, Sommerville, NJ.

gain was lower for PI, $46.67, than ALI, $51.97, treatment (P<.05). Breakeven was determined by total cost per cwt of final shrunk body weight. Total cost included transportation, processing ($5.94/head), yardage ($.25/head/day), and feed cost. The PI treatment had lower breakeven than ALI, $62.26 vs $63.88 (P=.086).

Proper FDM can increase profits and improve feed efficiency without compromising ADG. The experiment demonstrated that a clean bunk management system (PI) did result in near ad libitum intake and reduced variation betwen daily feed deliveries. This system improved feed efficiency without compromising ADG.

Table 1. Diet formulations

| | % DM basis[a] | | | | |
|---|---|---|---|---|---|
| Ingredient | Step 1 | Step 2 | Step 3 | Step 4 | Step 5 |
| Ground hay | 55.0 | 35.0 | 25.0 | 18.0 | 8.0 |
| Whole shelled corn[b] | 36.9 | 56.9 | 65.9 | 72.9 | 82.7 |
| Liquid supplement | 4.0 | 4.0 | 4.0 | 4.0 | 4.5 |
| Dry supplement | 4.11 | 4.11 | 5.11 | 5.11 | 4.8 |
| Days on feed[c] | 1-2 | 3-5 | 6-7 | 8-11 | 12-finish |
| Crude protein, %[d] | 9.91 | 10.0 | 10.6 | 10.9 | 11.0 |
| $NE_m$, Mcal/cwt[e] | 75.7 | 83.4 | 87.8 | 90.6 | 94.5 |
| $NE_g$, Mcal/cwt[e] | 44.7 | 51.8 | 56.8 | 59.4 | 63.1 |

[a]11 g/T laidlomycin propionate.
[b]Includes 2:1 whole shelled corn:high moisture corn for 6 days; thereafter whole shelled corn.
[c]Ad libitum treatment.
[d]CP determined value.
[e]Tabular values.

Table 2. Interim and cumulative feedlot performance of steers fed by prescription or ad libitum feed bunk management

| Item | Treatment | | SEM | P[a] |
|---|---|---|---|---|
| | Prescription | Ad libitum | | |
| Init. wt., lb | 864 | 865 | 6.72 | NS |
| | 1 to 29 days | | | |
| BW | 1074 | 1082 | 7.56 | NS |
| ADG | 7.24 | 7.49 | .389 | NS |
| DMI | 19.82 | 24.92 | .317 | .0001 |
| F/G | 2.75 | 3.40 | .216 | .064 |
| Frequency of slick bunks, % | 90.7 | 42.7 | – | .001 |
| | 30 to 57 days | | | |
| BW | 1188 | 1205 | 4.47 | .0288 |
| ADG | 4.07 | 4.37 | .368 | NS |
| DMI | 23.96 | 26.04 | .826 | NS |
| F/G | 6.02 | 6.11 | .444 | NS |
| Frequency of slick bunks, % | 80.0 | 45.0 | – | .001 |
| | 58 to 85 days | | | |
| BW | 1283 | 1288 | 6.72 | NS |
| ADG | 3.41 | 2.99 | .281 | NS |
| DMI | 25.09 | 28.15 | .863 | .0361 |
| F/G | 7.47 | 9.87 | .827 | .0746 |
| Frequency of slick bunks, % | 60.7 | 41.4 | – | .001 |
| | 86 to 121 days | | | |
| BW | 1369 | 1372 | 12.29 | NS |
| ADG | 2.39 | 2.32 | .250 | NS |
| DMI | 25.10 | 26.47 | .857 | NS |
| F/G | 10.55 | 12.64 | 1.61 | NS |
| Frequency of slick bunks, % | 51.1 | 29.4 | – | .001 |
| | Cumulative (121 days) | | | |
| BW | 1328 | 1331 | 11.93 | NS |
| ADG | 3.84 | 3.85 | .110 | NS |
| DMI | 23.57 | 26.39 | .579 | .0088 |
| F/G | 6.15 | 6.90 | .281 | .0946 |
| Frequency of slick bunks, % | 69.3 | 39.7 | – | .001 |

[a]NS = P>.10.

Table 3. Carcass traits of steers fed prescription or ad libitum amounts of feed

| Item | Treatment | | SEM | P[a] |
|---|---|---|---|---|
| | Prescription | Ad libitum | | |
| Carcass wt, lb | 822 | 822 | 7.7 | NS |
| Dressing percentage | 61.93 | 61.79 | .164 | NS |
| Rib eye area, in.$^2$ | 13.78 | 13.60 | .193 | NS |
| Rib fat, in. | .414 | .434 | .015 | NS |
| KPH, % | 2.49 | 2.43 | .243 | NS |
| Marbling score[b] | 5.67 | 5.31 | .103 | .0854 |
| Percent choice | 74 | 79 | — | NS |
| Yield grade | 2.75 | 2.82 | .087 | NS |

[a]NS = P>.10.
[b]5.0 = Small°; 6.0 = Modest°.

# Effects of MGA on Prepubertal Beef Heifers

L.M. Butler,[1] H.L. Miller,[2] D.D. Zalesky,[3] D.M. Marshall,[4] K.VanderWal,[5] and C. Moret[5]
Department of Animal and Range Sciences

SDSU **CATTLE 96-6**

## Summary

A 2-year study (1995 and 1996) utilized prepubertal beef heifers to study the effects of feeding MGA to induce puberty. Heifers were allotted to two groups, control or treatment, based on breed, age and weight. Treatment heifers received MGA for 14 days at a rate of .4 mg/day with their diet, while control heifers received the same diet free of MGA. In year 1 (n = 55; control = 28, treatment = 27), heifers averaged 627.7 lb and were 301.9 days of age at the start of the treatment. There was no difference in age at puberty (P = .65) with control heifers 378.5 ± 8.3 days of age and treatment heifers 373.0 ± 8.5 days of age. Forty-seven of 55 heifers became pregnant during the breeding season (85.5%). Of the 47 heifers, 37 heifers gave birth to a live calf (78.7%). In year 2 (control = 20, treatment = 21), heifers averaged 609.0 lb and were 300.4 days of age at the start of the treatment. Control heifers were 373.6 ± 7.3 days of age and treatment heifers 382.4 ± 7.3 days of age at puberty (P = .40). Thirty-eight of 41 heifers became pregnant during the breeding season (92.7%). Thirty-five of 41 heifers were bred AI (85.4%). Thirteen of 16 control heifers and 12 of 19 treatment heifers became pregnant to AI (P > .50). The use of MGA to induce puberty has potential, but further research is needed to determine the age at which it should be administered.

Key Words: MGA, Puberty, Heifers

## Materials and Methods

A 2-year study was conducted using prepubertal crossbred (Angus, Hereford, Simmental, and Tarentaise) beef heifers maintained at the Beef Breeding Unit (BBU) at South Dakota State University (SDSU), Brookings. Prepubertal heifers were fed a diet with or without MGA for 14 days to determine if MGA alone can induce puberty.

### Animals and Care

Year 1. Crossbred heifers (n = 55) were weaned October 18, 1994. Fifty-two heifers were transported from the Antelope Research Station at Buffalo, SD, to the BBU in late October 1994. Three additional heifers raised at the BBU were also in the study. Heifers were on a dirt lot, received a cracked corn, alfalfa pellet ration, and had access to free choice grass hay. The final level at which the ration was fed was 6.6 lb/head/day. Heifers were subsequently weighed December 22, 1994, March 23, 1995, May 15, 1995, and August 17, 1995. Condition scores were taken at the start and end of the breeding season.

Animals were randomly allotted to one of two groups, control or treatment, based on their breed composition, age, and weight nearest the start of MGA feeding (Table 1). Treatment animals received .4 mg of MGA/head/day for 14 days. Control animals received the same diet as treatment animals only without MGA.

---

[1]Graduate Assistant.
[2]Associate Professor.
[3]Assistant Professor.
[4]Professor.
[5]Agricultural Foreman.

Table 1. Age and initial weight at the onset of treatments in 1995 and 1996

| Category | Year | Treatment group: Control | Treatment | P value |
|---|---|---|---|---|
| No. of observations | 1995 | 28 | 27 | |
| Age (days)[a] | | 301.9 ± 1.8 | 301.8 ± 1.9 | .97 |
| Weight (lb)[a] | | 621.9 ± 13.4 | 633.6 ± 13.2 | .54 |
| No. of observations | 1996 | 20 | 21 | |
| Age (days)[a] | | 300.3 ± 2.0 | 300.4 ± 2.0 | .96 |
| Weight (lb)[a] | | 608.1 ± 14.5 | 609.6 ± 14.3 | .94 |

[a]Least squares means ± standard errors.

