DAIRY DAY 1991

Report of Progress 640

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

The 1991 Annual

KSU DAIRY DAY

Sixth in the series—Managing High-Producing Herds:
Personnel Management on Dairies

Pottorf Hall — CICO Park (Riley County Fairgrounds)

8:00 A.M.	Registration - VISIT EXHIBITS
10:00	WELCOME - Dr. Jack Riley, KSU
10:05	TODAY'S CHALLENGES - Dr. J.E. Shirley, KSU
10:15	MINI RESEARCH UPDATES Heifer Rearing - Dr. J.L. Morrill, KSU Reproduction - Dr. J.S. Stevenson, KSU Nutrition - Dr. J.E. Shirley, KSU
10:45	PHILOSOPHY OF PERSONNEL MANAGEMENT - Jim Armbruster, Univ. Wisconsin-Madison
11:45	DAIRY DAY HONOREE - Harry C.M. Burger
NOON	LUNCH (Courtesy of Exhibitors)
1:45 P.M.	KANSAS QUALITY MILK AWARDS - Dr. J.R. Dunham, KSU
1:30	PANEL - Dee James, KSU LaVerne Myers, Abilene Steve Strickler, Iola
2:00	QUESTIONS/ANSWERS
2:30	ADJOURN - Visit Exhibits*
3:00	TOUR - New Research Barn Dairy Teaching Research Center (DTRC)

*A special "thanks" to the exhibitors who support KSU Dairy Day.

ON THE COVER: New Research Barn at DTRC

FOREWORD

Members of the Dairy Commodity Group of the Department of Animal Sciences and Industry are pleased to present this Report of Progress, 1991. Dairying continues to be a viable business and contributes significantly to the total agricultural economy of Kansas. Annual farm value of milk produced (1.225 billion lb) on Kansas dairy farms was $165 million in July, 1991. Wide variation exists in the productivity per cow, as indicated by the production testing program (Dairy Herd Improvement Association or DHIA) in Kansas. Nearly one-half of the dairy herds (n = 1,362) and dairy cows (n = 98,000) in Kansas are enrolled in DHIA. Our testing program shows that all DHI-tested cows average 17,345 lb milk compared with approximately 10,985 lb for all nontested cows. Dairy herds enrolled in DHIA continue to average more income over feed cost ($1,379/cow) than nontested herds ($732/cow). Most of this success occurs because of better management of what is measured in monthly DHI records. In addition, use of superior, proven sires in artificial insemination (AI) programs shows average predicted transmitting ability (PTA) of AI bulls in service to be +1,111 lb compared to non-AI bulls whose average PTA is only +317 lb milk. More emphasis should be placed on furthering the DHIA program and encouraging use of its records in making management decisions.

With our herd expansion program, which was begun in 1978 after we moved to the new Dairy Teaching and Research Center (DTRC), we peaked at about 210 cows. The herd expansion was made possible by the generous donation of 72 heifers and some monetary donations by Kansas dairy producers and friends. Herd expansion has enabled our research efforts to increase, while making the herd more efficient. Our rolling herd average was 17,555 lb in July, 1991, despite many research projects that do not promote production efficiency.

We are proud of our new 72-cow tie stall barn that was constructed in 1991 through the generous support of The Upjohn Company, Clay Equipment Company, and Monsanto Company and under the able direction of Dr. John Shirley. This new facility will give us the ability to expand our research efforts in various studies involving nutrition and feeding, reproduction, and herd management. The excellent functioning of the DTRC is due to the special dedication of our staff. Appreciation is expressed to Richard K. Scoby (Manager, DTRC), Gregory Kropf (Asst. Manager, DTRC), Cindy Siemens (Research Assistant), Dan Umsheid, Mary Rogers, Charlotte Kobiskie, Kathy Cochran, Becky Pushee, Robert Reeves, Tammy Redding, and Lloyd Manthe. Special thanks are given to Neil Wallace, Natalie Brockish, Betty Hensley, Lois Morales, and Cheryl Armendariz for their technical assistance in our laboratories.

As demonstrated, each dollar spent for research yields a 30 to 50 percent return in practical application. Research is not only tedious and painstakingly slow but expensive. Those interested in supporting dairy research are encouraged to consider participation in the Livestock and Meat Industry Council (LMIC), a philanthropic organization dedicated to furthering academic and research pursuits by the Department. More details about LMIC are provided at the end of this Report of Progress. Appreciation is expressed to Charles Michaels (Director) and the Kansas Artificial Breeding Service Unit (KABSU) for their continued support of dairy research in the Department. Appreciation also is expressed to the College of Veterinary Medicine for their continued cooperation. This relationship has fostered cooperative research and established an exemplary herd health program.

J. S. Stevenson, Editor
1991 Dairy Day Report of Progress

Dedicated to....

HARRY C.M. BURGER

Quiet, unassuming, determined, faithful, compassionate.....these are just a few words that describe Harry C.M. Burger. Born and raised on the family farm just north of Seneca, Harry assumed the responsibility of the dairy as a 16-year-old high school senior when his father passed away. The dairy, Nemaha Valley Holstein Farm, was established in 1908 and is the oldest continuously registered herd in Kansas.

For more than 50 years, Harry C.M. Burger has served the dairy industry and mankind. In 1939, he became a director of the Nemaha Cooperative Creamery Association at Sabetha and served as board chairman for nine years. Between 1967 and 1970, he played a key role in the merger of several cooperatives to form Mid-America Dairymen, Inc and served as chairman of the Kansas City Division and member of the corporate board until his retirement in 1991. He has long been an advocate of production testing and has given much time in support of organizations such as Farm Bureau, DHIA, Holstein Association, and the Cooperative Extension Service.

In 1984, Harry was named the Kansas Distinguished Dairyman. He also has been recognized for his many efforts by other dairy support groups, including Dairy Council, Midland UDIA, and National Milk Producers Federation, and received special recognition this year from Mid-America Dairymen, Inc as he completed 52 years of service to cooperative milk marketing.

His foresight and concern for the future are best illustrated by his endowed scholarship at Kansas State University for the benefit of dairy majors with high academic ranking. Harry also serves as a director of the Livestock and Meat Industry Council, Inc at K-State.

Kansas State University is pleased to recognize the many contributions of Harry C.M. Burger and to dedicate this Dairy Day Report of Progress to him.

BIOLOGICAL VARIABILITY AND CHANCES OF ERROR

Variability among individual animals in an experiment leads to problems in interpreting the results. Although the cattle on treatment X may have produced more milk than those on treatment Y, variability within treatments may indicate that the differences in production between X and Y were not the result of the treatment alone. Statistical analysis allows us to calculate the probability that such differences are from treatment rather than from chance.

In some of the articles herein, you will see the notation "P<.05". That means the probability of the differences resulting from chance is less than 5%. If two averages are said to be "significantly different", the probability is less than 5% that the difference is from chance or the probability exceeds 95% that the difference resulted from the treatment applied.

Some papers report correlations or measures of the relationship between traits. The relationship may be positive (both traits tend to get larger or smaller together) or negative (as one trait gets larger, the other gets smaller). A perfect correlation is one (+1 or -1). If there is no relationship, the correlation is zero.

In other papers, you may see an average given as 2.5 ± .1. The 2.5 is the average; .1 is the "standard error". The standard error is calculated to be 68% certain that the real average (with unlimited number of animals) would fall within one standard error from the average, in this case between 2.4 and 2.6.

Using many animals per treatment, replicating treatments several times, and using uniform animals increase the probability of finding real differences when they exist. Statistical analysis allows more valid interpretation of the results, regardless of the number of animals. In all the research reported herein, statistical analyses are included to increase the confidence you can place in the results.

CONTENTS

EFFECTS OF *ASPERGILLUS ORYZAE* EXTRACT (AMAFERM®) ON RUMINAL FIBROLYTIC BACTERIA AND IN VITRO FIBER DEGRADATION

A. A. Beharka and T. G. Nagaraja

Summary

The effect of Amaferm on growth of pure cultures of ruminal cellulose-digesting, hemicellulose-digesting and pectin-digesting bacteria was determined. The addition of Amaferm to the growth medium increased the growth of *Ruminococcus albus* and *Fibrobacter succinogenes*. Amaferm had no effect on the growth of the other bacteria. Additionally, selective antimicrobial compounds were used to assess the influence of Amaferm on microbial contributions to in vitro fiber degradation. Amaferm appeared to stimulate fiber digestibility of only certain feedstuffs, and this increase in digestibility was attributed to its stimulation of bacterial activity. Amaferm did not appear to stimulate fungal activity.

(Key Words: Rumen, Fungal, Microbial Feed Additive, Growth, Fiber.)

Introduction

Reports on the use of fungal supplements in ruminant diets date back to 1924. However, results of those early studies were inconclusive. In recent years, there has been renewed interest in the use of microbial products as feed additives in ruminant diets, partly because of concerns about antibiotics. Microbial feed additives contain either the microorganisms, the dry products of microorganisms, the medium in which they grew, and/or the residues of their metabolism. The microorganisms used are yeast, molds, and/or bacteria. Because microbial products are not identical in composition, mode of action differs between products, and considerable variation in animal performance has been reported.

One of several fungal products commercially available is Amaferm®, a fermentation extract of the mold *Aspergillus oryzae*.The addition of Amaferm or products containing Amaferm have been reported to increase digestion of dry matter, fiber, and crude protein in vivo and in vitro. In our studies with newborn calves, Amaferm supplementation was shown to increase ruminal microbial activity, as evidenced by increased VFA concentration and bacterial numbers, particularly those of fiber-digesting bacteria. The increased microbial activity was associated with increased dry feed consumption in some calves and earlier weaning. Similar increases in intake have been reported in cattle and are probably the consequence of increased rate of fiber digestion in Amaferm-supplemented animals. It has been proposed that fungal supplementation may increase the nutritive value of feedstuffs by increasing the digestion of dietary fiber.

Little work has been done on the effect of Amaferm supplementation on the ruminal protozoa and fungi populations. The fungal population has been shown to have high fiber-digesting ability and may contribute to overall fiber digestibility. The protozoa population has been shown to prey on bacteria; therefore, inhibition of the protozoa population by Amaferm may partially account for increased bacterial numbers. Therefore, our objectives were to determine the effect of Amaferm on growth rate of selected pure cultures of ruminal fibrolytic bacteria and on the extent of degradation of forage components by the different microbial populations.

Procedures

Pure cultures of ruminal fiber-digesting bacteria (*Fibrobacter succinogenes, Butyrivibrio fibrisolvens, Eubacterium cellulosolvens, Ruminococcus flavefaciens, R. albus, Prevotella* (*Bacteroides*) *ruminicola, and Lachnospira multiparus*) were grown in anaerobic, complete carbohydrate rumen fluid medium with filter-sterilized Amaferm at 2 or 5% of the medium to determine its effect on their specific growth. The medium was inoculated with late-log-phase culture, and growth was monitored by measuring absorbance.

Selective antimicrobial compounds (penicillin and streptomycin to inhibit bacterial growth and cycloheximide to inhibit fungal growth) were used to assess the influence of Amaferm on bacterial and fungal contributions to in vitro fiber degradation. A variety of ground, fibrous substrates (alfalfa hay, brome hay, high and low endophyte fescue, pure cellulose, wheat straw, corn silage and prairie hay, 0.5 g) were incubated with ruminal fluid inoculum (1:2 ruminal fluid to buffer). Amaferm was added at .4, .8 or 1.2 g/l. NDF and ADF digestibilities were determined after 96 h incubation and compared to a control.

Results and Discussion

The addition of Amaferm to the medium increased (P<.1) the growth of *Ruminococcus albus* (Growth rate .71 vs .61/h) (Figure 1) and *Fibrobacter succinogenes* (Growth rate .35 vs .26/h). Amaferm had no effect on growth of other fibrolytic bacteria (Figure 2). Addition of Amaferm increased (P<.1) NDF and ADF digestion of brome and alfalfa hay. Amaferm addition at .4 or .8 g/l, but not 1.2 g/l, increased NDF and ADF digestion of high endophyte fescue (Table 1). The enhanced fiber degradation by Amaferm was attributed to its stimulation of bacterial activity. Amaferm did not appear to stimulate fungal activity, nor did Amaferm alone have any significant ability to digest fiber. Addition of Amaferm had no effect on NDF or ADF digestion of pure cellulose, low endophyte fescue, wheat straw, corn silage and prairie hay. In conclusion, Amaferm appears to stimulate NDF and ADF digestibility of only certain feedstuffs, and this increase in digestibility may be a consequence of growth stimulation of some fibrolytic bacteria.

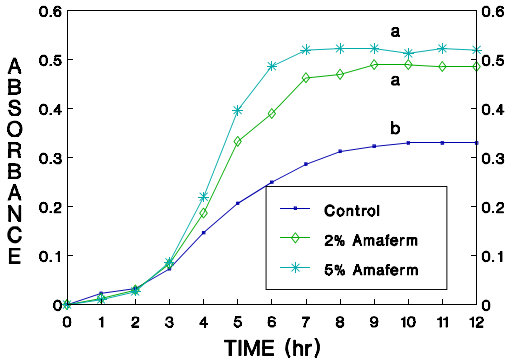

Figure 1. Effect of Amaferm on the Specific Growth Rate of *Ruminococcus albus*. Lines with Uncommon Superscript Letters Differ (P < .10).

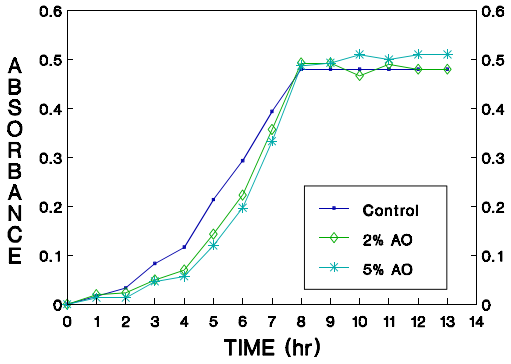

Figure 2. Effect of Amaferm on the Specific Growth Rate of *Eubacterium cellulosolvens*.

Table 1. Effect of Amaferm Supplementation on In Vitro NDF Digestion with Antimicrobial Compounds

	Feedstuff		
Item	Alfalfa hay	Brome hay	High endophyte fescue
% NDF in feedstuff	53.2	69.3	71.0
% NDF digested by:			
Bacteria + Fungi + protozoa (Whole rumen fluid or WRF)			
Amaferm	37.8[a]	55.4[a]	60.0[a]
AO = .4 g/L	42.2[b]	56.8[b]	64.3[b]
AO = .8 g/L	42.3[b]	60.3[b]	65.5[b]
AO = 1.2 g/L	43.0[b]	61.5[b]	59.2[a]
Bacteria (WRF + cycloheximide)			
No Amaferm	32.1[a]	50.8[a]	57.0[a]
AO = .4 g/L	37.8[b]	55.9[b]	62.4[b]
AO = .8 g/L	37.6[b]	56.1[b]	64.9[b]
AO = 1.2 g/L	39.2[b]	56.3[b]	55.2[a]
Fungi and protozoa (WRF + penicillin and streptomycin)			
No Amaferm	25.4	30.0	31.8
AO = .4 g/L	28.1	28.9	31.4
AO = .8 g/L	25.7	25.0	32.2
AO = 1.2 g/L	28.8	27.5	32.4
Negative control (WRF + P, S, C)			
No Amaferm	3.2	0	0
AO = .4 g/L	4.0	0	3.7
AO = .8 g/L	3.5	3.6	0
AO = 1.2 g/L	2.8	3.0	2.3
Amaferm alone (No WRF)			
No Amaferm	0	0	0
AO = .4 g/L	<1	<1	<1
AO = .8 g/L	<1	<1	<1
AO = 1.2 g/L	<1	<1	<1

[a,b]Means within a column with uncommon superscript letters differ (P<.1).