Blood collection occurred weekly for subsequent sera removal and progesterone determination. Collection of blood started 3 weeks before the initial MGA feeding. Blood was not collected from animals receiving MGA during the 14 days on the assumption endogenous progesterone levels would be low. As heifers were determined to be cyclic, bleedings were discontinued. A level of 1 ng/ml progesterone was considered indicative of an active corpus luteum. If a pattern of two high progeseterone levels and one low progesterone level occurred, cyclic activity was determined to be occurring. Three bleedings after the AI period were taken to determine pregnancy rates to AI.

Blood samples were collected via jugular venipuncture into vaccutainer tubes. Samples were allowed to clot for approximately 12 hours at 4°C and were centrifuged for 20 minutes at 4°C. Sera was poured into polypropylene tubes and immediately analyzed for progesterone or frozen at -20°C and analyzed at a later date.

The breeding season started May 9, 1995. Heifers were detected for estrus by visual observation for half an hour twice a day. Heifers detected in heat in the morning were bred AI the same evening. Heifers in heat in the evening were bred AI the next morning. Heifers that were not bred were given Lutalyse (UpJohn Company, Kalamazoo, MI) on day 7. Heifers were detected for estrus and bred as discussed before. A clean-up bull was placed with the heifers on pasture on day 10 of the breeding season. The bull was removed 63 days after the start of the AI period.

Heifers were ultrasounded for pregnancy 37 days after the end of the breeding season. The Aloka 500V (Corometrics Medical Systems, Inc., Wallingford, CT) with a 5.0 MHZ probe was used transrectal to determine pregnancy. Pregnancy was later confirmed by rectal palpation at approximately 90 days after the end of the breeding season and by actual calving data.

Year 2. Crossbred heifers (n=41) were weaned October 17, 1995. Animals were transported to the BBU in late October 1995 and placed on dry grass pasture. Diet consisted of a cracked corn and SBM pellet concentrate fed at a rate of 7.5 lb/head/day with access to free choice grass hay. Subsequent weights were taken December 7, 1995, January 2, 1996, February 8, 1996, March 27, 1996, May 13, 1996, and August 22, 1996.

Heifers were allotted to a control or treatment group based on the same criteria as in year 1. Feeding of MGA and blood collection and progesterone analysis were conducted as discussed in year 1.

Thirty-one days before the breeding season a synchronization program utilizing MGA and Lutalyse was initiated. Heifers were fed MGA for 14 days at .4 mg/head/day. After MGA feeding, heifers were bled weekly for 2 weeks. Seventeen days after the last feeding of MGA, Lutalyse was administered. Heifers were detected for estrus by visual observation for half an hour twice a day. Heifers that were detected in estrus were bred the next morning. Heifers were bred AI for 3 days beginning May 15, 1996. On day 4, a clean-up bull was

placed with the heifers for the remaining 61 days of breeding season on grass pasture. Pregnancy determination utilized ultrasound 38 days after the end of the breeding season as in year 1.

**Statistical Analysis**

Statistical analysis was conducted using Procedure General Linear Model (Proc GLM) of SAS with the Least Squares Means (LSMeans) function. Treatment, breed, year, and age group were entered as independent variables into the model. Age, weights, condition scores, and age at puberty were entered into the model as dependent variables. Treatment interactions with breed, year, and age group were analyzed.

Treatment, week, and period within week were entered as independent variables with progesterone as the dependent variable. Interactions of week and period within week with treatment were also analyzed.

Reproductive data—pregnancy rates to AI and the breeding season and calving rates to AI and the breeding season—were analyzed by Chi-square analysis with one degree of freedom.

## Results and Discussion

Year 1. Heifers averaged 627.7 lb and were 301.9 days of age at the start of MGA feeding (Table 1). Average daily gains prebreeding and breeding weights were similar (Table 2). Heifers averaged 715.0 lb and gained approximately .62 lb/day. Condition scores of these heifers averaged 3.4 on a 1 to 9 scale (Table 2).

Heifers improved their average daily gain from .62 lb/day prebreeding to 1.6 lb/day during the breeding season. Condition scores improved from 3.4 prebreeding to 4.7 during the breeding season (Table 3).

Control heifers were 378.5 ± 8.3 days of age and treatment heifers were 373. ± 8.5 days of age at puberty (P = .65; Table 4). One heifer in each treatment did not reach puberty by the end of the breeding season and were not included in the calculation of puberty. Conception ages were similar for treatments (P = .74; Table 4). Control heifers were 429.7 ± 3.5 days of age and treatment heifers were 428.0 ± 3.5 days of age at conception.

Conception rate, determined by ultrasound and rectal palpation, was not different for the breeding season (P > .975; Table 5). Twenty-four of 28 control heifers and 23 of 27 treatment heifers conceived for a 85.5% conception rate for the breeding season. Pregnancy rates for AI were not different (P > .975; Table 5). Nine of 13 control heifers and 11 of 16 treatment heifers became pregnant by AI.

Of the 47 pregnant heifers, 37 gave birth to live calves (Table 5). Losses included two open heifers (one from each treatment), six dead calves on arrival or died shortly after birth (three from each treatment) and two abortions (one from each treatment). Of the two open heifers, both were approximately 160 days pregnant at rectal palpation.

Heifers were housed on a dirt lot. Conditions during late winter and early spring were very wet and animals carried large amounts of mud throughout the spring. These conditions contributed to the number of incidences of foot rot. This may explain the low gains and the body condition scores at the start of the breeding season. Once on grass after the AI period, heifers had compensatory gains.

Year 2. At the start of the treatment, heifers were of similar weights and age. Heifers averaged 609.0 lb and were 300.4 days of age (Table 1). Heifers gained approximately 1.67 lb/day from the start of the treatment to the breeding season (Table 2). Once on pasture, heifers gained approximately 1.08 lb/day (Table 3).

Control heifers averaged 373.6 ± 3.1 days of age and treatment heifers averaged 382.4 ± 7.3 days of age at puberty (P = .40; Table 4). One heifer did not reach puberty by the end of the breeding season and was not included in the calculation of puberty. Control heifers averaged 433.7 ± 3.1 days of age and

Table 2. Condition scores, breeding weights, and average daily gain from treatment initiation to the beginning of the breeding season for 1995 and 1996 heifers

| | | Treatment group | | |
|---|---|---|---|---|
| Category | Year | Control | Treatment | P value |
| No. of observations | 1995 | 28 | 27 | |
| Body condition score[a] | | 3.4 ± .1 | 3.4 ± .1 | .88 |
| Weight (lb)[a] | | 709.1 ± 15.0 | 721.4 ± 15.4 | .57 |
| ADG (lb/day)[a] | | .62 ± .04 | .62 ± .04 | .94 |
| No. of observations | 1996 | 20 | 21 | |
| Weight (lb)[a] | | 834.5 ± 19.6 | 827.4 ± 19.1 | .80 |
| ADG (lb/day)[a] | | 1.69 ± .07 | .74 ± .07 | .51 |

[a]Least squares means ± standard errors.

Table 3. Condition scores, end weights, and average daily gain during the breeding season for 1995 and 1996 heifers

| | | Treatment group | | |
|---|---|---|---|---|
| Category | Year | Control | Treatment | P value |
| No. of observations | 1995 | 28 | 27 | |
| Body condition score[a] | | 4.7 ± .1 | 4.6 ± .1 | .52 |
| Weight (lb)[a] | | 860.4 ± 17.2 | 876.0 ± 17.4 | .52 |
| ADG (lb/day)[a] | | 1.61 ± .04 | 1.65 ± .07 | .65 |
| No. of observations | 1996 | 20 | 21 | |
| Weight (lb)[a] | | 939.8 ± 20.2 | 941.6 ± 19.8 | .95 |
| ADG (lb/day)[a] | | 1.03 ± .07 | 1.12 ± .07 | .31 |

[a]Least squares means ± standard errors.

Table 4. Age at puberty and conception age for 1995 and 1996 heifers

| | | Treatment group | | |
|---|---|---|---|---|
| Category | Year | Control | Treatment | P value |
| No. of observations | 1995 | 27 | 26 | |
| Puberty (days)[a] | | 378.5 ± 8.3 | 373.0 ± 8.5 | .65 |
| No. of observations | | 24 | 23 | |
| Conception age (days)[a] | | 429.7 ± 3.5 | 428.0 ± 3.5 | .74 |
| No. of observations | 1996 | 20 | 20 | |
| Puberty (days)[a] | | 373.6 ± 7.3 | 382.4 ± 7.3 | .40 |
| No. of observations | | 19 | 19 | |
| Conception age (days)[a] | | 433.7 ± 3.1 | 434.9 ± 3.1 | .79 |

[a]Least squares means ± standard errors.

treatment heifers averaged 434.9 ± 3.1 days of age at conception (P = .79; Table 4).