PERFORMANCE OF MID-LACTATING DAIRY COWS FED A GRAIN SORGHUM-SOYBEAN SILAGE BASE DIET

H. Hartadi, L. Harbers, J. Shirley, and K. Bolsen

Summary

Whole-plant silage from intercropped grain sorghum and Williams 82 soybean was compared to corn silage in a mixed diet for mid-lactation dairy cows. Cows fed the grain sorghum-soybean silage yielded 45.13 lb and those fed corn silage yielded 44.05 lb of fat (4%)-corrected milk daily. Milk yield, milk fat, and milk lactose percentages were similar between cows fed the two silages. Protein and solids non-fat percentages for the cows fed the corn silage diet were .09 and .06 units greater than those of cows fed the grain sorghum silage. Cows fed the corn silage tended to gain more (+105.8 lb) than those fed the grain sorghum-soybean silage (+95.2 lb). We conclude that, if the cost for producing intercropped grain sorghum and soybean silage (ton/acre) is at least similar to that of producing corn silage, the intercropped grain sorghum and soybean silage can be substituted for corn silage in a mid-lactation dairy cow diet.

(Key Words: Intercrop, Silage, Mid-lactation.)

Introduction

Corn is the silage crop preferred by Kansas dairy farmers. Under favorable environment, corn will usually have adequate nutrients, sufficient dry matter, and a natural microflora that often leads to a successful silage fermentation. Research relative to intercropping soybeans and corn or sorghum for forage or silage has been done in this country since 1920. The objective of intercropping is to improve ensiled materials through the complementary effects of the desirable characteristics of the crops. The improvement includes increased crude protein, reduced amount of nitrogen fertilizer application, and reduced protein supplementation to the total diet. In Kansas, the leading state in sorghum silage production, intercropping soybean with grain sorghum appears to be more favorable than with corn because of the greater drought resistance of the sorghum plants. Studies on intercropping have been continuous at Kansas State University since 1986. The overall results indicated that grain sorghum-soybean silage was inferior to grain sorghum silage when those silages were used as a high roughage basal diet for growing beef steers. The objective of the experiment was to observe the performance of mid-lactating dairy cows when they were fed whole-plant corn or grain sorghum-soybean silages.

Procedures

Acres of corn and intercropped DeKalb 42Y grain sorghum and Williams 82 soybean were seeded near the KSU Dairy Research Units in 1988. Whole-plant corn was harvested when kernels at the center of the ear reached the two-thirds milk line stage of maturity and ensiled in a 12 × 50 ft concrete stave tower silo. The grain sorghum-soybean intercrop was harvested when kernels reached the late-dough stage. Plants were cut with a swather, wilted to approximately 35% dry matter (DM), and ensiled in a 8 × 100 ft AgBag®. Biomate® silage inoculant was applied to the grain sorghum-soybean intercrop prior to ensiling at a rate of 2.4 gallons per ton of fresh material.

In this experiment, 48 Holstein-Friesian cows (average weight = 1390 lb) were used in a mid-lactation trial. Cows were grouped according to their individual days in milk, parity, milk production, milk fat test, body weight, height, and body condition score. The cows were divided into two groups and placed in two separate free-stall areas. Each group was fed either corn silage (CS) or grain sorghum-soybean silage (GSS) basal diets on a group basis. The groups also received

different concentrate supplementations and alfalfa hay (Table 1) to meet their requirements of DM, crude protein (CP), net energy for lactation (NEL), calcium, phosphorous, micro-minerals, and vitamins. Chemical composition of the diet components is shown in Table 2. The experiment was conducted in 60-day period from January 18 to March 18, 1989. Daily feed offered and milk production were recorded. Milk samples were collected every 2 wk (morning and afternoon) and analyzed for milk composition. Changes in body weight were recorded as the average of weighings on 2 consecutive days at the beginning, the middle, and the end of the experiment. Performance of the cows was evaluated from their individual average daily milk produced, milk composition, feed consumption, and feed conversion.

Results and Discussion

Results of this experiment are presented in Table 3. There were no statistical differences between groups for average daily intake of DM (50.8 and 52.8 lb) by individual cows; however, those values were higher than expected (46.9 and 47.8 lb) for corn silage and grain sorghum-soybean silage based diets. Percentage of DM intake from silage was slightly higher for GSS (38.6) than from CS (38.3), although the differences were not significant. The average yield of milk, fat (4%)-corrected milk (FCM), and milk composition produced by individual cows in both groups were similar. Percentages of fat, protein, and solid non-fat in milk were .01, .09, and .06 units greater for cows fed CS than those fed GSS, respectively.

Average body weight change of the individual cows was not different between silages. Cows fed CS gained 105.8 lb/cow, and those fed GSS gained 95.2 lb/cow. The amount of feed to produce each lb of milk was 1.12 lb and 1.13 lb for CS and GSS based diets, respectively. More GSS based diet was consumed (2 lb) than the CS diet. However, there may be some economic advantage for the GSS diet, because its grain mixture contained 20.2% CP, whereas the CS diet contained 24.4% CP, assuming inputs for producing both CS and GSS were equal.

Further work following an entire lactation is needed to confirm these results.

Table 1. Diet Composition for Lactation Experiment (Dry Matter Basis)

Ingredient	CS[a] (lb/day)	GSS[a] (lb/day)
Roughages		
Alfalfa hay	4.50	4.50
Corn silage	18.15	-
Sorghum-soybean silage	-	19.25
Distil. grain	1.80	1.80
Concentrate		
Protein supplement	7.58	4.66
Grain mix	13.68	16.55
P supplement	.15	.16
Ca supplement	.29	.20
Bicarbonate	.36	.36
Magnesium oxide	.18	.18
Trace mineral salt	.12	.12
Vitamin premix	.07	.07
Estimated daily intake, kg per cow		
Dry matter	46.90	47.80
Crude protein	8.11	8.07
Neutral det. fiber	14.30	14.70

[a]CS:Corn silage, ISW:Grain sorghum-soybean silage.

Table 2. Chemical Composition of Diet Components, %

Diet component	DM	CP[a]	NDF[a]	ADF[a]
Corn silage	39.73	8.20	49.50	28.20
Grain sorghum-soybean silage	39.46	15.04	46.92	32.37
Alfalfa hay	87.40	17.20	50.40	42.80
Supplement for CS	93.33	24.42	-	-
Supplement for GSS	93.42	20.17	-	-

[a]Percent of DM.

Table 3. Intake, Milk Production, Body Weight Change, and Milk Composition for Cows Fed Corn and Intercropped Grain Sorghum-Soybean Silages

Item	CS[a]	GSS[a]
No. of cows	24	24
DM intake, lb/cow/day	50.80	52.80
- Grain, %	51.88	51.55
- Hay, %	9.84	9.82
- Silage, %	38.28	38.64
Milk produced, lb/cow/day	45.26	46.60
Milk composition:		
Fat, %	3.82	3.81
Protein, %	3.46	3.37
Lactose, %	4.85	4.86
Solid non-fat, %	12.71	12.65
Fat-corrected milk (FCM)[b], lb/cow/day	44.05	45.13
Body weight change, lb/cow	105.8	95.2
Feed/lb of milk, lb of DM	1.12	1.13

[a]CS: Corn silage, GSS:Grain sorghum-soybean silage.
[b]4 percent FCM = [(0.4)(kg of milk) + 15(kg of fat)].

THE EFFECT OF PROCESSED SOYBEANS AND ADDED ENERGY IN CALF STARTERS ON THE GROWTH OF HOLSTEIN CALVES

P. V. Reddy and J. L. Morrill

Summary

In Trial 1, 91 Holstein calves were fed starters containing either soybean meal (SBM), extruded soybeans (ESB), roasted soybeans (RSB), SBM+soy oil (SO), or SBM+rumen inert fat (RIF) from birth to 10 wk of age. There were no differences in overall feed consumption, except that calves fed RSB consumed more than calves fed SBM+SO. There were no significant differences in weight gains, but calves fed SBM+SO tended to gain less. In trial 2, 71 Holstein calves were fed starters containing roasted soybeans from birth to 10 wk of age. Three of the starters contained 18% protein and soybeans roasted at 210, 260, or 290 F; the fourth starter contained 15% protein and soybeans roasted at 260 F. Calves fed starter containing soybeans roasted at 290 F consumed more feed, gained more weight, and were more efficient in converting feed and energy to gain than were the other calves fed 18% protein. Feed consumption was high and gains were intermediate by calves fed starter containing 15% protein. Growth in body size correlated with weight gains.

(Key Words: Calves, Starter Diets, Soybeans.)

Introduction

Young calves require a feed high in protein and energy. Soybean meal (SBM) has been a major source of protein in calf starters for many years and is a satisfactory source, although utilization of the protein may be increased in some diets by heat treatment to make the protein less degradable in the rumen. Fat supplementation increases the concentration of energy in diets but may decrease palatability and fiber digestion in the rumen.

Raw whole soybeans are a good source of protein and fat but contain several antinutritional factors. Proper heat treatment destroys these factors and decreases the degradation (increases the "bypass") of the protein in the rumen. Several processing methods are now available that may improve soybean utilization, and the benefits of heat processing soybeans for lactating cows are well documented. Among processing methods, the energy expenditure and fixed costs are lower for roasting than for extrusion, thereby warranting further research on this type of heat treatment. Less is known about the requirements of the calf for bypass protein, the effect of adding fat to calf diets, or the optimum conditions for processing soybeans. This experiment was conducted to answer some of these questions.

Procedures

Trial 1

Ninety one Holstein calves were used from birth to 10 wk of age. They were fed colostrum for 3 d and then whole milk at 4% of birth weight twice daily and could consume calf starter ad libitum. Calves were weaned when they consumed 1.5 lb or more starter per day for 2 consecutive days. Calves were assigned randomly to one of five pelleted calf starters, which contained either soybean meal (SBM), extruded soybeans (ESB)[1], roasted soybeans (RSB)[2], SBM+soy oil (SO), or SBM+rumen inert fat (RIF)[3].

Starter consumption was recorded, and weekly intake was calculated. Twice daily, each calf was assigned a value for consistency of feces (1,normal to 4,watery). All calves were weighed weekly. At birth and at 10 wk of age, wither height, length, and heart girth measurements were recorded.

Trial 2

Seventy one Holstein calves were used from birth to 10 wk of age. Feeding and management were as described in trial 1. Calves were assigned randomly to each of four pelleted calf starters, which were formulated by using soybeans roasted at either 210, 260, or 290 F temperatures with a Jet Pro Roaster[4], to provide 18% protein in three starters and soybeans roasted at 260 F temperature to provide 15% protein in the fourth starter. Calves were allowed to consume calf starter and water free choice. Body measurements and weights were recorded as in trial 1.

Results and Discussion

Trial 1

Average weekly feed consumption is shown in Figure 1. There were no differences in weekly feed consumption except at wk 3, 4, and 5. A trend was observed up to 8 wk of age for depressed feed intake in calves fed SBM+SO. Total feed consumptions for the 10 wk period were 173, 171, 177, 157, and 168 lb for calves fed SBM, ESB, RSB, SBM+SO, and SBM+RIF starters, respectively. There were no differences in overall feed consumption except that calves fed SBM+SO tended to consume less than RSB-fed calves. The soy oil-containing pellets were softer and broke apart more easily, which accounted for at least part of the reduced consumption.

Average weekly gains are shown in Figure 2. There were no differences in gains except at wk 3 and 10; calves fed SBM at wk 3 and SBM or SBM+RIF at wk 10 gained more weight than calves fed SBM+SO. Total gains for the 10 wk period were 85, 83, 85, 78, and 83 lb for calves fed SBM, ESB, RSB, SBM+SO, and SBM+RIF containing starters, respectively. None of these were significantly different.

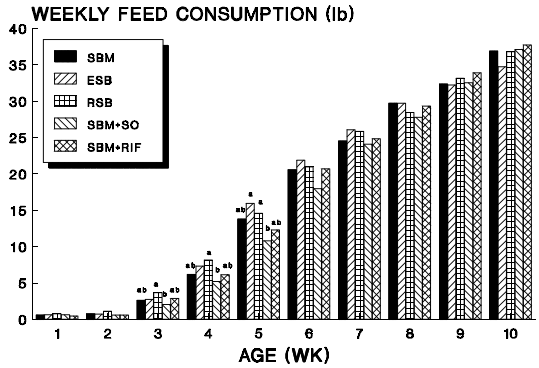

Figure 1. Mean Weekly Feed Consumption (lb) of Calves Fed Processed Soybeans or Added Energy in Their Diets. Means within a Week with Different Superscripts Differ (P<.05).

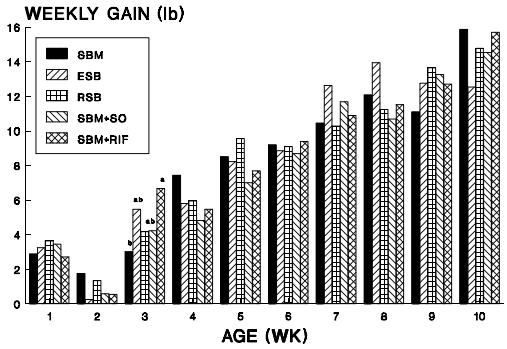

Figure 2. Mean Weekly Gains (lb) of Calves Fed Different Starters. Means within a Week with Different Superscripts Differ (P<.05).

Body measurement increases and fecal scores are shown in Table 1. Measurement increases reflected weight gains. There were no significant differences in increase in wither height and length from birth to 10 wk, but calves fed SBM had greater (P<.05) increases in heart girth measurements than SBM+SO-fed calves. The average fecal scores were not different, except that calves fed SBM had lower scores than ESB- or RSB-fed calves.

In conclusion, calves fed SBM+SO consumed less than RSB-fed calves. Weight gains

were not significantly different; however, there was a trend for calves fed SBM+SO to gain less. Lower body measurement increases were observed in calves fed SBM+SO. Calves fed starter containing SBM had lower fecal scores than RSB-or ESB-fed calves.

Trial 2

The overall feed consumption for the 10-wk period is shown in Figure 3. As the roasting temperature increased from 210 to 290 F, greater feed consumption by calves was observed.

Total gains for the 10-wk period are shown in Figure 4. Weight gains were reflective of feed consumption. Calves fed either RSB-290 or RSB-260 (15%) containing starters had higher gains than calves fed RSB-210.

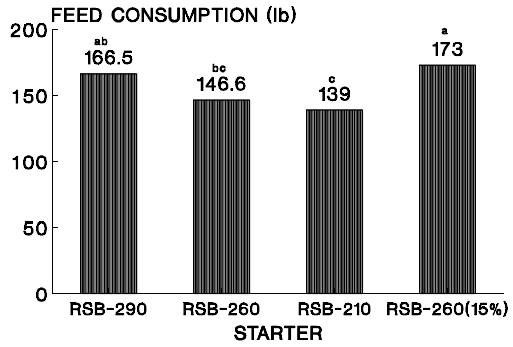

Figure 3. Overall Feed Consumption of Calves Fed Soybeans Processed at Different Temperatures. Means with Different Superscripts Differ (P<.05).

Feed and energy efficiencies during 6-10 wk of age are shown in Table 2. Calves fed RSB-260 (15%) required more feed than calves fed RSB-290 or RSB-260 to gain 1 lb of body weight. Calves fed starters containing either RSB-260 (15%) or RSB-210 consumed more energy to gain body weight than RSB-290 fed calves.

Body measurement increases and fecal scores are shown in Table 3. Calves fed RSB-210 were smaller in body size than others. The average fecal scores were not different among calves fed different starters.

In conclusion, as processing temperature increased from 210 to 290 F, calves consumed more feed, gained more weight, and were more efficient in converting feed and energy to gain weight. Calves fed starter containing 15% protein had higher feed consumption and moderate body weight gains. Body measurement increases were reflective of weight gains.

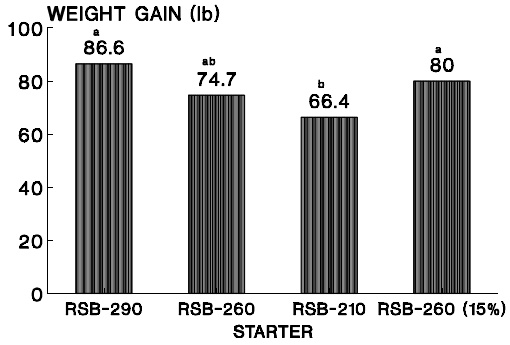

Figure 4. Overall Weight Gains of Calves Fed Soybeans Roasted at Three Different Temperatures. Means with Different Superscripts Differ (P<.05).

[1]Extruded at 290 F with an Insta Pro Dry Extruder Model 2000. Triple F Products, Des Moines, IA 50322.

[2]Roasted at 260 F for 2 minutes with Rickel-Aire Roaster. Rickel Inc, Kansas city, MO 64112.

[3]Energy Booster 100, Milk Specialties Co., Dundee, IL 60118.

[4]Sweet Jet-Processing Co., Springfield, OH 45505.

Table 1. Body Measurement Increase and Fecal Score of Calves Fed Processed Soybeans and Addded Energy in Their Diets

Item	SBM	ESB	RSB	SBM+SO	SBM+RIF
Height, in	4.9	4.6	4.4	4.1	4.6
Length, in	6.2	6.2	5.6	5.1	6.0
Heart girth, in	12.7[a]	11.3[ab]	11.5[ab]	10.2[b]	11.2[ab]
Fecal score	1.15[b]	1.27[a]	1.28[a]	1.25[ab]	1.24[ab]

[a,b]Means in same row with different superscripts differ significantly (P<.05).

Table 2. Effect of Roasting Temperatures and Protein Concentration on Feed and Energy Efficiencies during 6-10 Wk of Age

Starter	ADG	g gain/ lb feed	ME (Mcal/lb)	Mcal ME/ lb gain
RSB-290	1.52[a]	172[a]	1.55	4.21[b]
RSB-260	1.34[a]	168[a]	1.55	4.32[ab]
RSB-210	1.21[b]	159[ab]	1.55	4.55[a]
RSB-260 (15%CP)	1.39[a]	145[b]	1.51	4.75[a]

[a,b]Means within a column with different superscripts differ (P<.05).

Table 3. Body Measurement Increases and Fecal Scores of Calves Fed Soybeans Roasted at Different Temperatures

	Starter			
Item	RSB-290	RSB-260	RSB-210	RSB-260 (15%)
Height, in	4.6[a]	4.0[a]	3.5[b]	4.4[a]
Length, in	6.1[a]	5.2[a]	4.6[b]	5.9[a]
Heart girth, in	13.1[a]	11.9[a]	10.6[b]	12.40[a]
Fecal score	1.16	1.15	1.20	1.16

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

PERFORMANCE OF HOLSTEIN CALVES FROM THREE TO TWELVE MONTHS OF AGE

J. Velazco, J. L.Morrill,
R. T. Brandt, Jr., and R. Schalles

Summary

Sixty-four Holstein steers were used to study the effect of season and age on performance. Animals beginning the trial in spring were heavier (P<.05) and more efficient than calves started in other seasons. There were no differences (P>.05) among seasons in average daily gain and feed conversion after 6 mo of age. Rate of growth was reduced after 9 mo of age for all seasons.

(Key Words: Calves, Growth, Seasons, Age.)

Introduction

There are approximately 98,000 dairy cows in Kansas, most of which are predominantly Holstein. Assuming a calf crop of 92%, of which 51% are males, there are 46,450 bull calves born in Kansas each year. Because of the intensive use of artificial insemination by the dairy industry, few of these bull calves are needed for breeding purposes. In the past, most have been used to produce meat, mainly as steers. Many times these steers are kept on a deferred program for long periods of time, usually ending in the feedlot, resulting in production of a large carcass with an excess of fat, at a high cost. Part of the reason for this has been the lack of information concerning the effect of different types of growing systems and of season on performance and body composition of Holsteins.

There is evidence to indicate that the Holstein, if fed to produce rapid gains, will efficiently produce lean, tender meat. However, more data are needed concerning body composition at various stages of growth as affected by age and season, especially when the diet is formulated to contain a high energy concentration and rumen escape protein. With this information, it would be possible to develop alternative feeding programs for surplus Holstein bulls to meet more nearly the changing demands of the consumer.

The objective of this research was to study the effect of age and season on growth of Holstein steers. Data concerning body composition were also collected and will be reported elsewhere.

Procedures

Sixty-four Holstein steers were used. During each season (winter, spring, summer, and fall), for 2 yr, two calves were assigned to each of four treatments at 3 mo of age. Animals assigned to treatment A were slaughtered at that time to determine initial body composition; the six remaining calves were randomly allocated to treatment B, C, or D, which consisted of growing the animals until 6, 9, or 12 mo of age, respectively. Animals remained on their treatments until slaughter.

Diets (Table 1) B, C, and D were fed to animals that were 3 to 6 mo, 6 to 9 mo, and 9 to 12 mo of age, respectively. They contained the same energy concentration and were formulated according to NRC recommendations for beef cattle to meet the requirements for each stage of growth. Diet B contained Deccox® during the first 14 days. The main difference between these diets was the protein content, which was 16, 14, and 12% of the dry matter of diets B, C, and D, respectively.

Table 1. Diet Formulation (% as Fed Basis)*

	Diet		
Ingredients	B	C	D
Sorghum grain	0.00	15.20	22.10
Cracked corn	49.20	49.20	49.20
Rolled wheat	13.60	0.00	0.00
Cotton seed hulls	10.00	10.00	10.00
Extruded soybeans	18.80	15.70	7.30
Carmil molasses	6.00	6.90	7.10
Soybean oil	0.00	0.60	1.90
Mineral premix	2.25	2.25	2.25
Vitamin premix	0.15	0.15	0.15

*Each diet contained Tylan® and Rumensin®, each at 10 g/ton.

Animals were individually allocated to pens and fed twice daily to assure ad libitum consumption. Every 14 days the calves were weighed and average daily feed intake was calculated.

The treatments evaluated performance during four seasons and at three different stages of growth with one single feeding system. Data were analyzed as a repeated measures in time experiment, evaluating the effect of seasons and age. The parameters evaluated were feed consumption, average daily gain, feed conversion, and body weight.

Results and Discussion

Feed Consumption

Animals representing a season were born 3 mo before. Animals started on experiment in spring had higher intake ($P<.05$) during the entire trial (Figure 1). This difference was especially obvious in the 9 to 12 mo period. Three parts of the graph show depressed intake. These are the result of observations to determine body composition using the urea dilution technique. There were no differences in intake ($P>.05$) for calves started in the fall, winter, and summer at any of the growth stages.

Feed Conversion

Feed conversion is shown in Table 2. Feed conversion was found to be erratic and was greatly affected by stress. Differences were observed for feed conversion at 3 and 6 mo ($P<.05$). However, no difference ($P>.05$) was found between 9 and 12 mo. Animals gained weight slower as they got older. Overall feed conversion in the last period of growth was poorer ($P<.05$) than that at the other ages; feed conversion mean values for the last period were higher than those for the other stages of growth, except for those steers of 9 to 12 mo of age during summer.

Body Weight and Average Daily Gain

There were no differences ($P>.05$) among seasons at 9 and 12 mo (Table 2). Nevertheless, animals at 3 to 6 mo of age differed ($P<.05$), with spring and winter calves being heavier than fall and summer calves. The rate of growth was

affected by age mostly in the last period. Higher means were obtained between 6 and 9 mo.

Initial weight at 3 mo of age averaged 208.3 lb. Average weight at 1 yr of age was 1056.3 lb (Figure 2). Animals assigned to spring were heavier (P<.05) than animals at other seasons. This advantage continued through the trial until animals reached 9 mo of age. Rate of growth was significantly reduced during the last 3 mo of the experiment. At that stage, animals suffered joint damage, particularly under cold temperatures, because of the concrete floor. That problem may be the cause of the decreased rate of growth. Growth followed a linear pattern (R^2 =.95).

Table 2. Feed Conversion (FC) and Average Daily Gain (ADG) at Different Stages of Growth

	Seasons							
Age,	Fall		Summer		Spring		Winter	
mo	ADG	FC	ADG	FC	ADG	FC	ADG	FC
3	1.98[d]	3.54[b]	2.24[cd]	3.48[b]	2.29[cd]	3.28[ab]	2.56[c]	2.78[a]
6	3.96[c]	3.48[a]	3.48[c]	4.32[b]	3.88[c]	4.66[ab]	3.95[c]	4.00[a]
9	3.80[c]	5.66[a]	2.90[c]	6.84[a]	3.39[c]	6.00[a]	3.06[c]	6.94[a]
12	3.30[c]	6.78[a]	3.66[c]	5.56[a]	2.57[c]	7.84[a]	2.46[c]	9.45[a]

[ab]FC within row with uncommon superscript letters differ (P<.05).
[cd]ADG within row with uncommon superscript letters differ (P<.05).

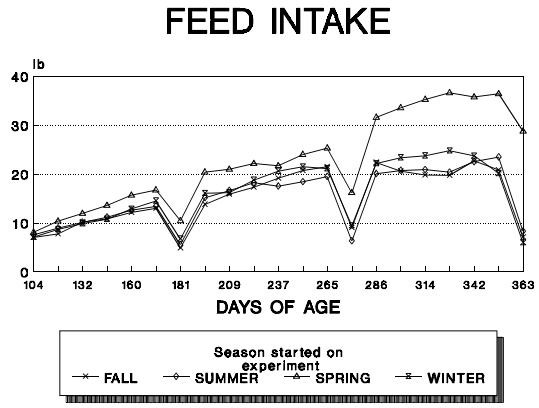

Figure 1. Daily Feed Intake of Holstein Calves from 3 to 12 Months of Age.

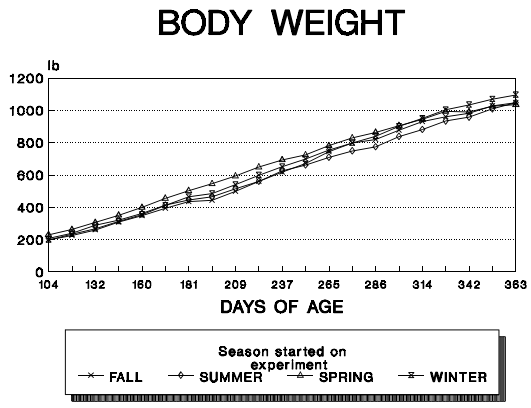

Figure 2. Body Weight of Holstein Calves from 3 to 12 Months of Age.

HEIFER FEEDING AND MANAGEMENT AFFECT EFFICIENCY

J. R. Dunham

Heifer feeding and management programs have a great impact on the efficiency of the future dairy herd. Dairies that feed and manage heifers for calving at about 24 mo of age are optimizing milk production, feed cost for raising heifers, number of replacement heifers available, and return on investment.

Replacement heifers represent a considerable investment in labor and feed, with no return on that investment until they freshen. A summary of Kansas DHIA Holstein herds shows that some herds are receiving a good return on investment as early as 22 mo of age, whereas other herds are not reaping any return until 31 mo (Figure 1). The summary also shows that herds with heifers freshening at an average age of 24 to 25 mo have the highest Rolling Herd Averages for milk production.

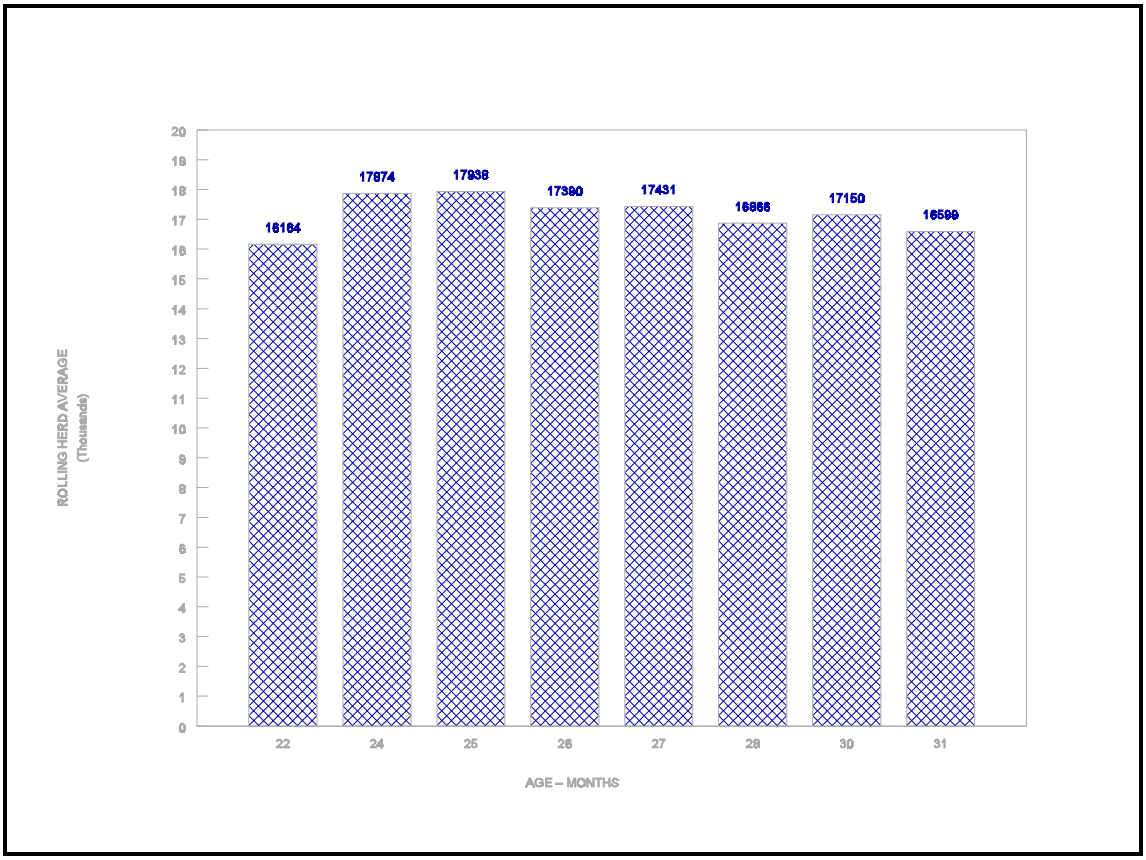

Figure 1. Rolling Herd Average vs Age at First Calving.

These same herds seem to emphasize sire selection as indicated by the PTA$ values of first lactation heifers in Figure 2. Therefore, a return on the genetic investment is being realized earlier. In addition, herds with heifers freshening at about 24 mo of age have more replacements available than herds with heifers freshening at older ages.