Overall conception rate was 92.7% (Table 6). Nineteen of 20 control heifers and 19 of 21 treatment heifers became pregnant to the breeding season (P > .75; Table 6). Conception rate to AI was 25 of 35 heifers (71.4%; Table 6). Thirteen of 16 control heifers and 12 of 19 treatment heifers became pregnant to the AI service (P > .50; Table 6).

The responses may be due in part to the severe sub-zero temperatures during the time when heifers were fed MGA and thereafter. All heifers but three responded favorable to the synchronization MGA.

The potential of MGA to induce puberty is still unknown. Environmental conditions, physiological maturity, and sufficient age and weight of the heifers may be key to inducing puberty. With sufficient age (less than a year) and weight, MGA should be able to induce puberty in prepubertal beef heifers.

Table 5. Pregnancy rate to AI, pregnancy rate during the breeding season and number of calves born alive for the 1995 BBU heifers

| Category | Control | Treatment | P value | Total |
|---|---|---|---|---|
| No. pregnant to AI[a] | 9/13 (69.2)[b] | 11/16 (68.8)[b] | >.975 | 20/29 (69.0)[b] |
| No. pregnant to season[a] | 24/28 (85.7)[b] | 23/27 (85.2)[b] | >.975 | 47/55 (85.5)[b] |
| No. calves born alive[a] | 18/24 (75.0)[b] | 19/23 (82.6)[b] | >.75 | 37/47 (78.7)[b] |
| No. calves born to AI alive[a] | 5/9 (55.6)[b] | 9/11 (81.8)[b] | >.10 | 14/20 (70.0)[b] |

[a]Chi-square analysis.
[b]( ) Percentage.

Table 6. Pregnancy rate to AI and pregnancy rate to the breeding season for the 1996 BBU heifers

| Category | Control | Treatment | P value | Total |
|---|---|---|---|---|
| No. pregnant to AI[a] | 13/16 (81.3)[b] | 12/19 (63.2)[b] | >.50 | 25/35 (71.4)[b] |
| No. pregnant to season[a] | 19/20 (95.0)[b] | 19/21 (90.5)[b] | >.75 | 38/41 (92.7)[b] |

[a]Chi-square analysis.
[b]( ) Percentage.

# Kappa-Casein and Beta-Lactoglobulin Genotype Effects on Milk Production and Maternal Calf Growth Traits in Crossbred Beef Cattle[1]

D.A. Henderson[2] and D.M. Marshall[3]
Department of Animal and Range Sciences

SDSU

**CATTLE 96-7**

Summary

Cows were genotyped at the kappa-casein and beta-lactoglobulin loci and evaluated for milk yield, calf birth weight, weaning weight, and average daily gain from birth to 109 days and from birth to 211 days of age. The interaction of breed-group with genotype was significant for milk yield at both loci. Cow genotype and additive allelic effects were significant or approached significance for both measures of calf average daily gain and weaning weight at the kappa-casein locus. Cow genotype and additive allelic effects were significant for calf average daily gain to 109 days at the beta-lactoglobulin locus. Cow genotype approached significance for calf average daily gain to 211 days at the beta-lactoglobulin locus. The quadratic effect of number of A alleles in the cow's genotype (i.e., 0, 1, or 2) was significant or approached significance for several measures of calf growth, suggesting possible dominance effects.

Key Words: Beef cattle, Genotype, Milk, Growth

## Introduction

Marker-assisted selection has received increasing interest as DNA technologies have developed. Potential benefits of marker-assisted selection include 1) a reduction in generation interval since superior animals can be identified at an early age, even before birth and 2) the accuracy of predicted performance (heritability, $h^2$) increases when DNA marker information is combined with performance information of the individual and(or) its relatives. A number of DNA markers have been located, but the actual effects of such loci are mostly unknown to date. Candidate genes may have a direct influence on production traits, and can serve as linkage markers to other genes affecting traits of interest. Kappa-casein and beta-lactoglobulin have been suggested as candidate genes for possible effects on milk yield, milk composition, and calf preweaning growth. The objective of this study was to evaluate the effect of cow genotype at the kappa-casein and beta-lactoglobulin loci on milk production and preweaning calf growth in a beef herd.

## Materials and Methods

Production data for this study were collected from 1991 to 1995 at the Beef Breeding Unit at South Dakota State University in Brookings, South Dakota. The cows were 3 to 10 years old and maintained in one of three two-breed rotational crossbred groups: Tarentaise-Hereford cross, Angus-Hereford cross, or Simmental-Hereford cross. Traits measured include estimated cumulative milk yield, calf birth weight, calf average daily gain from birth to 109 days and 211 days, and calf weaning weight. Cumulative milk yield was estimated by nonlinear regression procedures using weigh-suckle-weigh measurements taken on six or seven dates each year.

DNA was extracted from blood samples of each cow. Genotyping procedures included amplification of a portion of the target gene by the polymerase chain reaction (PCR), followed

[1]This material is based upon work supported by the Cooperative State Research Service, U.S. Department of Agriculture, under Agreement No. 94-37208-1038.

[2]Data Specialist, Pig Improvement Company, Franklin, KY.

[3]Professor.

by restriction enzyme digestion of the amplified DNA into fragments and gel electrophoresis to separate the DNA fragments. The genotype of a particular cow is determined from the banding pattern of the DNA fragments. Each locus was assumed to have two alleles, designated A and B, segregating in these beef populations. Thus, the possible genotypes for a given locus in a particular cow were AA, AB, or BB.

Mixed-model statistical analyses were conducted to calculate least squares means by genotype. In a second analysis, linear and quadratic covariates for the number of copies of allele A (i.e. 0, 1, or 2) in a cow's genotype were included in the model. Separate analyses were conducted for the kappa-casein and beta-lactoglobulin loci. Variance components were estimated for use in the mixed-model analysis, and the resulting heritability values are presented in Table 1.

Table 1. Number of records (n) and heritability values by trait

| Trait | n | Heritability |
|---|---|---|
| Estimated milk yield | 231 | .38 |
| Calf birth weight | 223 | .37 |
| Calf ADG to 109 days | 226 | .46 |
| Calf ADG to 211 days | 222 | .44 |
| Calf weaning weight | 222 | .40 |

## Results and Discussion

For estimated milk yield, a breed-group by genotype interaction was significant for both kappa-casein and beta-lactoglobulin (Table 2). For both loci, genotype rankings within Tarentaise-Hereford cows were different as compared to the other two breed-groups. At the kappa-casein locus, milk yields for the BB genotype was lower than for the other two genotypes among Simmental-Hereford and Angus-Hereford cows, whereas the AA genotype was associated with the lowest milk yield in the Tarentaise-Hereford cows. At the beta-lactoglobulin locus, the AA genotype was associated with lower milk yield among Simmental-Hereford and Angus-Hereford cows, but with the most milk among Tarentaise-Hereford cows. These interactions suggest the possible existence of additional genes affecting milk yield that are linked to (i.e., located near) the kappa-casein and beta-lactoglobulin loci.

Table 3 shows least-squares means by cow genotype for calf growth traits. The effect of cow genotype on birth weight was not significant at either locus. At the kappa-casein locus, average daily gains and weaning weight were similar for calves from AA versus AB cow genotypes, whereas calves from BB cows gained less and weighed 21 lb less at weaning than calves from AA cows. At the beta-lactoglobulin locus, average daily gain to 211 days and weaning weight were similar for calves from AB and BB cows, whereas calves from AA cows gained slower and weighed 26 lb less at weaning than calves from BB cows.

It is interesting to note the number of weaning records for the two loci in Table 3. The fewest cows exist for the genotype least favoring calf growth, that being BB for kappa-casein and AA for beta-lactoglobulin. This raises speculation that perhaps previous selection for increased calf growth has resulted in increased frequency of the A allele of kappa-casein and B allele of beta-lactoglobulin in these populations.