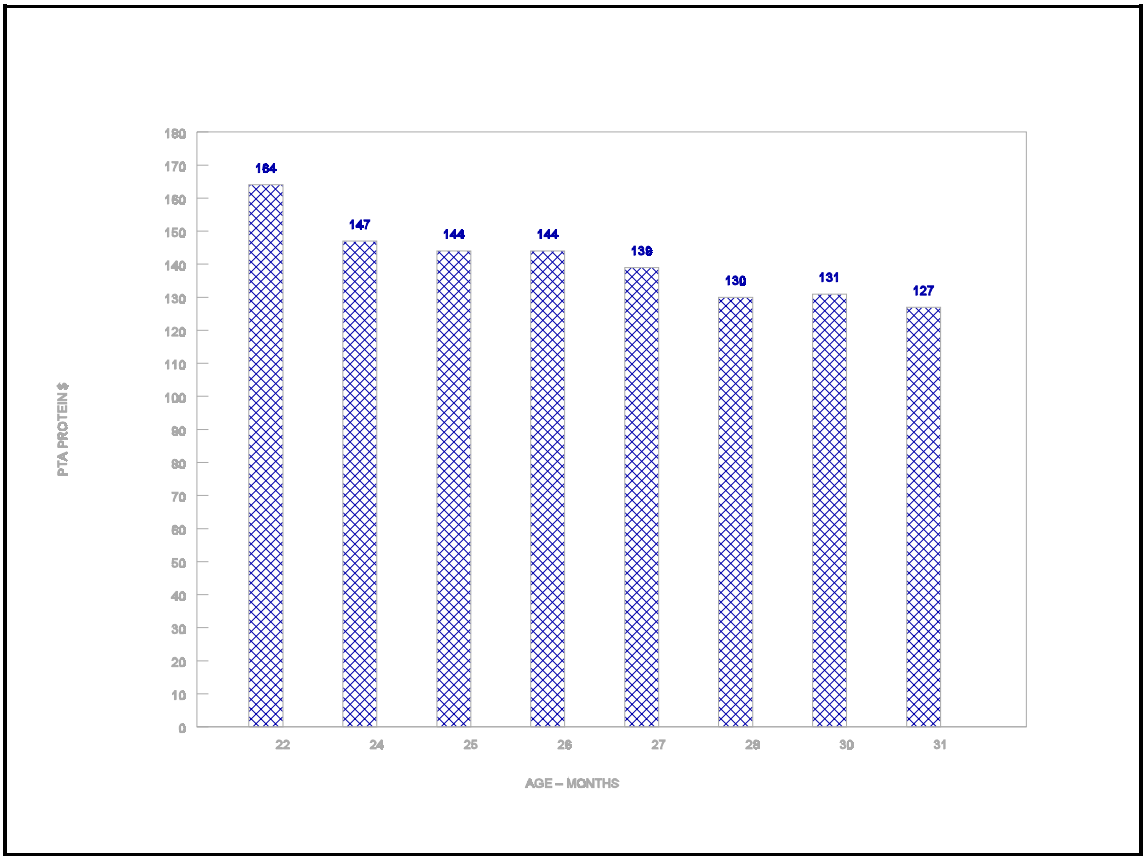

Figure 2. PTA$ of First Lactation Heifers vs Age at First Calving.

Having heifers freshening at about 24 mo of age is a realistic goal. However, heifers must be well grown in order to perform up to their potential when freshening this young. A rather constant rate of growth, 1.75 lb per day, is required from 3 mo of age until calving at 24 mo. These heifers will weigh about 1350 lb before calving. A key to proper heifer development is a constant rate of growth.

Total feed cost is less when heifers are grown fast enough to freshen at 24 mo, even though feed cost per day is more. Heifers freshening at an older age and growing at a slower rate have more total feed cost, because the maintenance cost is paid for a longer period. Table 1 shows the estimated amount of feed required for growing heifers to 1350 lb at various rates of growth.

Table 1. Estimated Feed Requirements for Growing Heifers from Three Months of Age to 1350 Pounds

Age at Calving (mo)	Rate of Growth (lb)	Soybean Meal (lb)	Grain (lb)	Hay (lb)	Feed Cost* ($)
29	1.45	1325	3174	11423	593.54
27	1.55	1304	3083	10185	552.75
26	1.65	1263	3185	9705	538.54
24	1.75	1340	3576	8108	513.58

*Feed prices used -- Soybean Meal = $9.50/cwt, Grain = $4.00/cwt, and Hay = $3.00/cwt.

Even with all of the advantages of Holstein heifers freshening at 24 mo of age, too many herds are not taking advantage of this opportunity. The average age of first lactation Holsteins in Kansas DHIA herds is 27.3 mo. However, progress is being made, because the average age was 28.2 mo during 1988.

For more information, a bulletin, "Raising Dairy Heifers", is available at your County Extension Office. Also, a computer program to formulate heifer rations is available from your County Extension Office or from KSU Extension Dairy Science.

PERFORMANCE OF HOLSTEIN HEIFERS REARED ON 100 OR 115% OF NRC REQUIREMENTS FROM 3 TO 12 MONTHS OF AGE AND THEN SWITCHED TO THE OPPOSITE TREATMENT

E. J. Bortone, M. G. Daccarett, J. L. Morrill, J. S. Stevenson, and A. M. Feyerherm[1]

Summary

Holstein heifers from the Kansas State University Dairy Teaching and Research Unit were used from 3 mo of age until 21 d before estimated date of calving. They were fed either 100 (control, C) or 115% (enhanced, E) of the 1989 National Research Council (NRC) requirements for major nutrients from 3 to 12 mo of age, then, until 21 d before freshening, the treatments were switched from 100 to 115% NRC (CE) or from 115 to 100% NRC (EC). At puberty, heifers had similar body weights (613, E vs 617, C) but heifers fed E were 1 month younger (11 vs 12 mo). Heifers fed the E diet were heavier and had larger heart girth at 12 mo of age than the group fed C. After switching, the group fed CE increased more in body weight, body length, wither height, and body condition than the group fed EC.

(Key Words: Heifer, NRC, Switch, Puberty, Diet.)

Introduction

Accelerating growth of replacement heifers by feeding high energy diets, thereby allowing breeding at an earlier age, can reduce feed costs and allow an earlier return on investments. However, several studies have shown that rearing heifers on high energy diets during the prepubertal stage of growth results in the detrimental accumulation of adipose tissue in the mammary gland, resulting in less milk yield after first parturition.

Heifers are often bred by age rather than weight, consequently, the size per age advantage of those animals growing more rapidly is not realized. Research has indicated that heifers fed to attain higher average daily gains (ADG > 1.6 lb/d) were younger at onset of puberty than controls (ADG<1.6 lb/d) but they attained puberty at similar body weight (614 lb).

Often, recommendations are to have dairy heifers gain an average of at least 1.6 lb/d from 3 to 24 mo of age and freshen at around 24 mo of age with BW between 1,200 and 1,300 lb. In order to achieve these goals the heifers must attain ADG of at least 1.6 lb/d and must conceive no later than 15 mo of age. Data from a study at Kansas State showed that heifers fed 115% of NRC requirements from 3 mo of age until 21 d before freshening could achieve the desired body weight without being over conditioned, calve at an earlier age (22.6 vs 23.8 mo), and produce equal quantities of milk as heifers fed to gain 1.6 lb/d (100% NRC). However, the question of what would be the effects on performance of feeding 115% of NRC requirements for part of the growth period remained unanswered. Therefore, this research was conducted to compare performace of Holstein heifers fed either 100 or 115% of NRC requirements from 3 to 12 mo of age and then fed the opposite diet until 21 d before estimated calving date.

Procedures

Holstein heifers (n=89) from the Kansas State University Dairy Research Unit were used from 3 mo of age until 21 d before estimated date of

[1]Department of Statistics.

calving. At 3 mo of age they were assigned randomly to either 100% (C) or 115% (E) of 1989 NRC requirements for energy, crude protein, Ca, P, and vitamins A and D for large dairy heifers gaining 1.6 lb/d. At 12 mo of age, the treatments were switched from 100 to 115% NRC (CE) and from 115 to 100% NRC (EC) until 21 d before freshening. Body weights were recorded weekly, and diets were least-cost formulated, based on the average body weights of heifers in the group. From 3 to 6 mo of age, the diet consisted of alfalfa hay and a concentrate composed of rolled sorghum grain, soybean meal, trace mineralized salt, Ca and P, and a vitamin E supplement. From 6 mo of age until approximately 21 d before calving, a total mixed diet was fed once daily and consisted of alfalfa hay; prairie or brome grass hay; rolled sorghum grain; trace mineralized salt; Ca and P supplement; and supplemental vitamins A, D, and E.

At 3-mo intervals, measurements of body weight and size (wither height, body length, and heart girth) were recorded. Starting at 6 mo of age, at 3-mo intervals, body condition scores were assessed using a 1 (thin) to 5 (over conditioned) scale. Pelvic area and distance between pin bones were measured and recorded. Breeding began when heifers weighed at least 770 lb BW.

Heifers (n=20) from each of the groups were selected randomly at 6 mo of age, and blood samples were collected biweekly until 14 mo of age. The samples were analyzed for progesterone (to estimate pubertal ovulation) by radioimmunoassay.

Results and Discussion

Measurements of body size and weight from 3 to 24 mo of age are shown in Figures 1 and 2. At the beginning of the experiment, the heifers were similar for all of the traits measured; however, at 9 and 12 mo, the heifers fed the EC diet had larger heart girth and were longer and heavier than the heifers fed the CE diet. Conversely, no significant differences between the two groups in wither height were noted throughout the experiment. After 12 mo of age, the CE group gained more weight ($P<.01$) and increased more in heart girth than the EC group. Heart girth measurements and body weight were greater ($P<.05$) for the CE than for the EC group between 15 and 24 mo of age.

Body condition scores (BCS) are shown in Figure 3. At 6 mo of age, no significant differences in BCS were found; however, at 9 and 12 mo of age, the heifers fed the enhanced diet had higher BCS than the control group. After switching diets, the BCS increased more for the CE heifers than for the EC heifers, and BCS was greater ($P<.05$) at 15, 18, 21, and 24 mo of age.

Body weights, age at puberty, and reproductive traits are shown in Table 1. Heifers fed the enhanced diet were 23 days younger at puberty than controls. Body weights at puberty were similar between groups. At 12 mo of age, the heifers fed EC were 48 lb heavier than the group fed CE (648 and 600 lb, respectively). Therefore, these results agree with earlier studies in that puberty in Holstein heifers occurs at approximately 612 lb and is related more to body weight than to age.

Measurements of body weight and size 21 d before freshening are shown in Table 2. No significant differences were found between groups in age at 21 d before estimated calving date. Body weights, withers height, heart girth, and body length also were similar between groups.

In conclusion, feeding 115% of NRC requirements from 3 to 12 mo of age increased rate of gain, body weight at 12 mo, body condition, and heart girth and hastened puberty without changing body weight at puberty or reducing reproductive performance, compared to feeding 100% of NRC. Switching diets at 12 mo of age decreased the rates of gain and growth for the EC group, but increased the rates of gain and growth for CE, permitting CE to gain weight and grow at a faster rate between 12 and 24 mo of age. Although CE had the advantage after 12 mo of age, no differences were observed in age, BW, and size measuremnets at 21 d before estimated

calving date, suggesting that there was no advantage in either of the treatments used. Therefore, based on these results and those of the previous study at Kansas State University, we recommend feeding Holstein dairy heifers 115% of NRC requirements of all major nutrients from 3 mo of age until shortly before freshening.

Table 1. Average Age at Puberty, and Reproductive Traits of Holstein Heifers Fed 100 or 115% NRC from 3 to 12 Mo of Age

Diet, % NRC	Puberty, age, d	Puberty, wt, lb	BW 12 mo	ADG 3-12 mo, lb/d	Serv. per conc.
100	360	612	600	1.5	1.4
115	337	619	648	1.7	1.6
SE P[1]	7, .02	7, NS	7, .001	.02, .008	.2, NS

[1]Standard error, Probability level

Table 2. Average Body Weights and Size Measurements of Holstein Heifers 21 Days before Freshening

	Treatment[1]				
	CE		EC		P
Variables[2]	Means	SE	Means	SE	
No. heifers	20		15		
Age, d	744	.4	729	.4	NS
BW, lb	1318	12	1283	12	NS
WH, in	52.4	1	52.7	1	NS
HG, in	78.3	2	78.0	2	NS
BL, in	66.5	2	66.1	1	NS

[1]100 to 115% NRC (CE), 115 to 100% NRC (EC)
[2]Body weight (BW), withers height (WH), heart girth (HG), and body length (BL).

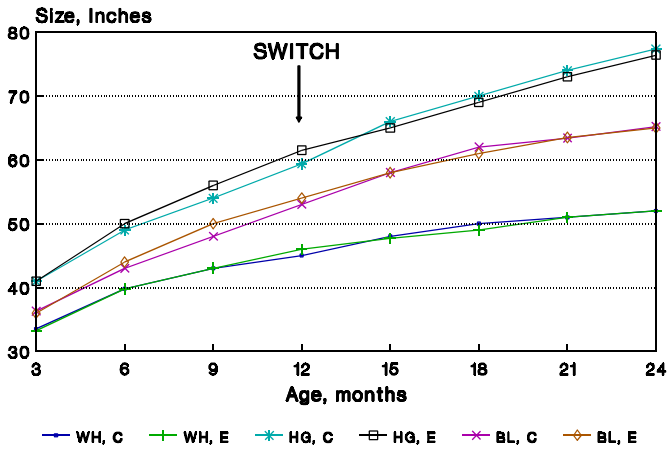

Figure 1. Size Neasurements of Holstein Heifers Fed 100 or 115% NRC. For Explanation of Symbols see Text.

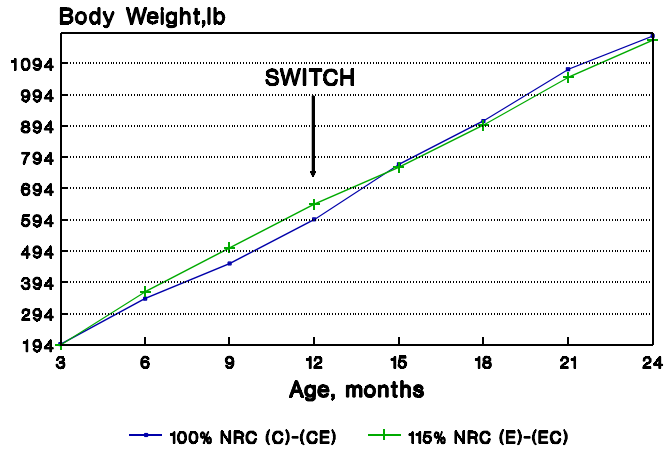

Figure 2. Body Weight of Holstein Heifers Fed 100 or 115% of NRC.

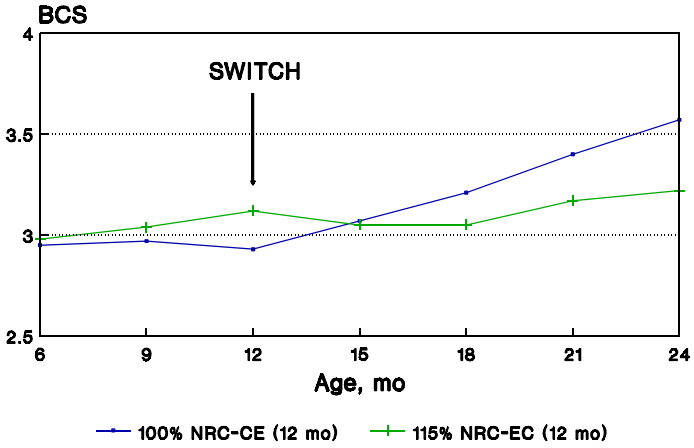

Figure 3. Body Condition Scores (BCS) of Holstein Heifers Fed 100 or 115% of NRC.

LEUKOCYTE FUNCTION AND HEALTH STATUS OF CALVES SUPPLEMENTED WITH VITAMINS A AND E

S. D. Eicher-Pruiett, J. L. Morrill, F. Blecha[1], C. G. Chitko-McKown[1], and N. V. Anderson[2]

Summary

Forty-four Holstein calves were fed milk replacers with varied concentrations of vitamins A and E from 3 to 45 d of age to determine their effects on concentrations of plasma vitamin A (retinol and retinyl palmitate) and vitamin E (α-tocopherol), lymphocyte and neutrophil functions, and health of calves. Plasma α-tocopherol was unaffected by increased vitamin A supplementation. Fecal scores, and eye and nose membrane responses were improved with increased vitamin A and lower vitamin E concentration, whereas the same treatment tended to reduce neutrophil cytotoxic and bactericidal activity by 6 wk of age. Increased supplemental vitamin E tended to enhance neutrophil functions. However, age appeared to have an effect on response to both vitamins.

(Key Words: Calves, Leukocytes, Vitamins, Health.)

Introduction

Previous research has shown improved immune function of lymphocytes with increased vitamin E supplementation to young calves. However, research with other species indicated that absorption of α-tocopherol diminished with increased dietary vitamin A, leading to the hypothesis that increased dietary vitamin A may interfere with absorption of dietary vitamin E in the calf. Therefore, vitamin A may limit availability of vitamin E to enhance immune functions. Many milk replacers contain more than 10 times the NRC requirement of vitamin A and amounts less than or equal to NRC recommendations of vitamin E. This experiment was conducted to determine if 1) increased vitamin A interferes with plasma α-tocopherol concentrations and 2) various concentrations of vitamins A and E in the diet affect lymphocyte and neutrophil functions and other health traits. All concentrations of vitamins that were used reflect concentrations present in milk replacers on the market.

Procedures

Forty-four Holstein calves, blocked by sex and age, were fed colostrum and then transition milk for 3 d. They were then fed experimental milk replacer at 10% of body weight, adjusted weekly. Vitamin A concentrations provided in milk replacers were low (LA; 3,200 IU/lb) or high (HA; 39,900 IU/lb) and vitamin E concentrations were low (LE; 5.1 IU/lb) or high (HE; 25.9 IU/lb). Concentrations of vitamin A and vitamin E reflect those amounts contained in milk replacers. The four experimental milk replacers were designated LA-LE, HA-LE, LA-HE, and HA-HE. Twice daily fecal scores and discharges of eyes and nose were recorded. Calves were weighed weekly. At 0, 3, and 6 wk, blood was sampled for determination of plasma retinol, retinyl palmitate, and α-tocopherol. Blood samples were collected at 3 and 6 wk to determine lymphocyte proliferation and neutrophil cytotoxicity and bactericidal and chemotactic functions (measures of immune health of calves). Concanavalin A was used as the mitogen for lymphocyte proliferation. The cytotoxicity assay was an

[1]Department of Anatomy and Physiology.
[2]Department of Surgery and Medicine.

antibody-dependent cellular-cytotoxicity (ADCC) assay using chicken red blood cells as the target cells. The neutrophil bactericidal assay targeted *Staphylococcus aureus*. Chemotaxis was measured under agarose with zymosan-activated serum as the chemoattractant for directed:random migration.

Results and Discussion

Plasma Vitamin Concentrations

Concentrations of plasma α-tocopherol were not affected adversely by increased supplementation of vitamin A at 6 wk (Table 1) but reflected the supplementation of vitamin E. However, α-tocopherol concentrations tended to increase overall with high vitamin A supplementation and were higher ($P<.05$) at 3 wk. Plasma retinol and retinyl palmitate did not consistently reflect the increased supplementation of vitamin A. Some of the inconsistencies may have been due to a retinol ester that is formed or because of tissue stores (neither measured in our analysis).

Growth and Health

Gain in body weight was similar between treatments for the total 6-wk period (72, 71, 64, and 66 lb for LA-LE, HA-LE, LA-HE, and HA-HE, respectively). The mean fecal score (1=solid, 4=fluid) for the 6-wk period of the HA-LE calves was lower ($P<.10$) than the scores of both LA treatment groups. The HA-LE group tended to have the lowest fecal score at 2 to 5 wk (Figure 1). The increase for the LA-HE group at 2 wk may explain the decrease in gain of that group that occurred then. The eye discharges increased, beginning at 2 wk for all treatments and remained high through 5 wk (Figure 2). The discharges observed in this study were clear, probably in response to fly irritation. Therefore, an increased discharge was considered a healthy response of the eye membrane. The HA-LE treatment tended to have the greatest occurrence of eye discharges. Total nasal discharges across weeks were greater for the LA-HE treatment ($P<.10$; data not shown). These discharges were thick mucous that occurred in few calves and for short periods of time and were considered a sign of infection.

Leukocyte Function

No differences in lymphocyte blastogenesis occurred among treatments at 3 or 6 wk (Table 2). Neutrophil phagocytosis and bactericidal activity tended to be lowest at 6 wk for calves on HA-LE treatment. Significant differences ($P<.05$) in bactericidal activity occurred between HA-HE and LA-HE treatments at 3 wk. The chemotaxis index indicated a greater response to a chemoattractant at 6 wk for LA-HE-supplemented calves.

Conclusion

Increased supplementation of vitamin A tended to improve responses that rely on a healthy mucous membrane. Simultaneously, the immune functions that utilize vitamin E tended to be improved by increased vitamin E and were inhibited when lower vitamin E and higher vitamin A concentrations were fed. The response of neutrophils to the chemoattractant, although enhanced by HE supplementation, was inhibited when HA was fed simultaneously, indicating possible interference of vitamin A with vitamin E utilization when both are fed at high concentrations. An age effect on vitamin E was seen both in plasma concentrations and leukocyte responses.

Table 1. Plasma Retinol, Retinyl Palmitate, and α-Tocopherol Concentrations in Calves Fed Experimental Milk Replacers

	Vitamin supplementation				
	LA-LE	HA-LE	LA-HE	HA-HE	SE
Vitamin & wk	---------- (µg/dl) ----------				
α-Tococpherol					
3 wk	266[c]	255[c]	298[b]	354[a]	7.6
6 wk	285[b]	297[b]	439[a]	452[a]	8.4
Retinol					
3 wk	101[b]	95[c]	102[b]	109[a]	2.2
6 wk	72[b]	191[a]	89[b]	77[b]	11.7
Retinyl Palmitate					
3 wk	51[b]	55[b]	52[b]	63[a]	3.1
6 wk	50[c]	66[b]	72[ab]	84[a]	5.5

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

Table 2. Cellular Functions Weeks 3 and 6 of Calves Fed Experimental Milk Replacers

Measurement	Vitamin supplement				
and Wk	LA-LE	HA-LE	LA-HE	HA-HE	SE
Lymphocyte Blastogenesis (CPM)					
3 wk	193244	179062	179798	167536	18715
6 wk	191916	170630	169899	195659	17076
ADCC (%Lysis)					
3 wk	40.1	42.4	35.1	34.5	4.1
6 wk	42.4	37.5	44.8	45.4	6.1
S. aureus (% Kill)					
3 wk	27.1[ab]	20.5[b]	19.7[bd]	31.7[ac]	6.3
6 wk	24.0	18.8	25.6	26.9	5.6
Chemotaxis Index[1]					
3 wk	3.8	2.5	3.8	3.2	.1
6 wk	4.2[ab]	5.1[ab]	7.9[a]	4.0[b]	.3

[a,b,c,d]Means within row with different superscripts differ ([ab]P<.10); [cd]P<.05).

[1]For description of test see test.

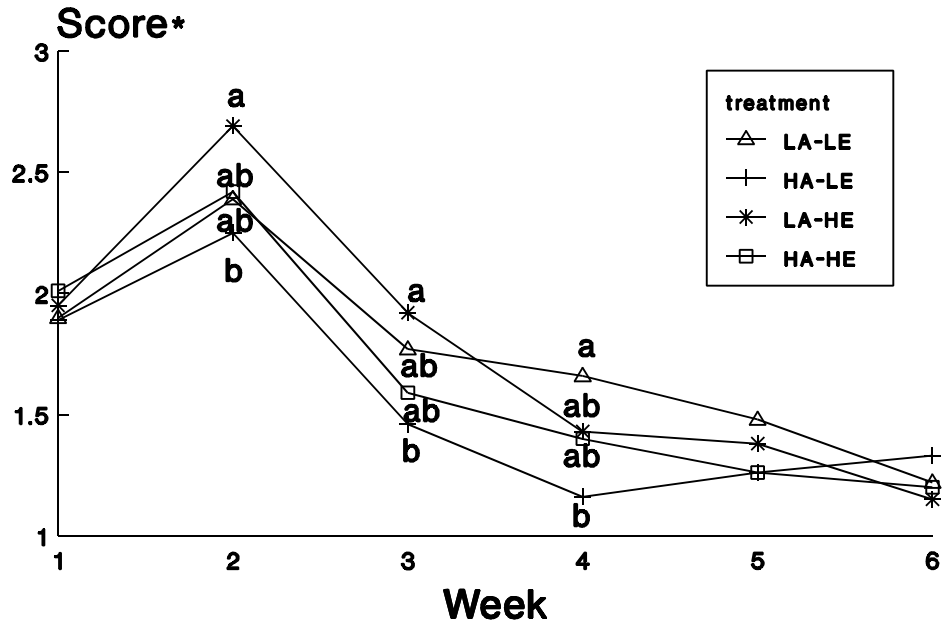

Figure 1. **Weekly Fecal Scores of Calves Fed Experimental Milk Replacers. Means Within a Week with Different Superscripts Differ (P<.10). 1 = Solid to 4 = Fluid.**

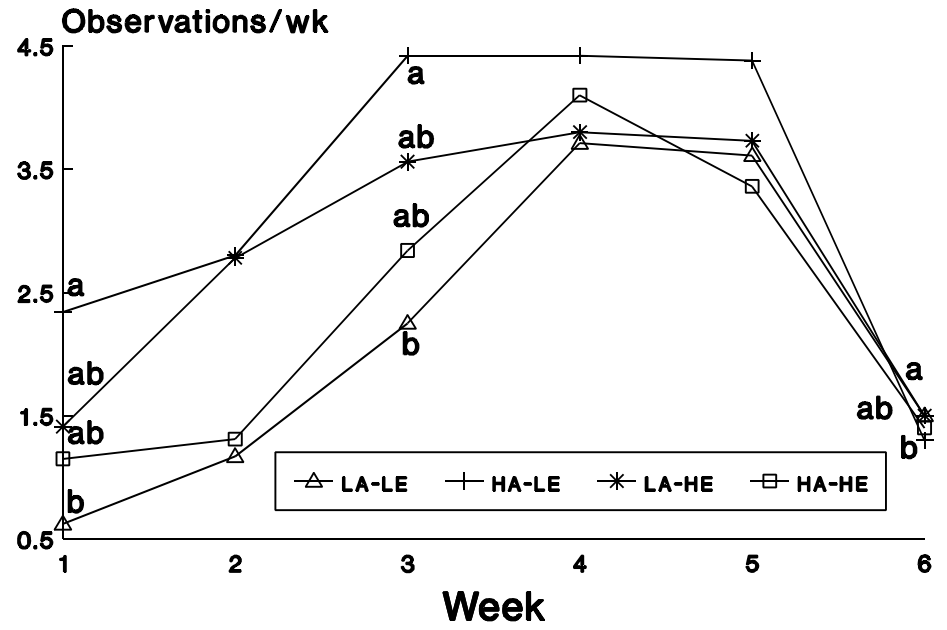

Figure 2. **Weekly Eye Discharges of Calves Fed Experimental Milk Replacers. Means Within a Week with Different Superscripts Differ (P<.10).**

SEVERE FLEA INFESTATION IN DAIRY CALVES

M. W. Dryden[1] and A. B. Broce[2]

Summary

In June 1991, an investigation was conducted of a severe flea infestation in 23 Holstein dairy calves in South Central Kansas. Inspection of the dairy revealed massive numbers of fleas on calves and in the barn where they were housed. Analysis of blood samples from 10 calves revealed that nine of them had mild to severe anemia. A management program was initiated consisting of treatments of calves and premises with insecticide and insect growth regulator and removal of straw bedding from the barn. Inspection of the dairy 9 wk after this complete control program was initiated revealed that fleas were not evident on calves or on the premises.

(Key Words: Dairy, Calves, Fleas, Methoprene, Anemia.)

Introduction

In early June, a report was received of a flea infestation in Holstein calves at a Grade A dairy in South Central Kansas; flea problems had existed on this farm for the past 5 yr. The flea infestation had become severe during the past yr, with owners attributing the deaths of three calves to fleas. Several pesticides had been used both on the calves and in the premises in attempts to control the problem. The list included malathion, diazinon, chlorpyriphos, pyrethrins, and permethrin.

Upon inspection of the dairy, massive numbers of fleas were found infesting a large barn used to house the young bottle calves. At the time of initial inspection, 23 calves, ages 1 to 3 months, were housed in a 40' × 60' (12.2 × 18.3 m) barn. Calves were maintained on 8 to 12" (20 to 30.5 cm) of wheat straw bedding, in individual calf pens until approximately 2 months of age. Calves were then moved to larger group pens in the same barn, holding three to six calves.

Fleas could be observed in all calf pens. Those pens that had been unoccupied for several days had the highest flea numbers. Large numbers of fleas also could be seen in walkways between pens and in doorways of the barn. Fleas also were found on the ground and in weeds on all sides of the barn and on a driveway 50' (15 m) from the barn.

Procedures

Examination of calves revealed fleas on all 23 of them. Although fleas were found over the entire body of the calves, they were most numerous in the inguinal region, head, back of neck, and withers. Several of the younger calves appeared weak and emaciated and had pale mucus membranes. Older calves housed in a different barn and cows did not have any evidence of flea infestation. Further inspection of the farm revealed approximately 30 stray cats and one mixed breed dog. Cats that we were able to inspect and the dog all had moderate to heavy flea infestations. Fleas were combed from two cats and the dog and placed in 70% alcohol for identification.

Ten calves (five bulls and five heifers), 29 to days of age, were selected for further examination. An initial data base included determination of CBC, serum iron, and total iron binding capacity. Several fleas were removed from each calf, using a fine toothed flea comb, and placed

[1]Department of Laboratory Medicine.
[2]Department of Entomology.

into 70% alcohol for identification. Live fleas also were placed into a glass jar to allow for egg production, in order to assess reproductive capability of fleas feeding on calves.

Total flea population assessments were attempted on two of the calves. Calves were placed on a white sheet and sprayed thoroughly with an alcohol-based pyrethrin flea spray. Calves were then combed and brushed for 30 to 40 minutes to remove as may fleas as possible.

A couple of methods were used to assess flea populations in the environment. A small amount of bedding material was removed from several pens. This material was taken to the laboratory and sifted through a 12-mesh screen, in an attempt to recover flea larvae. The owners had been using three lighted flea traps with sticky boards (Happy Jack Flea Trap; Happy Jack) in walkways between pens to help reduce flea populations in areas where they had to work. Although these traps only collected fleas from a small area of the barn, we decided that continued use of the traps would give us an indication of the flea population levels over time. All trap sticky bottoms were collected weekly or every other week.

Management recommendations included removal of existing straw bedding and treatment of the premise with a chlorpyriphos-methoprene formulation (Siphotrol plus II house treatment; Vet-Kem). The barn should be left empty for 3 wk and retreated before allowing new calves into the facility. All calves should be treated once weekly with a pyrethrin-methoprene flea spray (Ovitrol Plus; Vet-Kem), until fleas were no longer evident. Stray cats should be live-trapped and removed from the dairy. The dog also should be treated with the pyrethrin-methoprene spray twice weekly.