Table 2. Least-squares means by genotype and breed-group for estimated cumulative milk yield (lb)

| Item | Simmental-Hereford | Angus-Hereford | Tarentaise-Hereford |
|---|---|---|---|
| Kappa-casein genotype | | | |
| AA | 3411 | 3385 | 3177 |
| AB | 3614 | 3329 | 3502 |
| BB | 2772 | 3114 | 3529 |
| Beta-lactoglobulin genotype | | | |
| AA | 3051 | 2360 | 4091 |
| AB | 3509 | 3235 | 3431 |
| BB | 3541 | 3398 | 3257 |

Table 3. Least-squares means (± standard error) by genotype and breed-group for calf growth traits

| | Genotype | | | | | |
|---|---|---|---|---|---|---|
| | AA | | AB | | BB | |
| Item | Mean | s.e. | Mean | s.e. | Mean | s.e. |
| | Kappa-casein | | | | | |
| No. weaning records | 129 | | 77 | | 38 | |
| Birth wt, lb | 107 | 1.5 | 103 | 1.8 | 105 | 2.4 |
| ADG to 109 days, lb/day | 1.78 | .03 | 1.81 | .03 | 1.66 | .05 |
| ADG to 211 days, lb/day | 2.04 | .03 | 2.05 | .03 | 1.93 | .04 |
| Weaning wt, lb | 532 | 5.6 | 534 | 6.9 | 511 | 9.1 |
| | Beta-lactoglobulin | | | | | |
| No. weaning records | 13 | | 83 | | 148 | |
| Birth wt, lb | 109 | 3.5 | 105 | 1.7 | 105 | 1.5 |
| ADG birth to 109 days, lb/day | 1.69 | .06 | 1.75 | .03 | 1.81 | .03 |
| ADG birth to 211 days, lb/day | 1.89 | .06 | 2.03 | .03 | 2.03 | .03 |
| Weaning wt, lb | 504 | 13.4 | 529 | 6.5 | 530 | 5.7 |

Linear and quadratic effects of the number of A alleles in the cow's genotype are shown in Table 4. Linear values are analogous to additive allele effects, sometimes called the effect of allele substitution. They represent an estimate of the average change in a production trait for each additional A allele in the cow genotype. Quadratic values measure non-linearity of the regression and might be indicative of dominance effects at the locus. Linear or quadratic effects were not significant for calf birth weight at either locus in this study. Linear and quadratic effects at both loci were significant or approached significance for several of the measures of calf growth after birth. In general, the significant linear (additive) values suggest a positive association with calf growth for cows having the A allele at the kappa-casein locus and the B allele at the beta-lactoglobulin locus. However, calves of heterozygous cows had similar preweaning growth to calves from cows with two copies of the favorable allele, sometimes resulting in a significant quadratic effect, and indicating a possible dominance effect.

Table 4. Linear and quadratic values for regression on the number of A alleles in the cow's genotype

| | Linear effect[a] | s.e. | Quadratic effect[a] | s.e. |
|---|---|---|---|---|
| | Kappa casein | | | |
| Birth wt, lb | 1.5 | 1.19 | 2.54 | 1.9 |
| ADG to 109 days, lb/day | .04* | .02 | -.09** | .03 |
| ADG to 211 days, lb/day | .04† | .02 | -.07* | .03 |
| Weaning wt, lb | 7.5† | 4.45 | -12.7† | 7.1 |
| | Beta lactoglobulin | | | |
| Birth wt, lb | 1.2 | 1.39 | 1.8 | 2.29 |
| ADG to 109 days, lb/day | -.12** | .03 | -.10 | .04 |
| ADG to 211 days, lb/day | -.04 | .02 | -.07† | .04 |
| Weaning wt, lb | -7.6 | 5.20 | -12.0 | 8.77 |

[a]Linear values are in actual units of the trait; quadratic values are in units$^2$.
†P<.10; *P<.05; **P<.01.

## Implications

These data indicate possible associations of cow genotype with milk yield and calf preweaning growth at the kappa-casein and beta-lactoglobulin loci. Such associations could possibly result from a direct influence of these genes, or from the linkage of these genes to other genes affecting the traits evaluated, or from a combination of both.

# Assessment of Failure of Colostral Absorption Among Well-Managed Herds Using a Simple Screening Test

Bill Epperson,[1] Dick Pruitt,[2] Don Marshall,[3] and Anna Drew[4]
Departments of Veterinary Science and Animal and Range Sciences

SDSU **CATTLE 96-8**

Summary

Failure of calves to ingest colostrum early in life is associated with an increased risk of illness and death. Colostral antibody absorption can be easily estimated with a blood sample collected after the calf is 24 hours old. This study was conducted to determine the proportion of calves born at the four SDSU beef units that were affected with inadequate passive transfer (IPT) as a result of inadequate colostral antibody absorption. Of the 333 calves, 44 were affected with IPT (13.2%). There were significant differences in IPT between units, suggesting that environmental factors unique to each unit may have a role in contributing to IPT. Calves of first calf heifers tended to be affected with IPT in a greater proportion than calves born to cows. Females that required assistance at birth produced calves that were 2.5 times as likely to be affected with IPT as females requiring no assistance (P = .058). Calves born during the late evening hours tended to be at greater risk for IPT compared to calves born in the early morning or during the work day. The incidence of IPT appeared to vary among herds, suggesting that control of IPT is possible.

Key Words: Colostrum, Total protein

## Introduction

Prevention of calf losses represents a major hurdle for beef producers. Nationwide, an average of 8% of calves are reported lost before weaning. Of all these losses, 69% occur within the first 96 hours of life. Dystocia (difficult birth) is the main cause of calf loss followed by health problems, mostly scours and respiratory disease, and then injuries.

Prevention of early calf loss requires attention to many factors, some of which are determined as early as the time of conception. Strategies to minimize calfhood disease have been proposed and attempted. Fundamental to disease control is enhancing resistance to disease. The single most important activity to enhance calf resistance to neonatal disease is ingestion and absorption of an adequate volume of high quality colostrum. Studies suggest that failure to ingest adequate colostrum, which results in failure of passive transfer of antibodies to the calf, may be associated with an increased risk of mortality (3 to 6 times). A recent study from the Meat Animal Research Center (MARC) indicated that calves affected with failure of passive transfer at birth have a higher incidence of illness in the feedlot. This suggests that colostrum may have a long term effect on the immune system and animal health and re-emphasizes its importance.

The goal of this report is to assess the rate of failure of passive transfer in four SDSU beef herds using a screening technique that is inexpensive and presently available to field veterinarians and producers. The data for this report were analyzed descriptively to reveal major trends present at the herd level. These data represent a portion of a larger dataset compiled during the 1996 calving season and other reports will follow.

---

[1]Assistant Professor, Veterinary Science.
[2]Associate Professor, Animal Science.
[3]Professor, Animal Science.
[4]Senior student, Animal Science.

## Materials and Methods

The four SDSU beef herds, one located in Buffalo (Antelope Range Station), one in Cottonwood (Cottonwood Research Station), and two in Brookings (Cow-Calf Unit [CCU] and Beef Breeding Unit [BBU]) were utilized. These units represent both intensively managed, winter drylot type operations as well as extensively managed range operations.

To ascertain intake of colostrum, a blood sample was obtained from each calf after it was 24 hours old when absorption of colostrum would be expected to be complete. A total of 333 samples were obtained between February 24, 1996, and April 24, 1996. Either the stock persons at the units (Antelope and Cottonwood) or a student assistant collected blood samples. Blood was collected and placed into vacutainer tubes containing an EDTA additive. Samples were centrifuged, plasma harvested, and stored frozen at $0^0$ F in labeled vials. Calf ear tag number, date, and time of blood sampling was recorded. Other data collected included dam ID, parity, calving ease, date and time of birth, calf sex, and birth weight. Calving ease was recorded on a subjective ordinal scale but for analysis was divided into two categories of either assistance given or no assistance given.

After the completion of the calving season, all plasma samples were thawed and total protein determined using refractometry. Refractometry is a fast, easy, inexpensive, accurate method to determine total protein and can be used on the ranch. Total protein is well correlated with the variable of primary interest, total immunoglobulin (Ig). Unfortunately, at present, direct measurement of total Ig is quite expensive (over $8.00/sample) and is only performed in the laboratory setting.

All data were analyzed using a computer program (EpiInfo 6). Calves were grouped into categories of either adequate passive transfer or inadequate passive transfer based on the total plasma protein obtained from the blood sample taken after 24 hours of age. Literature sources suggest that adequate passive transfer would be expected if calves had plasma protein concentrations at or above 5.8 mg/dl. This was the cutoff point used for the analysis.

## Results and Discussion

None of the study herds had ongoing health problems. Very few abortions occurred prior to the 1996 calving season, and the stillbirth rate was not abnormally high. Aside from some injuries that led to the loss of a small number of calves, there was very low mortality and very few of the calves had a record of treatment for any disease condition early in life.

The overall rate of inadequate passive transfer (IPT) is given in Table 1 and is stratified by unit. There was a significant ($P<.001$) difference between units in the percentage of calves in the IPT group, with a range of 1.9% to 28.3%. Reasons for the pronounced variation among herds is not clear, and relatively little work has been published to quantitate specific factors associated with passive transfer. Possible reasons for the variation in IPT between herds include differences in the parity distribution between herds, degree of calving difficulty, and other management factors.

Calves born to first calf heifers (parity = 1) have been reported to have a threefold increased rate of preweaning death compared to calves born of cows in the same herd. Heifers produce a lower quality colostrum and have less satisfactory mothering skills. Our study tended to suggest that calves born to heifers may have a higher rate of IPT, though the trend was not significant ($P=.44$). With the exception of one unit (CCU), calves born to heifers had a numerically higher rate of IPT than calves born to cows (Table 1). The reasons for the apparent reversal of this trend at the CCU is not clear, and a closer examination of the management of heifers at this unit is needed to determine what procedures were used to limit the incidence of IPT in calves born to heifers.