Although the owners agreed to initiate the control program, they said that cleaning of the barn could not be attempted for 3 to 4 wk, because of impending wheat harvest.

Results

Analysis of blood samples taken from each of 10 calves selected for further study revealed that nine of these calves had some blood parameter associated with anemia; the data indicated that the anemia was severe in some of the animals (Figures 1 to 4). Fleas collected were identified as *Ctenocephalides felis felis*, the cat flea. Total flea recovery attempts resulted in 2,808 (1,564 females & 1,244 males) and 5,317 (3,884 females & 1,433 males) fleas from calves number 1 and 10, respectively.

Fleas removed from calves laid 126 eggs in the jar. Eggs were placed in flea rearing media in a rearing jar and maintained at 29^0C (84^0F) and 80 to 85% relative humidity for 4 wk. Forty-seven adult fleas emerged. Approximately 1 lb (450 g) of straw bedding was sifted, resulting in the collection of 405 flea larvae.

Fleas collected in the lighted flea traps were individually counted where possible. Some of the trap bottoms had collected extremely high numbers of fleas. Therefore, fleas on those trap bottoms were estimated by counting fleas in subsamples. It was estimated that a total of over 92,000 fleas were collected in the three traps (Table 1).

Between wk 1 and 4, all cats were removed from the farm and calves were treated weekly. During wk 4 the barn was cleared of all bedding and the floors were treated. Inspection of the calves 6 wk after the initial visit (2 wk since barn was treated) revealed the presence of only one flea on one calf. The flea traps had caught only 17 fleas in the previous 24 hours, compared to over 3,000 per day during the initial visit. A final inspection, during wk 13 (9 wk after treatment of barn) revealed no fleas in the barn or on the new calves placed in it.

Shortly after studies had been initiated at this dairy, we received a report about a second dairy with a similar flea problem; this second dairy was located within 5 miles of the first dairy. About 80 calves were housed in two barns, also using wheat straw for bedding. Ten randomly selected calves were inspected and all were found to be infested with cat fleas. Of interest was that there were only two cats at this facility. A control program similar to that used at the first farm was recommended and initiated.

Discussion

Ctenocephalides felis, the cat flea, occurs worldwide, parasitizing many species of wild and

domestic animals, including dogs, cats, ferrets, raccoons, opossums, bear, chickens, cattle, sheep, and goats. In the U.S., it is the most common flea infesting dogs and cats. It is the most common ectoparasite of domestic pets, responsible for production and transmission of several diseases of animals, including flea allergy dermatitis, anemia, Murine Typhus, and *Dipylidium caninum*, a dog and cat tapeworm. American pet owners spend several hundred million dollars annually in attempts to control this parasite.

The cat flea, and others in the same genus, commonly infest livestock in the Middle East, India, and Africa,. These flea infestations are often severe, with both anemia and death in calves and lambs commonly reported. In these reports, little information is given concerning numbers of fleas on calves or in the environment, other than that the animals were massively infested.

Documented cases of flea infestations in livestock in the U.S. have been rare. Two cases were reported from Georgia in 1982 and Ohio in 1990 of dairy calves suffering from severe anemia because of heavy infestation with *C. felis*. Other similar cases also have been reported recently from Texas and California.

Cat fleas have a high reproductive potential, producing an average of 25 to 30 eggs per day when feeding on cats. This high reproductive rate can lead to massive infestations, if environmental conditions are optimal for larval survival. Under conditions of 25 to 29^0C (approximately 77 to 84^0F) and 75 to 85% relative humidity, greater than 50% of the eggs laid can develop into adult fleas in 3 to 4 wk. These conditions are often found when calves are raised on straw bedding. The bedding becomes soaked with urine and feces, resulting in a compost. Flea larvae migrate up or down in the straw until they locate the optimal thermal and humidity zone. As was cited previously, massive infestations have been reported frequently outside the U.S. under such conditions. But, even though many dairy calves are raised on straw bedding in the U.S. and many of these farms have flea-infested cats, flea infestations had not been commonly reported. The apparent recent increase in reports of fleas infesting dairy cattle in the U.S. and our experiences with the massive outbreaks in South Central Kansas are of considerable interest.

Treatment of this flea infestation necessitated the use of both insecticides to kill adult fleas and an insect growth regulator (methoprene) to inhibit egg hatch and larval development. Insect growth regulators are synthetic insect hormones that inhibit flea eggs from hatching and prevent flea larvae from forming pupa. With such large numbers of fleas on the calves, massive numbers of eggs were being deposited into the straw bedding. Without elimination of developing eggs and larvae, it is doubtful that control could have been achieved using just insecticides.

This is the first documented report of fleas infesting dairy calves in the midwest. This is also the first report in which flea infestation levels were documented. We estimated that the fleas infesting calf #10 were consuming 10.5 to 14% of that calf's blood weekly.

Table 1. Flea Collections from Three Lighted Flea Traps in Flea-infested Calf Barn

Trapping period	Fleas collected in lighted traps: No. days in trapping period	Fleas collected in lighted traps: Average No. of fleas/day
previsit	10	3,353
wk 0 - 1	7	1,691
wk 1 - 2	7	2,616
wk 2 - 4*	14	1,839
wk 4 - 6	13	194
wk 6 - 7	7	17
wk 13	14	0

*Insecticide treatment of premise initiated Wk 4.

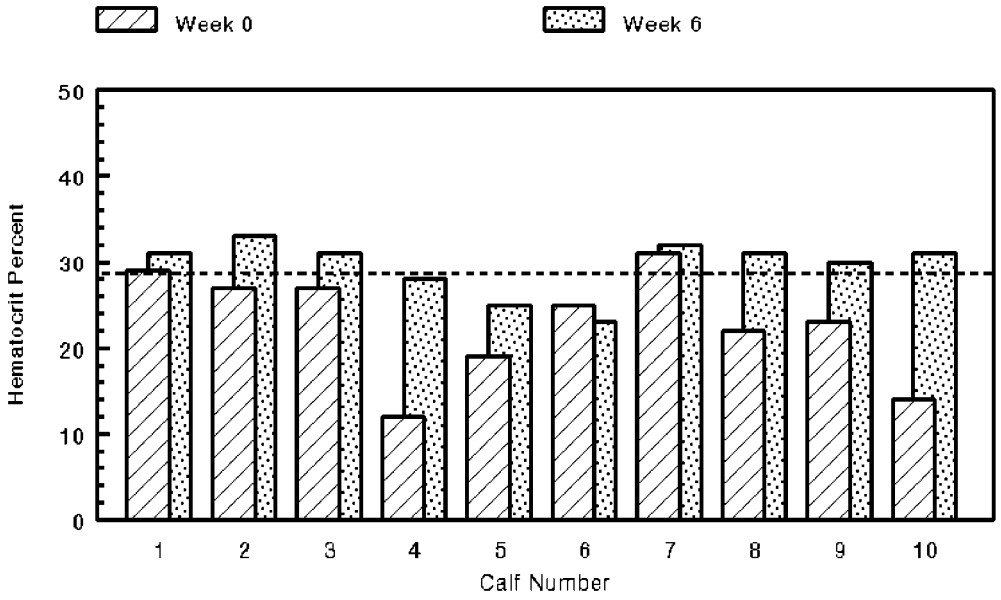

Figure 1. Hematocrit of Dairy Calves Infested with Cat Fleas. Dotted Horizontal Line Indicates Low Normal Values for Calves.

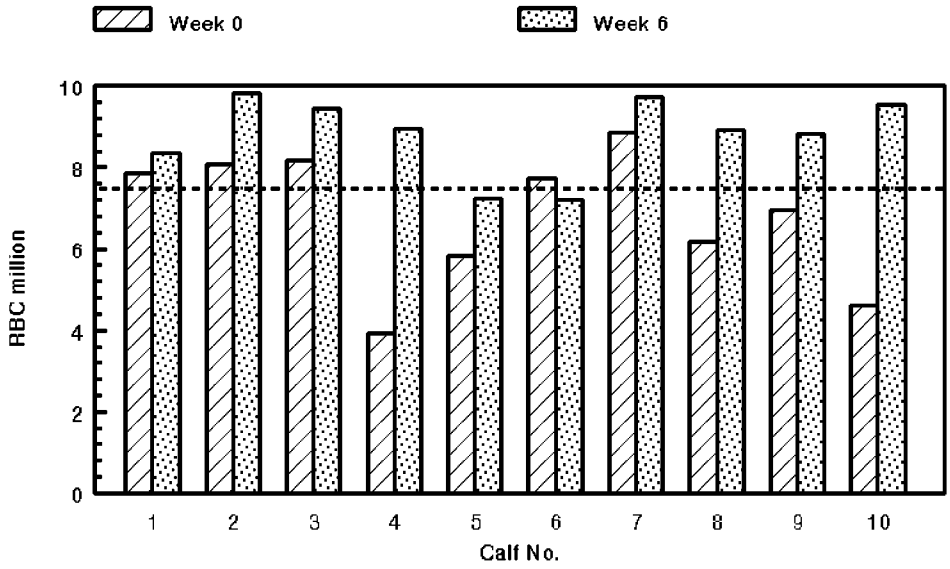

Figure 2. Red Blood Cell Counts in Dairy Calves Infested with Cat Fleas. Dotted Horizontal Line Indicates Low Normal Values for Calves.

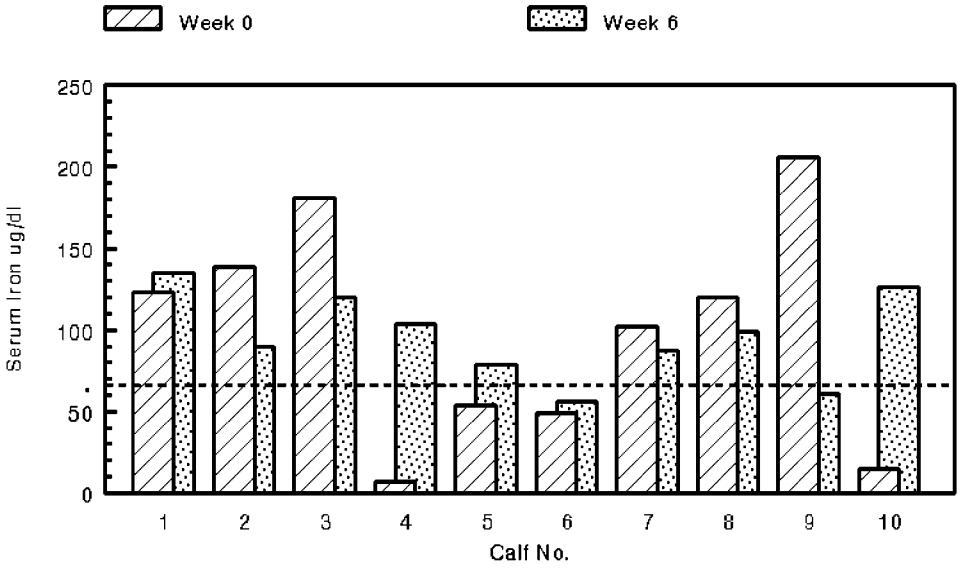

Figure 3. Serum Iron of Dairy Calves Infested with Cat Fleas. Dotted horizontal Line Indicates Low Normal Values for Calves.

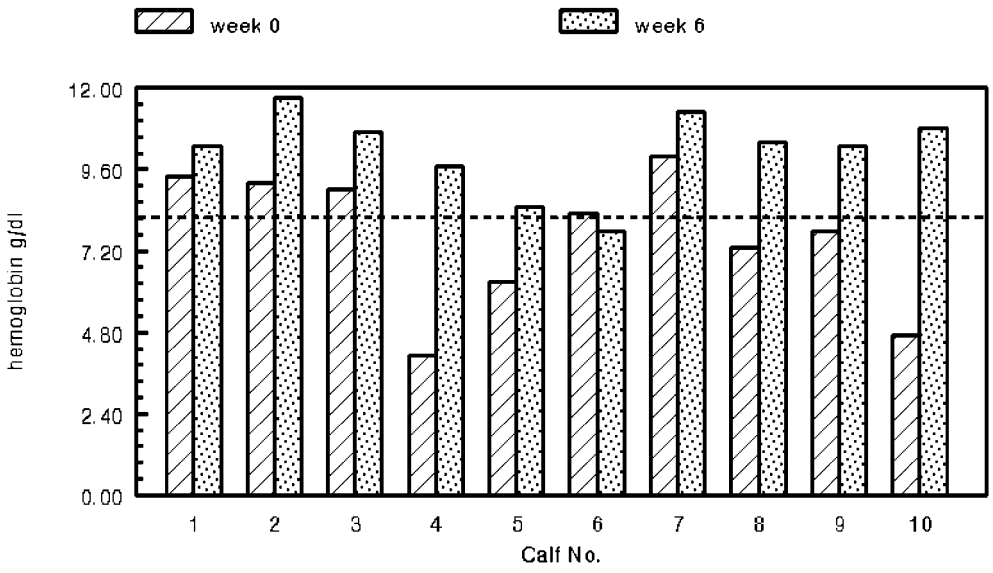

Figure 4. Hemoglobin Concentration of Dairy Calves infested with Cat Fleas. Dotted horizontal Line Indicates Low Normal Values for Calves.

RELEASE OF PARASITIC WASPS TO CONTROL STABLE FLIES IN KANSAS DAIRIES

G. L. Greene[1]

Summary

After release of fly parasites in Kansas dairies during 1991, parasitism increased from May to late June then dropped in July. The parasite released was *Spalangea nigroaenea* of Kansas origin to assure its adaption to Kansas conditions. Additional studies of fly parasite releases are needed to develop a reliable fly reduction program for Kansas dairies before fly parasite purchases can be reliably recommended. Release of adapted parasite species and removal of fly breeding areas will be essential for reduction of fly numbers at Kansas dairies.

Introduction

Several dairy operations inquired about using fly parasites to control flies during 1991. Those requests prompted experimental releases of a Kansas strain of *Spalangia nigroaenea* that had shown promise for reduction of stable flies in cattle feedlots. The similarity of dairies and feedlots suggested that stable fly control would be similar in both livestock confinements. Parasites were purchased and released at several dairies and fly pupal samples were taken to record if parasitism by the released parasite increased. In addition to parasite releases, suggestions were made to help reduce the fly breeding areas. Those suggested changes contributed to the reduced fly numbers in most dairies.

Procedures

Cooperating dairies were surveyed prior to parasite releases to estimate the number of parasites needed. The fly breeding area at each dairy was estimated, and the number of parasites released was 20,000 or 40,000 per week depending on the number of cattle present and potential fly breeding area. The KK dairy received a variable number of parasites (40,000 to 250,000/week) based on the stable fly catches and size of the fly breeding area.

Fly pupae were collected at each dairy, with an attempt to collect 100 or more on each date. Those fly pupae were held individually, and fly or parasite emergence was recorded. One sample (May 25) was missed at the non-release dairy, DK.

Results and Discussion

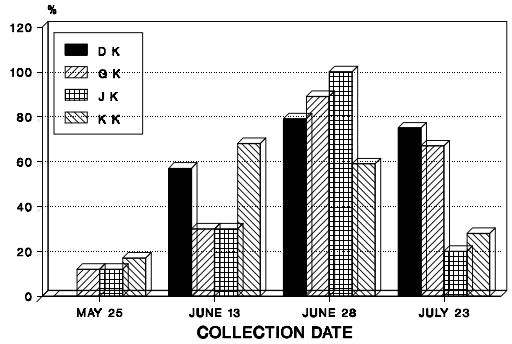

Figure 1. Parasite Emergence from Fly Pupae Collected from Four Dairies with the Reciprocal Percentage Being Flies.