The differences between units in the percentage of the herd that was first calf heifers did not explain the overall variation in IPT that was observed. Applying a standardized rate of IPT to each unit for calves born to heifers (16.7% or .167 IPT calf/calf born) and to calves born to cows (12.6% or .126 IPT calf/calf born)

Table 1. Incidence of calves born with Inadequate Passive Transfer (IPT)

| | Unit | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Antelope | | BBU | | CCU | | Cottonwood | | Overall |
| | N[1] | % | N | % | N | % | N | % | % |
| Parity 1 | 6/23 | 26.1 | 0/0 | – | 1/11 | 9.1 | 1/14 | 7.1 | 16.7 |
| ≥2 | 11/76 | 14.5 | 15/53 | 28.3 | 9/67 | 13.4 | 1/89 | 1.1 | 12.6 |
| Overall[2] | 17/99 | 17.2[ab] | 15/53 | 28.3[a] | 10/78 | 12.8[bc] | 2/103 | 1.9[d] | |

[1]N = Number with IPT/total females in group.
[2]Percentages with different superscripts differ (P<.05) by individual (2x2) Chi square testing.

multiplied by the number of heifers and cows in each unit would give an "expected" or standardized herd rate of IPT. If the standardized rate of IPT equaled the observed rate in each herd, then the herd differences in IPT were due solely to differences in the parity distribution (percentage of heifers vs cows) between herds. Table 2 gives the results of the standardization. The parity distribution between herds did not explain the observed rate of IPT. This suggests that there were other factors at work in determining the overall rate of IPT between the production units.

Table 2. Standardization of rate of IPT

| | Unit | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Antelope | | BBU | | CCU | | Cottonwood | |
| Parity | N[1] | sIPT[2] | N | sIPT | N | sIPT | N | sIPT |
| 1 | 23 | 3.8 | 0 | -- | 11 | 1.8 | 14 | 2.3 |
| ≥2 | 76 | 9.6 | 53 | 6.7 | 67 | 8.4 | 89 | 11.2 |
| Expected total IPT[3] | | 13.4 | | 6.7 | | 10.2 | | 13.5 |
| Actual total IPT[4] | | 17 | | 15 | | 10 | | 2 |

[1]N = Number of animals in parity group at respective location.
[2]sIPT = standardized IPT. Calculated as N • .167 for parity 1, N • .126 for parity ≥2.
[3]Expected total IPT = sIPT for parity 1 and parity ≥2.
[4]Actual total IPT from Table 1.

Other studies would suggest that a greater difference in IPT between heifers and cows should have occurred. Examining the difference in IPT in parity 1 vs parity ≥2 animals in the three units that included first calf heifers (Antelope, CCU, and Cottonwood) resulted in an incidence of IPT of 8/48 (16.7%) in first calf heifers and 21/232 (9.1%) in cows. Excluding the BBU data from the comparison in IPT between parity groups is appropriate, since the BBU had no parity 1 animals. Though not significant (P=.17), exclusion of BBU data suggested that first calf heifers were 1.8 times as likely to have a calf affected with IPT compared to cows. This result represents a more appropriate description of the association between IPT and parity group and agrees more closely with other studies.

Calving ease can have an important influence on viability of the calf, ability to nurse shortly after birth, and ultimately on passive transfer. Dividing the data into animals that calved unassisted versus assisted indicated that females that received assistance at calving had calves that were 2.5 times as likely to have IPT as those not requiring assistance (P=.058). In order to save as many calves as possible, management to avoid IPT in assisted calves should be implemented shortly after birth. This may include hypersupplementation with colostrum, intravenous or oral fluids, or other supportive care.

The time of birth may have an impact on IPT. Calves born at night may be unobserved for several hours. These data suggest a tendency for calves born between 5 p.m. and midnight to have nearly twice the risk of IPT as do calves born in the day (8 a.m. to 4 p.m.) or early morning (midnight to 8 a.m.; P=.16).

Those calves born between 5 p.m. and midnight may be observed only casually until the next morning, since most of the night check concentrates on finding and assisting cows that are calving. Therefore, those calves born in the early evening may be 12 hours or more old before they are carefully observed to confirm nursing. Though the trend in our dataset was not significant (P=.16), it may be worthwhile for producers to monitor calves born between 5 p.m. and midnight to determine if they should modify their management procedures for calves born during this time period.

In summary, IPT was not uncommon in these well managed beef units. Despite IPT, direct calf losses have been low. However, in at least one unit, over 15% of calves have required therapy for some condition (primarily respiratory disease) that have occurred in the period prior to weaning. This study will continue to gather data on the health events of these calves throughout the production cycle. Passive transfer is easily measured and can be a useful objective criterion to assess calving time management. Some studies suggest IPT rates of over 20% may be expected in beef herds. Our data suggest that there is considerable variation in IPT rates between herds, and that IPT can be reduced to very low levels. Producers should consider monitoring their herds for IPT, for as few as 15 randomly drawn calf samples can be used to detect herds with a prevalence of IPT of ≥20%.

---

Special thanks are expressed to the stock persons at the cooperating beef units: Kevin VanderWal, Jarrod Johnson, Ron Swan, Brian Sarsland, Ron Haigh, Cody Moret, and Sara VanderWal.

# Long-Term Protection from Bovine Viral Diarrhea Virus in Feedlot Cattle

C.C.L. Chase,[1] J. Hanson,[2] T. Fraser,[3] L.Braun,[3] S. Anderson,[4] and D.J. Hurley [5]
Departments of Veterinary Science and Biology/Microbiology

SDSU

**CATTLE 96-9**

Summary

Bovine viral diarrhea virus (BVDV) causes respiratory and reproductive disease. The duration of immunity of an inactivated vaccine (Virashield 5: Grand Laboratories, Freeman, SD) was measured in two challenge studies. In both studies the vaccinated animals demonstrated fewer clinical signs when challenged with Type II BVDV at 11 or 13 months post vaccination. These results indicate that an inactivated vaccine administered properly can protect animals against disease up to at least a year post vaccination.

Key Words: Bovine viral diarrhea virus, BVDV, Vaccine, Challenge

## Introduction

Bovine viral diarrhea virus (BVDV) has emerged as the major viral disease of cattle. BVDV is the predominant virus isolated from bovine respiratory disease (BRD) and from abortions at the Animal Disease Research and Diagnostic Laboratory at South Dakota State University. BVDV was isolated from 100 submissions and represented 89% of all BRD viral isolations made in 1995. Two biotypes of BVDV virus have been recognized. Type I BVDV is the major type that has been responsible for most clinical BVDV in South Dakota. Type II BVDV has emerged in several areas of the country and has been implicated in acute BVDV outbreaks.

BVDV vaccines have traditionally been either modified live virus (MLV) or inactivated viruses. MLV vaccines have been touted on their ability to produce cell immunity and to have a longer duration of action.

This study was designed to assess the efficacy and duration of cattle vaccinated with the inactivated Virashield 5 (Grand Laboratories, Freeman, SD) by challenging the animals with BVDV. This report details the results of these clinical trials.

## Materials and Methods

*Animals*

Trial 1

Vaccinates. Six crossbred calves (Charolais cross, 500-750 lb) seronegative for BVDV were vaccinated in June 1994 with 5 ml of Virashield 5 intramuscular. A second dose was administered 1 month later.

Control. Three crossbred calves (Charolais cross, 400-500 lb) seronegative for IBR, BVDV, and BRSV were used as controls.

Trial 2

Vaccinates. Six yearling calves (Holstein cross, 1100-1200 lb) seronegative for BVDV were vaccinated in October of 1994. The animals were injected with 5 ml of Virashield 5 intramuscular. A second dose was administered

[1]Associate Professor, Veterinary Science Department.
[2]Undergraduate student.
[3]Microbiologist, Veterinary Science Department.
[4]Graduate student.
[5]Associate Professor, Biology/Microbiology Department.

one month later. In November 1995, the animals were moved to the Department of Veterinary Science, South Dakota State University.

Control. Three yearling calves (Holstein cross, 1100-1200 lb) seronegative for BVDV were used as controls.

*Challenge*

Virus. The BVDV challenge virus was from the National Veterinary Service Laboratory, Ames, IA. The challenge vials were labeled "NVSL BVD Challenge Virus (890) Lot# 94-9. The challenge upon dilution with 2.8 ml of diluent was $10^{7.2}$ tissue culture infectious dose 50 (TCID 50:the amount of virus required to kill 50% of the cells) per animal.

Virus Inoculation

Trial 1

Nine animals were challenged 11 months following the first vaccination with the BVDV virus inoculum described above. Each calf was swabbed prior to challenge, 2 ml per nostril (4 ml total) of inoculum was administered with an atomizer in each nostril and the calves were swabbed for virus isolation post inoculation.

Trial 2

Nine animals were challenged 13 months following the first vaccination with the BVDV virus inoculum described above. Each calf was swabbed prior to challenge, 2 ml per nostril (4 ml total) of inoculum was administered with an atomizer in each nostril, and the calves were swabbed for virus isolation post inoculation

*Testing Procedures*

Clinical Respiratory Signs and Body Temperature. During each challenge, animals were observed daily for clinical signs beginning 3 days prior to challenge and continued until 14 days post challenge. The animals were observed for lacrimation, conjunctivitis, dyspnea, and nasal discharge and clinical scores assigned. The basal body temperature was also measured rectally with a digital thermometer beginning 3 days prior to challenge and continued until 14 days post infection. Statistical analysis was done using a student T-test with significance cutoff of 0.05.

Clinical Diarrhea Signs-BVDV. Fecal consistency was measured beginning 3 days prior to challenge and continued until 14 days post infection in the BVDV challenge. The scoring system was 0 = normal consistency; 1 = loose consistency, and 2 = watery consistency. Statistical analysis was done using a student T-test with significance cutoff of 0.05.

Serology. Blood samples were drawn from all animals in each challenge. The samples were drawn prior to infection and at -2, 5, 12, and 26 days post infection. Serum was harvested and stored at -70° C. The serum was shipped to Grand Laboratories, Larchwood, IA, for serum neutralization testing.

## Results and Discussion

BVDV Clinical Respiratory Scores (includes body temperature)

Trial 1. Prior to challenge, all the cattle had a mild serous nasal discharge. At day 7 post infection, there was a threefold increase over pre-challenge scores in the control animals. This continued out to day 13 post infection. There was a significant increase ($P<.05$) in clinical scores between the two groups on days 8 to 13 of the BVDV experiment (Figure 1).

Trial 2. Prior to challenge, all the cattle had a mild serous nasal discharge. There was no difference in the clinical signs between the two groups. On days 7 and 8 post challenge, the controls had higher scores, but there was no clear trend. The body temperatures in these groups did not vary much. On days 8 and 9, the controls had temperatures 2° higher than the vaccinates (data not shown).

Clinical Diarrhea Scores BVDV

Trial 1. Fecal consistency was similar for both groups prior to challenge and up to day 7 post infection (Figure 2). On days 8, 10, and

11, there was a significant increase ($P<.05$) in diarrhea in the control animals (Figure 2).

Trial 2. There was no difference in fecal scores between the two groups (data not shown).

Serology

Trial 1. Vaccinated animals developed BVDV serum titers that peaked 2 to 3 months following the first vaccination (Figure 3). Figure 3 is representative of the serological response in Trial 1 against either Type I or Type II BVDV. Following infection, the serum titers of the vaccinated animals reached very high levels compared to the controls.

Trial 2. The serological response was similar to Trial 1 (Figure 4). Figure 4 is representative of the serological response in Trial 2 against either Type I or Type II BVDV.

These results indicate that vaccination with a properly administered inactivated vaccine can result in protection of feeder cattle from challenge with BVDV Type II over a year after vaccination. Respiratory disease in feedlot cattle continues to be a serious problem in the cattle industry. One of the important questions yet to be answered concerns the protection of cows against fetal BVDV infection. This infection results in abortions and BVDV persistently infected calves in the herd. These persistently infected animals maintain the virus in the herd and are a threat to even well vaccinated animals. Future studies are planned to answer these questions.