The live fly pupae collected at the GK and JK dairies were increasingly parasitized through June 28, then parasitism decreased on July 23 (Figure 1). That suggests that fly parasite releases increased parasitism. A similar trend was seen at the non-release dairy, DK, where parasitism was 57 to 79 percent. That was higher than observed in cattle feedlots and was high relative to the

[1]Southwest Kansas Research-Extension Center.

extremely high fly populations present. The decline in parasitism on July 23 may relate to the decrease in fly populations and the change from stable fly to house fly. In comparison to the parasite release dairies, there was considerable parasitism in the non-release dairy, even though flies were more numerous there.

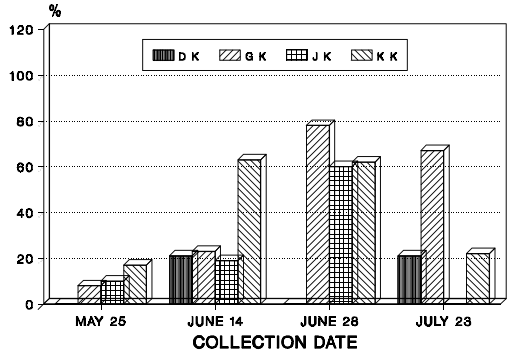

Figure 2. Percentage of Fly Pupae Collected from Dairies that Produced *S. nigroaenea* Parasites.

The percentage of live fly pupae producing *S. nigroaenea* parasites increased with time at the GK and JK dairies (Figure 2). That increase was not as apparent at KK dairy, where the percentage decreased by July 23. The DK dairy, where no parasites were released, had very few *S. nigroaenea*. However, they did occur there on June 14 and July 23, suggesting that the parasite species occurs naturally in central Kansas dairies. The low parasitism on May 25 prior to the effects of released parasites and the three times greater parasitism in the KK dairy on June 14 where releases began earlier show the effects of *S. nigroaenea* releases. The reduced percentage of *S. nigroaenea* on July 23 resulted from an increase of *Muscidifurax* from house fly pupae.

Comparing the composition of the fly parasites by species (Figure 3), *S. nigroaenea* contributed over 60 percent of the emerged parasites in 11 of 15 samples. That is a high percentage, considering the number of house fly pupae collected. House flies are much more attractive to *Muscidifurax* than to *Spalangia*. Several of the house fly samples were predominately parasitized by *Muscidifurax* and produced some of the 0 percent *S. nigroaenea* bars in Figure 3. With the predominance of house flies after June 14, a lower percentage of *S. nigroaenea* would be expected, because non-release feedlots yield 38 percent *S. nigroaenea*. The 100 percent bar for DK on June 14 was only two specimens.

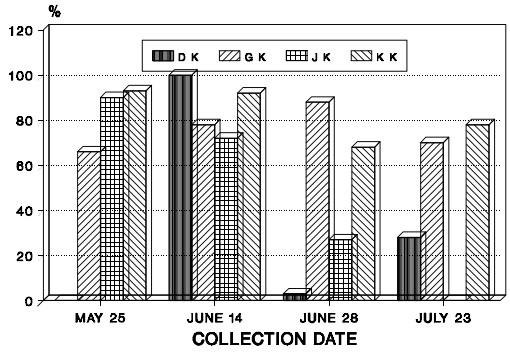

Figure 3. Percentage of Parasites Emerging from Fly Pupae Collected from Dairies that Were *S. nigroaenea.*

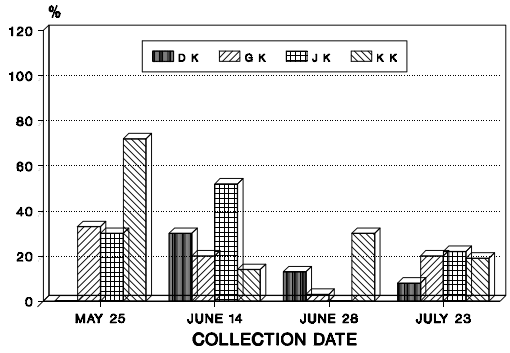

Figure 4. Percentage of Emerging House Fly and Stable Fly Adults from Fly Pupae Collected from Dairies.

The fly emergence from the collected pupae was very low (Figure 4). Even the non-release dairy had low fly emergence compared to the large number of flies present. Most collections were below 20%, with only 7 of 15 above 20% and 2 above 40% fly emergence. The dry and hot conditions in the dairy locations may have reduced fly survival.

PREGNANCY RATES OF HOLSTEIN COWS AFTER POSTINSEMINATION TREATMENT WITH PROGESTERONE

J. S. Stevenson and M. O. Mee

Summary

The objective of this experiment was to determine if pregnancy rates following first services would be improved by supplementing lactating dairy cows with progesterone during two phases after insemination. Cows were inseminated at estrus (day 0), and progesterone was administered via a progesterone-releasing intravaginal device (PRID) from days 5 to 13 or days 13 to 21 after first service with untreated cows serving as controls. Pregnancy rates at first services were unaffected by the progesterone treatments whether the cows received a PRID from days 5 to 13 (13/36 or 36%), a PRID from days 13 to 21 (18/36 or 50%), or no PRID (39/92 or 42%). Fewer nonpregnant cows receiving the PRID returned to estrus 17 to 27 days after the first service compared to the controls (27 vs. 49%). However, this apparently was not associated with improved embryonic survival in the cows receiving progesterone because the pattern of cows returning to estrus after first service was similar, except for 17 to 27-day period cited above. Supplementing progesterone to lactating dairy cows after first services did not seem to improve fertility.

(Key Words: Pregnancy Rates, Cows, Progesterone.)

Introduction

The presence of the corpus luteum (CL) and its progesterone-secreting capacity is essential to maintain pregnancy in the cow. Pregnancy elevates concentrations of progesterone in the blood stream as early as day 6 after estrus (day 0) and ensures that the uterus is noncontractile during development of the embryo and fetus. Attempts to improve pregnancy rates by stimulating the CL to secrete more progesterone using various gonadotropin substances have produced some positive and negative results. In addition, providing supplemental progestogen at various doses and methods of administration after insemination either increased or had no effect on pregnancy rates.

Our objective was to determine if supplementing progesterone during two phases after first postpartum services using an intravaginal device known as the PRID would improve the fertility of lactating dairy cows. We chose to supplement progesterone during a period of increasing titers of progesterone in the blood and rapid CL growth (days 5 to 13) and during a period of maximal progesterone secretion (days 13 to 21) once the CL has reached its near maximal diameter.

Procedures

Lactating Holstein cows (n=179) utilized in this study calved between July, 1989 and June, 1990. Three groups of cows were formed after first services were given. Two groups received exogenous progesterone via an experimental progesterone-releasing intravaginal device (PRID), authorized by the U.S. Food and Drug Administration as Investigational New Animal Drug Application #6450. The PRID is a silastic elastomer coil (2 × 10 in) that is impregnated with 1.5 g crystalline progesterone. It is inserted into the vagina and rests against the cervix, making contact with the dorsal, lateral, and ventral portions of the vagina, allowing the progesterone to be absorbed into the vaginal wall. The three groups of cows received after first service (ranging from 42 to 85 days postpartum): 1) a PRID from days 5 to 13 (PRID-5; n=44); 2) a PRID from days 13 to 21 (PRID-13; n=43); or 3) no PRID (controls; n=92). Blood samples were collected from some of the cows in each treatment group on days 5, 13, and 21 after estrus and insemination (i.e., at the time the PRID treatments

were inserted or removed). Pregnancy rates were determined by palpation of the uterus and its contents at 42 to 56 days after insemination.

Results and Discussion

Retention of the PRIDs was 83%. Eight PRIDs were not retained for the full 8-day period in the PRID-5 group and seven PRIDs were lost in the PRID-13 group, leaving 36 cows in each PRID group for comparison of pregnancy rates with the control cows. Pregnancy rates of the three experimental groups are shown in Table 1. Pregnancy rates appeared to be slightly less in the PRID-5 and control cows compared to the PRID-13 group. Two other studies reported a tendency for increased pregnancy rates (PRID inserted from days 13 to 21 after first service) or a significant increase in pregnancy rates when a PRID was inserted from days 5 to 12 or from days 12 to 17 after first services during both summer and winter.

Table 1. Pregnancy Rates after First Service and Supplemental Progesterone Treatment

Treatment group	Pregnancy rate
Control	39/92 (42%)
PRID-5	13/36 (36%)
PRID-13	18/36 (50%)

Concentrations of progesterone in serum of nonpregnant cows are illustrated in Figure 1. Progesterone was similar in all three groups of cows on days 5 and 13 after estrus and insemination but was elevated (P<.05) in PRID-13 cows on day 21 compared to the PRID-5 and control cows. Concentrations of progesterone in the PRID-13 cows were due to the treatment effect of the PRID, which was removed after the day-21 blood sample was collected.

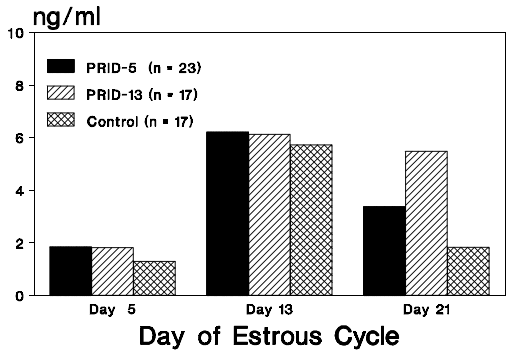

Figure 1. Concentrations of Progesterone in Serum of Nonpregnant Cows on Days 5, 13, and 21 after Estrus (Day 0) and First Service.

Concentrations of progesterone in serum of pregnant cows were similar in all groups on days 5 and 13 but were higher (P<.05) in the PRID-13 cows than the PRID-5 cows on day 21 of pregnancy (Figure 2).

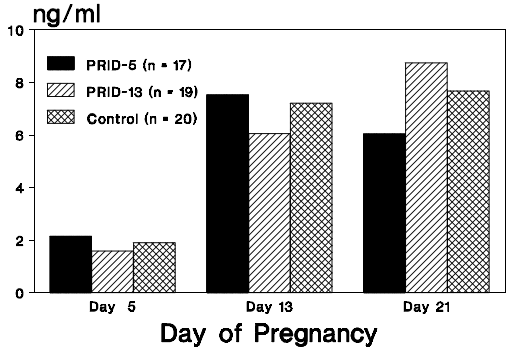

Figure 2. Concentrations of Progesterone in Serum of Pregnant Cows on Days 5, 13, and 21 after Estrus (Day 0) and First Service.

The percentage of nonpregnant cows returning to estrus 17 to 27 days after first service was reduced (P<.05) to 27% in the combined PRID groups compared to 49% of the control cows. Percentages of cows returning to estrus were similar at days 25 to 38, days 39 to 47, days 48 to 59, and days 60 to 70 after first service, indicating that embryonic survival was unaffected by the treatments. Although we successfully elevated progesterone in these cows via the PRID, pregnancy rates were unaltered.

ADMINISTRATION OF GnRH AT INSEMINATION IN REPEAT BREEDING DAIRY COWS: IMPROVED PREGNANCY RATES, HORMONE SECRETION, AND LUTEAL FUNCTION

J.S. Stevenson, M.O. Mee, and E.P. Call

Summary

Administering saline to 14 repeat breeders or 100 µg GnRH to 38 repeat breeders resulted in a greater (P=.07) proportion of pregnancies at 42 to 56 days after third service and fewer (P<.05) lost pregnancies during the 25- to 38-day period of placentation. Concentrations of LH in serum of six repeat breeders previously given 100 µg GnRH 12 hr after detected estrus (day 0) were reduced (P<.05) on days 1, 3, and 8 after estrus compared to those in six cows previously given saline at estrus. Concentrations of FSH were similar among treatment groups on days 1 and 3, but were elevated (P<.05) on day 8 in GnRH-treated cows. Furthermore, all six GnRH-treated cows had detectable FSH pulses on day 8 compared to two of six control cows. Concentrations of progesterone in serum were elevated (P<.05) on days 8 to 10 after estrus in GnRH-treated cows, and their corpora lutea obtained on day 10 after estrus and treatment contained a greater (P<.05) proportion (31 vs. 14%) of large-diameter (21 to 37 µm) luteal cells and a lesser (P<.05) proportion (69 vs. 86%) of small-diameter (10 to 17 µm) luteal cells than corpora lutea from control cows. *In vitro* production of progesterone in response to LH was reduced (P<.05) in luteal tissue obtained on day 10 after estrus from cows previously treated with GnRH at estrus compared to cows given only saline. It appears that pregnancy rates are improved in repeat breeders given GnRH at the time of insemination as a result of increased secretion of progesterone related to alterations in the morphology and function of the corpus luteum, as well as possible influences of FSH secretion from the pituitary gland.

(Key Words: Pregnancy Rates, Progesterone, LH, FSH, GnRH, Luteal Function.)

Introduction

Dairy cattle that fail to conceive after several inseminations are a source of frustration and economic loss to the dairy enterprise. These so-called "repeat-breeders" are cows that fail to become pregnant after two or more services but continue to show estrus every 18 to 24 days. There are several potential causes of repeat breeding, including fertilization failure (29 to 41%), embryonic mortality (21 to 35%), defective luteal secretion of progesterone and other hormonal imbalances, errors in heat detection, various defects in sperm or egg function, and nutritional imbalances.

In three experiments conducted since 1981 involving over 2,200 repeat-breeding dairy cows located in Kansas, Oklahoma, and California, we have documented a 25% improvement in pregnancy rates when GnRH (100 µg Cystorelin®) was injected at the time of the third insemination (1988 Dairy Day, KAES Rep. Prog. 554, pp 16-18 and 1990 KAES Dairy Day Rep. Prog. 608, pp 34-37). A series of studies over the last 3 yr have been conducted to determine why GnRH is effective in improving pregnancy rates in these low fertility cows. Our purpose was to determine how GnRH affects hormone secretions and luteal function of cows treated at the time of insemination (12 hr after detected estrus), in order to better understand those components that influence and control fertility in cattle.

Procedures

In Experiment 1, 32 cows eligible for third service were assigned randomly as they were detected in estrus to receive (i.m.) either saline or 50, 100, or 250 µg GnRH (eight cows per group; Cystorelin, SANOFI Animal Health, Inc., Overland Park, KS) immediately following insemination (12 hr after detected estrus). Blood was collected on alternate days for 30 days beginning 4 days after estrus (day 0) to measure serum concentrations of progesterone.

In Experiment 2, an additional 12 cows were assigned to receive either saline or 100 µg GnRH immediately following insemination (12 hr after detected estrus). Blood was collected daily from estrus (day 0) until 40 days after estrus to measure concentrations of progesterone in serum. In addition, blood was collected for 8 hr at 15-min intervals on days 1, 3, and 8 after estrus to characterize average concentrations and pulse frequency of LH and FSH.

In Experiment 3, eight cows were treated with either 100 µg GnRH or saline 12 hr after detected estrus. Blood was collected daily from estrus until day 10 of the estrous cycle to measure serum concentrations of progesterone. On day 10, the ovary containing the corpus luteum was removed and both ovary and corpus luteum were weighed. A slice of the corpus luteum was fixed for histological analysis of large and small luteal cells and the remaining luteal tissue was sliced into 0.3 mm slices to determine *in vitro* production of progesterone. Duplicate flasks containing 200 to 300-mg slices of luteal tissue were incubated in a Dubnoff metabolic incubator at 39^0C for 2 hr without LH or 2 hr with LH (10 ng/ml) in Dulbecco's Modified Eagles Deficient Medium supplemented with glucose and antibiotics. Following the incubation period, 6 ml cold ethanol were added to each flask to terminate synthesis of progesterone. Tissue samples, including the unincubated control, were transferred to culture tubes and stored at -20^0C until homogenized, extracted, and assayed for progesterone.