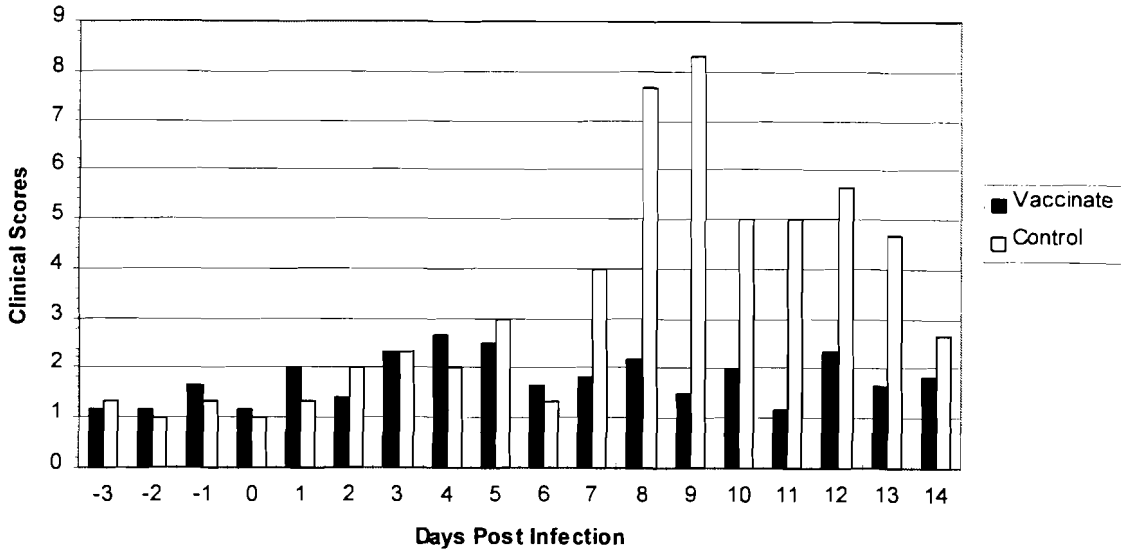



**Figure 1. Bovine Viral Diarrhea Virus Clinical Scores**

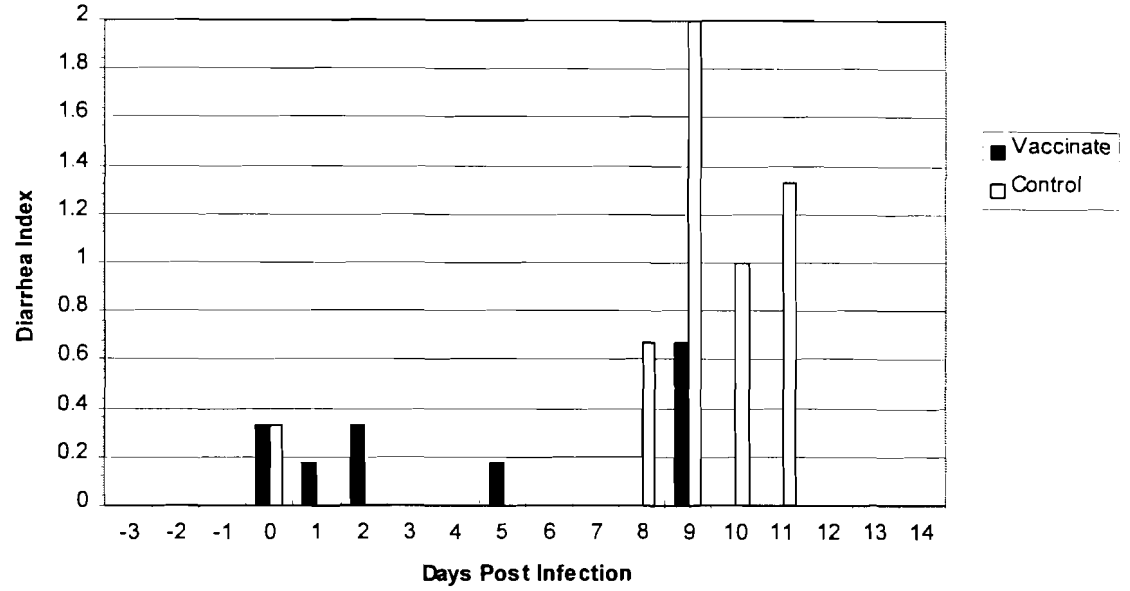



**Figure 2. Diarrheal Scores following BVDV Infection**

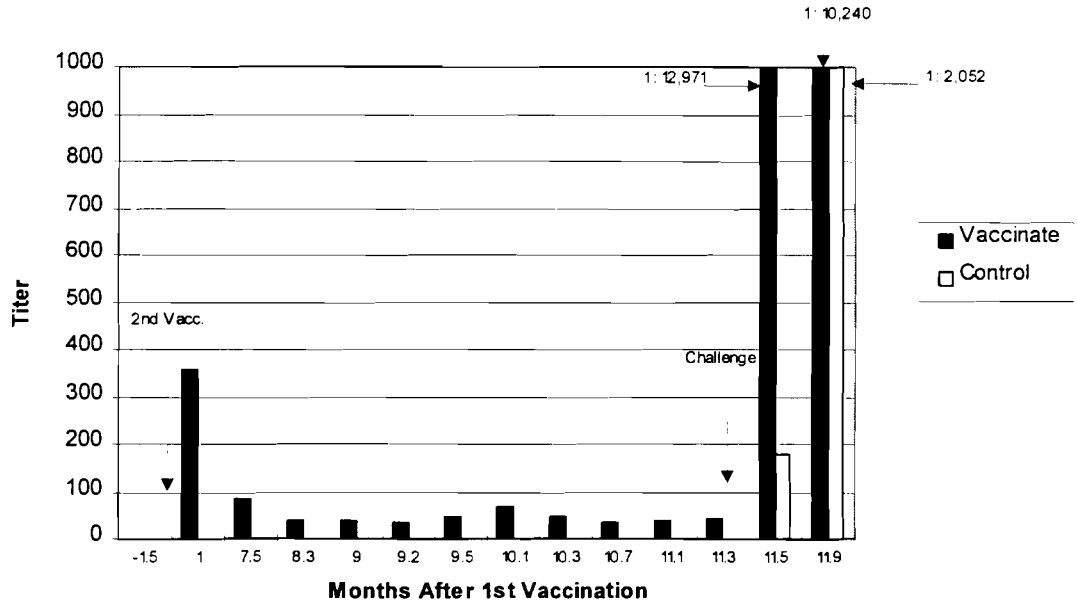



**Figure 3. BVDV-Trial 1 Serum Neutralization Titers**

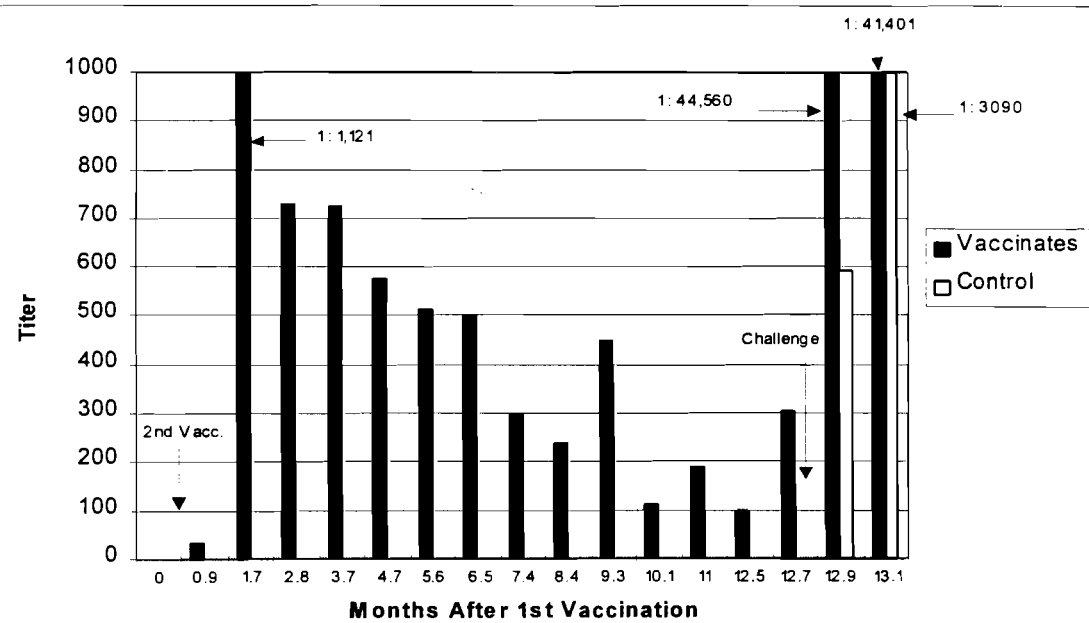



**Figure 4. BVDV-Trial 2 Serum Neutralization Titers**

# Pathogenesis of Bovine Herpesviruses in vitro

C.C.L. Chase,[1] S. Stone,[2] K. Bialas,[2] C. Carlson,[2] W. Wiese,[2] and L. Braun[3]
Department of Veterinary Science

SDSU **CATTLE 96-10**

Summary

Bovine herpesviruses cause acute disease in cattle. Bovine herpesvirus 1 (BHV-1 or IBR) is a respiratory virus, while bovine herpesvirus 5 (BHV-5) affects the brain and causes a viral encephalitis. Studies in the laboratory showed no difference in the growth rate of BHV-1 or BHV-5 in blood vessel, brain, or kidney cells. The ability of BHV-1 to cause cells to die is not caused by apoptosis (programmed cell death). Further studies on the pathogenesis of bovine herpesviruses need to be conducted to improve control and prevention measures.

Key Words: Bovine, Herpesvirus, Pathogenesis

## Introduction

Bovine herpesviruses (BHV) cause a myriad of clinical diseases in cattle. Infectious bovine rhinotracheitis (IBR) caused by bovine herpesvirus type 1 (BHV-1) is a contagious viral disease of cattle and the most common form seen in North America. Symptoms include upper respiratory tract disease that predisposes animals to shipping fever and abortion. Coughing, anorexia, depression, decreased milk production (in milking cows), weight loss, and increased salivation may also accompany these respiratory tract problems. A nasal discharge along with nasal congestion may develop and is referred to as red nose. Animals in a stressful environment such as a feedlot will often develop more complicated conditions of IBR and death will result. A second BHV-1 syndrome, infectious pustular vulvovaginitis (IPV) in the cow or infectious balanoposthitis (IBP), causes pustular lesions of the genital tract in females or males but rarely causes abortions and is seen in Europe. Disease of the reproductive system, IPV, is observed 1 to 3 days after mating and often leads to painful inflammation. The first signs of IPV are frequent micturition (urination) and a tail out of normal position followed later by small pustules on the vulva. Outbreaks of both the respiratory form, IBR, and genital disease, IPV, together are rare. A third syndrome, viral encephalitis, is caused by a virus closely related to BHV-1, bovine herpesvirus 5 (BHV-5). Clinical signs include incoordination, muscular tremor, aimless circling, blindness, confusion, recumbency, and death. BHV-5 (encephalitis) has been observed in scattered cases worldwide, with the highest prevalence in Australia and Argentina.

BHV-1 is transported by monocytes and white blood cells to target organs and then causes a life-long infection of the trigeminal nerve of cattle. This occurs with either natural BHV-1 infections or vaccination with modified live BHV-1. Recent research has suggested that BHV-5 is passed to the brain from the upper respiratory tract by branches of the trigeminal nerve. Some studies indicate the virus invades the blood stream by infecting the endothelial cells that line blood vessels and then directly infects the brain. By understanding the route of infection, improved methods of treatment and prevention can be targeted to the appropriate route.

BHV-1 causes massive cell destruction in any tissue infected with the virus. The cause of this cell death is unknown. Many viruses have been shown to kill cells by activating the programmed cell death cycle (apoptosis). Apoptosis results in a characteristic breakdown of the cell's genome, resulting in a DNA ladder.

---

[1]Associate Professor.
[2]Undergraduate student.
[3]Microbiologist.

Other viruses kill cells through necrosis, the process where the virus totally disrupts the cell. No DNA ladder is formed in this process. Understanding which process is involved will allow the use of prevention techniques that can block apoptosis. Two experiments were conducted to measure 1) any difference in vitro in the replication of BHV-5 and BHV-1 that might explain why BHV-5 infects the central nervous system and 2) apoptosis in BHV-1 infected cells.

## Materials and Methods

Cells. Primary endothelial cells were harvested from third trimester fetuses obtained from a slaughter house. Mardin Darby kidney (MDBK) and bovine turbinate (BT) cells were obtained from American Tissue Culture Collection (ATCC, Rockville, MD). Bovine neuronal (BN) cells were a gift from Dr. C. Jones, University of Nebraska, Lincoln, NE.

Viruses. BHV-1 (Cooper strain) was obtained from ATCC. BHV-5 was a gift from Dr. C. Whetstone, National Animal Disease Center, Ames, IA.

Virus Growth Curves. Flasks containing either MDBK, BT, or BN cells were inoculated with either BHV-5 or BHV-1 at a multiplicity of infection (MOI) of 10. Two flasks per virus were used each time period. The time periods used were 0, 12, 24, 36, and 48 hours. At time period 0 the virus was allowed to be in the flask for 1 hour and then removed. At each time point, the liquid media was removed, placed in a 3-ml snap cap tube, and frozen. The flask was then filled with 3 ml of minimum essential media (MEM) and placed in the -70°F (0°C) freezer. This was repeated for all time periods. The flasks were freeze-thawed three times and then the fluid centrifuged and removed from the cell pellet and placed in snap cap tubes and stored in the freezer. Tissue culture infectious dose 50 (TCID 50: the amount of virus required to kill 50% of the cells) was determined on the liquid media (supernatant) and the cell portion. MDBK cells were used in 96 well plates to measure the amount of each virus at the different time periods.

Apoptosis Measurements. Confluent monolayers of MDBK or BT cells were infected with BHV-1 at a MOI of 1. The cells were harvested at 0, 6, 12, 18, or 24 hours post infection or 0, 12, 24, 36, or 48 hours post infection. The cellular DNA was extracted and quantified and 800 to 1000 $\mu$g were loaded on a 1.0% agarose gel and electrophoresed in a horizontal gel apparatus. The DNA present in the gel was stained with ethidium bromide, visualized with UV light, and photographed.

## Results and Discussion

Virus Growth. Virus production was measured in three different bovine cell lines: endothelial (Figure 1), central nervous system (CNS; data not shown), and kidney (data not shown). The virus yield from the three different cell types was similar for both viruses as shown in Figure 1. The other two cell types had similar growth curves (data not shown).

Apoptosis. The extracted cellular DNA ran at a high molecular weight greater than 23 Kb. The results indicated no evidence of the multiple bands (DNA ladder) characteristic of apoptosis (data not shown).

Pathogenesis studies of bovine herpesviruses have been limited. The first experiment led us to conclude that the difference in disease syndromes produced by BHV-1 or BHV-5 did not correlate with in vitro growth in endothelial cells, the cell type that plays a role in the blood-brain barrier or in bovine CNS cells, the target of BHV-5 in vivo. The spread of BHV-5 into the brain to cause a viral encephalitis can not be explained by faster growth in either nerve or blood vessel cells. The second experiment indicated that BHV-1 infection of bovine cells in vitro does not trigger apoptosis. Other mechanisms need to be investigated to determine the factors responsible for the rapid cell death seen in BHV-1 infections. Further study needs to occur to define the pathogenesis of the infection to improve bovine herpesvirus treatment and prevention measures.

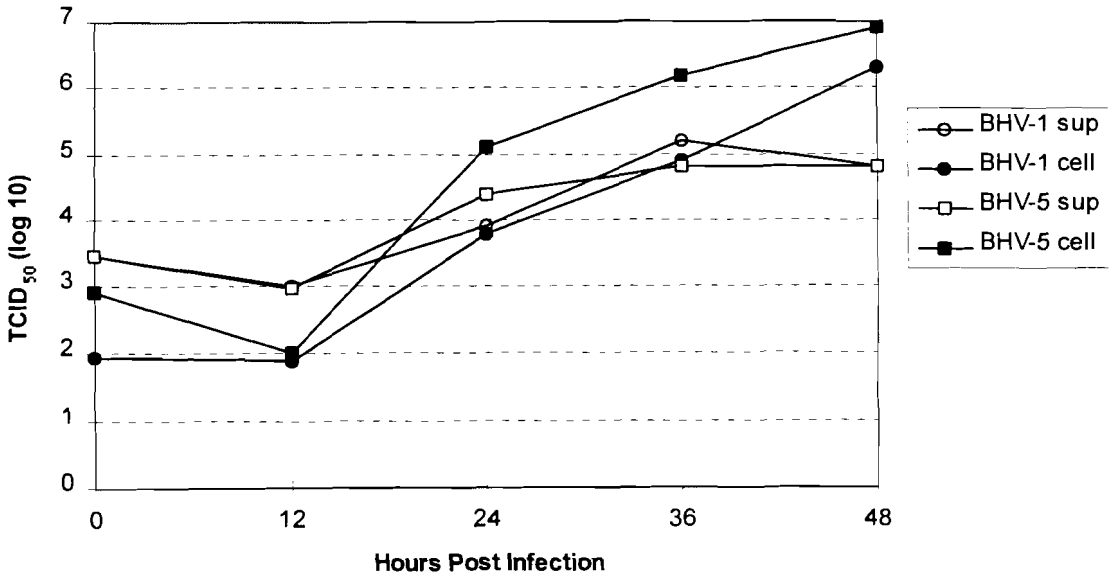



**Figure 1. Growth of BHV Subtypes in Endothelial Cells**

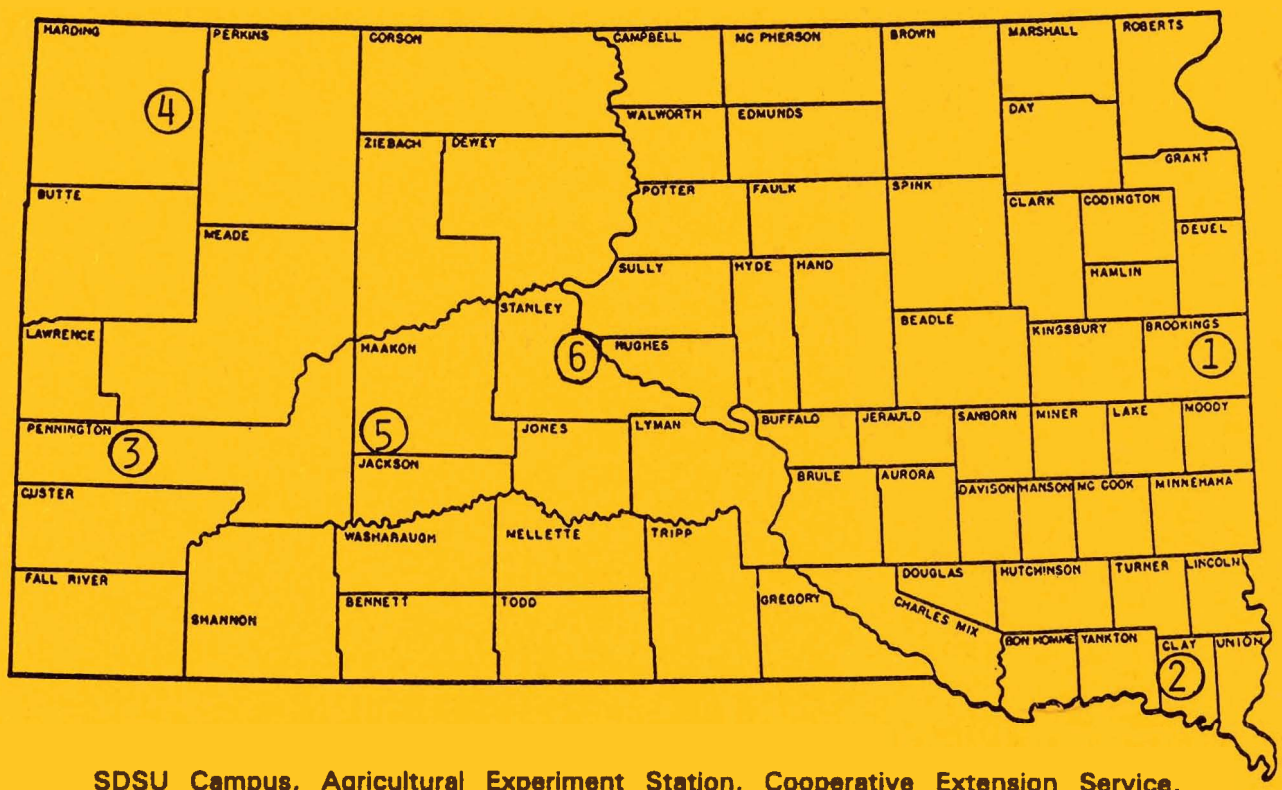
The faculty members of the Animal and Range Sciences Department are always ready to answer your questions. Our Brookings phone number is (605) 688-5165. Staff members in Rapid City (RC) may be reached at (605) 394-2236. The staff member at Ft. Pierre may be reached at (605) 773-5550. Please feel free 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 |
| CLAPPER, Jeffrey A. | Swine Reproductive Physiology | Research, Extension |
| COSTELLO, William J. | Meat Science | Teaching, Research |
| DUNN, Barry H. | Integrated Natural Resource Management | Extension Associate |
| GARTNER, F. Robert (RC) | Range Science | Research, Teaching |
| GEE, Dan H. | Evaluation/Marketing | Teaching, Research |
| HELD, Jeffrey E. | Sheep Nutrition and Production and Management | Extension |
| INSLEY, Larry W. | Beef Cattle Management and Nutrition/Horse Production | Teaching |
| JOHNSON, Bradley J. (June 1) | Ruminant Nutrition | Extension, Research |
| JOHNSON, James R. (RC) | Range Science | Extension, Research |
| JOHNSON, Patricia S. | Range Science | Research, Teaching |
| KRONBERG, Scott L. | 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. | 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, Teaching |
| WALKER, Julie A. (Ft. Pierre) | Ruminant Nutrition | Extension |
| ZALESKY, Douglas D. (RC) | Beef Cattle Management | Extension |

* * * * * * * * * * * * * * * *

# ANIMAL AND RANGE SCIENCES
# RESEARCH AND EXTENSION UNITS




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.

6. Hughes-Stanley County Extension Office, Ft. Pierre
   Area Beef and 4-H Extension Specialists

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.

## THE STATE OF SOUTH DAKOTA
## IS
## OUR CAMPUS * OUR RESEARCH LAB * OUR CLASSROOM

South Dakota State University, Animal and Range Sciences Department