Results and Discussion

Results of our previous work demonstrating improved pregnancy rates at repeat services in three different studies are illustrated in Table 1. These studies were conducted in one 5,000-cow dairy herd in Oklahoma, five 500-cow dairy herds in California, and in our KSU Dairy Teaching and Research herd in Manhattan. In each study, one injection (i.m.) of 100 µg or 2 ml of GnRH improved (P<.05) pregnancy rates by approximately 25% or 11 percentage points.

Table 1. Pregnancy Rates in Dairy Cows When Given GnRH at the Time of Repeat Inseminations.

Study	Control	GnRH
A	75/157 48%	84/144 58%[a]
B	108/344 31%	74/169 44%[a]
C	113/353 32%	169/406 42%[a]
Total	296/854 35%	327/715 46%

[a]Different (P<.05) from control.

In Experiment 1, we examined concentrations of progesterone and pregnancy rates in order to determine how pregnancy rates might be improved in cows given GnRH. Three doses of GnRH (50, 100, and 250 µg) were tested and the results were similar, so data from the three doses are combined in Table 2. The proportion of cows that recycled or returned to estrus 18 to 24 days after insemination and treatment with GnRH or saline (control) was similar, as was the proportion of cows with high concentrations of progesterone from 30 to 40 days after insemination and treatment. However, when cows were palpated to determine pregnancy status at 42 to 56 days after that service, 43% of the cows receiving GnRH at

insemination were pregnant compared to only 14% of the control cows. This suggested that five (71%) pregnancies in the control cows and three (19%) pregnancies in the GnRH-treated groups were lost sometime between about day 25 and the time of pregnancy diagnosis.

Table 2. Reproductive Characteristics in Repeat Breeders after GnRH Given at the Time of Insemination

Item	Control	GnRH
No. cows	14	30
No. returned to heat[1]	7 50%	14 47%
No. with high P_4[2]	7 50%	16 53%
No. pregnant[3]	2 14%	13 43%[a]
No. embryos lost[4]	5 71%	3 19%[a]

[a]Different (P<.05) from control.

[1]Number of cows returning to estrus 18 to 24 days after insemination and treatment.

[2]Number of cows with high progesterone until 30 to 40 days after insemination (assumed to be pregnant).

[3]Number of cows pregnant by palpation at 42 to 56 days after insemination.

[4]Number of potential embryos lost sometime from 25 days after insemination until palpation.

In Experiment 2, we examined the concentrations of the pituitary gonadotropins, LH and FSH, which are increased by the injection of GnRH. We examined these hormonal changes on days 1, 3, and 8 after estrus (day 0), when either GnRH or saline was given 12 hr after detected estrus. GnRH reduced (P<.05) average concentrations of LH on days 1, 3, and 8 compared to controls (Table 3), although the number of LH pulses was unaffected by treatment. There were no treatment effects on concentrations of FSH or number of FSH pulses on days 1 and 3, but GnRH treatment at estrus increased (P<.05) concentrations of FSH and the number of FSH pulses on day 8 compared to controls. All six treated cows had detectable pulses of FSH, whereas only two of six control cows had FSH pulses.

In Experiment 3, concentrations of progesterone were determined in eight cows treated with GnRH or saline 12 hr after estrus. Concentrations of progesterone were increased (P<.05) on days 8 to 10 after treatment with GnRH compared to saline (Figure 1).

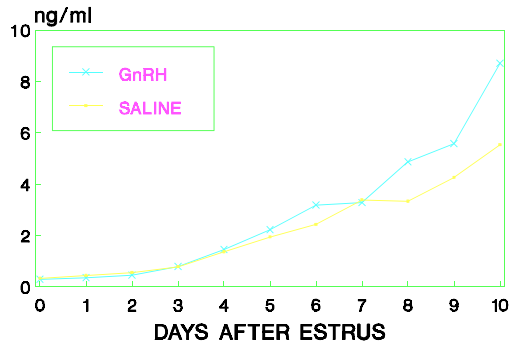

Figure 1. Concentrations of Progesterone in Serum on Days 0 to 10 after Estrus (Day 0) in Eight Repeat-breeding Cows Given Either GnRH or Saline 12 hr after Detected Estrus.

In each of those same eight cows, the ovary bearing the corpus luteum was removed on day 10 after estrus (GnRH was administered at 12 hr after detected estrus). Then the procedure was repeated 33 days later when the same eight cows were treated at estrus with saline, and the remaining ovary and the corpus luteum were removed on day 10 of a subsequent estrous cycle. Weights of the ovaries and corpora lutea were unaffected by treatments, but the day-10 corpora lutea of cows previously treated with GnRH at estrus contained a greater (P<.05) proportion (31 vs. 14%) of large-diameter (21 to 37 µm) luteal cells and a lesser (P<.05) proportion (69 vs. 86%) of small-diameter (10 to 17 µm) luteal cells than corpora lutea of control cows obtained on day 10 after

Table 3. Characteristics of LH and FSH in Serum on Days 1, 3, and 8 after Treatment with GnRH or Saline at Estrus

Item	Control	GnRH
Day 1		
Avg LH, ng/ml	1.2	0.6[a]
No. LH pulses	0	0.5
Cows w/ pulses	0/6	1/6
Avg FSH, ng/ml	0.4	0.4
No. FSH pulses	0	0
Cows w/ pulses	0/6	0/6
Day 3		
Avg LH, ng/ml	0.8	0.5[a]
No. LH pulses	1.8	1
Cows w/ pulses	4/6	2/6
Avg FSH, ng/ml	0.5	0.5
No. FSH pulses	0.1	0.5
Cows w/ pulses	1/6	1/6
Day 8		
Avg LH, ng/ml	0.8	0.5[a]
No. LH pulses	1.3	1.5
Cows w/ pulses	4/6	5/6
Avg FSH, ng/ml	0.6	0.8[a]
No. FSH pulses	1	2.3[a]
Cows w/ pulses	2/6	6/6

[a]Different (P<.05) from control.

[1]Blood was collected for 8 h at 15-min intervals on days 1, 3, and 8 after estrus (day 0). Treatment with saline (control) or 100 µg GnRH was given 12 h after detected estrus.

saline treatment. *In vitro* production of progesterone during 2 hr by luteal slices from the same cows described above was similar between cows previously treated with saline or GnRH, but after *in vitro* exposure to LH, production of progesterone was greater (P<.05) from day-10 corpora lutea of cows previously treated with saline. These differences in *in vitro* and *in vivo* progesterone production were anticipated, because GnRH-treated cows had higher peripheral concentrations of progesterone as a result of having more large luteal cells, which account for 85% of basal progesterone secretion (produced without the need for LH). In contrast, with fewer large luteal cells and proportionately more small luteal cells, which contain LH receptors, we expected to see more *in vitro* progesterone produced by the luteal slices from control cows.

In summary, GnRH treatment at the time of insemination resulted in improved pregnancy rates because of higher embryonic survival in the 25 to 38-day period. This is the period when the placenta attaches to the uterine wall of the cow and generally corresponds to what is called the "late embryonic period." These improvements appear to result from increased secretion of progesterone and perhaps altered secretion of both LH and FSH. Further research is needed to determine what role FSH is playing in this process.

RELATION OF DAYS OPEN TO RATIO OF 21 TO 42 DAY RETURNS TO HEAT, HEAT DETECTION EFFICIENCY, DAYS TO FIRST SERVICE, AND CONCEPTION RATES IN DAIRY HERDS

J. D. Gaines, C. B. Thomas, S. Eicker, D. Rhoda, M. Goedtel, P. L. Larson, E.R. Lindner, and M. Lindborg

Summary

Estimates of the cost of days open range from $2.00 to $5.00 for every day a dairy cow stands open over 100 days. The average days open of a dairy herd are determined by when cows are first bred (days to first service), how often they are bred (heat detection efficiency), and the chance that they will conceive when bred (conception rate). To determine the relative contribution of each of these variables to days open, multiple regression techniques were used to study reproductive performance of dairy herds. Days open were expressed by the equation: Days open = 9.11 (constant) + (.81 × days to first service) - (.6 × heat detection efficiency), R^2=.97. In other words, for every day that days to first service are reduced in a dairy herd, days open will be reduced by .81 days. Also, for every percentage increase in heat detection efficiency, days open will be decreased by .6 days. The fit of the model was very good; 97% (R^2=.97) of the variation in days observed was explained by this equation. Interestingly, the percent of returns to heat at 21 days or ratio of returns to heat at 21 days to returns to heat at 42 days had no significant influence on days open. Heat detection efficiency and herd conception rates were very highly correlated (r=.83); for every 1% increase in heat detection efficiency, conception rates increased 1%. Because of this strong association between conception rates and heat detection efficiency, conception rates were not included in the equation. In conclusion, the heat detection program of a dairy is a significant determinant of conception rate and days open.

(Key Words: Reproduction, Interestrous Interval, Conception, Heat Detection.)

Introduction

The normal interestrous interval in cattle is 21 days, with a range of 18 to 24 days. If a cow is bred and conceives and the embryo dies after day 15 or 16, this interval will be lengthened to more than 24 days. Alternatively, if the cow does not conceive and returns to heat at 21 days but is not detected, then the interestrous interval will be 42 days long. Therefore, in herds with decreased conception rates from early embryonic death, the number of intervals of abnormal length will be increased. If heat detection is decreased, then the ratio of intervals 21 days long to intervals 42 days long will be decreased. Optimally, this ratio of intervals should be 6:1. Clinical evaluation of several herds indicated that few herds actually reached a ratio this high. Therefore, reproductive performance of a sample of dairy herds on a popular dairy herd management program[1] was summarized and studied to determine the relations between interestrous intervals and days open, conception rates, and heat detection efficiency.

Procedures

Computer dairy herd files were gathered from cooperating veterinary practitioners. Each herd's reproductive performance was summarized, including conception rates, days to first service, heat detection efficiency, interestrous interval profiles, and days open. Normality of the data was tested by the Kolmogorov-Smirnov method.

[1]Dairy Comp 305, Valley Agricultural Software.

Because not all of the indices were normally distributed, we examined correlations of the relative rank of the indices with Spearman's r. Stepwise multiple regression was used to model the relationship of days open to other indices of reproductive performance. Alpha to enter or remove a variable was .05. The residuals of this model were shown to be normal by Kolmogorov-Smirnov to ensure that the data set met the assumptions of multiple regression (i.e, that the residuals have a mean of zero and a gaussian distribution).

Results

The average or typical interestrous interval profile is shown in Table 1. The typical herd found only 27% of returns at 21 days, and no herd reached the recommended ratio of 6:1 for interestrous intervals 21 days long to 42 days long. Typically, most herds had a ratio of 1.3:1. When pregnancy rates (Table 2) were examined by interestrous interval length, best conception rates were noted for normal intervals 18-24 days long, but good conception rates were noted for even abnormal intervals of 4-17 days or 25-35 days. It appears that the interestrous interval profile is not a good tool for evaluating dairy herd reproductive performance. Furthermore, cows can conceive even if the interestrus interval is abnormally short or long.

The Spearman correlation matrix is shown in Table 3. Interestrous intervals of any category did not have significant correlation to conception rates, heat detection efficiency, or days open. An interesting finding was the strong correlation between herd conception rates and heat detection efficiency (r=.83). This is illustrated in Figure 1, which shows that herd conception rates and heat detection efficiency are linearly related. In other words, as heat detection improves, so does conception. This lack of independence has not been reported before, and it has commonly been assumed that heat detection and herd pregnancy rates are independent. However, this statistical relationship does not prove cause and effect.

The best model that explained variation in days open was days open = 9.11 + (.81 × days to first service) - (.6 × heat detection efficiency). An index of herd conception rates was not included, because of the high correlation between heat detection and conception rates in a herd (r=.83). Inclusion of two explanatory variables with high correlation in a multiple regression equation may result in coefficients of variation between dependent and explanatory variables that are contrary to that expected and do not reflect the actual relationship. This was the case with herd conception rates and heat detection.

In conclusion, heat detection is the primary determinant of days open and conception rates in dairy herds. Efforts to improve heat detection will reduce days to first service, likely improve conception rates, and definitely reduce days open. Evaluation of profiles or ratios of herd interestrous intervals is of little value when investigating herds with reduced reproductive performance.

Table 1. Typical Interestrous Interval Profile of 71 Dairy Herds[a]

Interval, days	10th PCT	Median	90th PCT[b]
1-3	1	1	16
4-17	1	6	15
18-24	15	27	46
25-35	5	13	23
36-48	8	21	31
> 48	8	26	46
RATIO A	.5	1.3	3.6
RATIO B	.2	.5	1.3

[a]An interestrous interval is the number of days between consecutive detected estruses within a lactation. The interestrous interval profile, then, is the percent of all interestrous intervals within a particular herd that fall within particular categories, i.e. 18 to 24 days between consecutive detected estruses. RATIO A is the ratio of intervals in the 18-24 day category to those in the 36-48 day category. RATIO B is the ratio of intervals in the 18-24 day category to the sum of intervals in the 36-48 day category and >48 day category.

[b]Distribution of interestrous intervals is reported in percentiles. 10th PCT means 10% of the herds had less than this percentage of total intervals in this category. Median means 50% of herds were above and 50% of herds were below this point. At the 90th PCT, 90% of herds had less than this percentage of total intevals in this category.

Table 2. Pregnancy Rates by Interestrous Interval Category in 71 Dairy Herds

Interval, days	Pregnancy rate, %
1-3	59.3[a,c]
4-17	50.2[b,c]
18-24	62.8[a]
25-35	53.3[b,c]
36-48	54.9[b,c]
> 48	55.2[b,c]

[a,b,c]Percentages with uncommon superscript letters differ (P<.05).

Table 3. Spearman Correlation Matrix of Reproductive Indices of 71 Wisconsin Dairy Herds

	FSP	SSP	TSP	AVPG	1-3 days	4-17 days	18-24 days	25-35 days	36-48 days	> 48 days	DFS	Ratio A	Ratio B	Heat detect	DTP
FSP[a]	1.00[g]														
SSP[b]	.06	1.00													
TSP[c]	.40	.32	1.00												
AVPG[d]	.82	.50	.64	1.00											
1-3 days	.13	–.10	–.04	.04	1.00										
4-17 days	–.40	.03	–.39	–.34	–.05	1.00									
18-24 days	.08	–.15	–.33	–.09	–.19	–.15	1.00								
25-35 days	–.14	.09	–.15	–.15	–.08	.01	–.03	1.00							
36-48 days	.02	–.10	–.01	–.01	–.16	–.11	–.00	–.20	1.00						
> 48 days	.03	.19	.41	.23	–.11	–.15	–.61	–.25	–.30	1.00					
DFS[e]	–.12	.13	.20	.01	.10	–.10	–.27	.02	–.27	.34	1.00				
Ratio A	.03	.03	–.21	–.04	.00	–1.3	.67	.09	–.66	–1.4	.03	1.000			
Ratio B	.00	–1.6	–.45	–.19	–.08	.00	.94	.16	–.07	–.76	–.29	.669	1.00		
Heat detect	.80	.37	.35	.83	.03	.26	.15	.03	–.10	.13	.33	.000	–.10	1.00	
DTP[f]	–.51	–.17	–.07	–.46	.08	.05	–.30	–.04	–.24	.41	.76	.016	–.31	.82	1.00

[a]First-service pregnancy rate.
[b]Second-service pregnancy rate.
[c]Third-service pregnancy rate.
[d]Average pregnancy rate.
[e]Days to first service.
[f]Days to pregnancy.
[g]Signficant ($P < .05$) correlation if > .23 or < -.23.

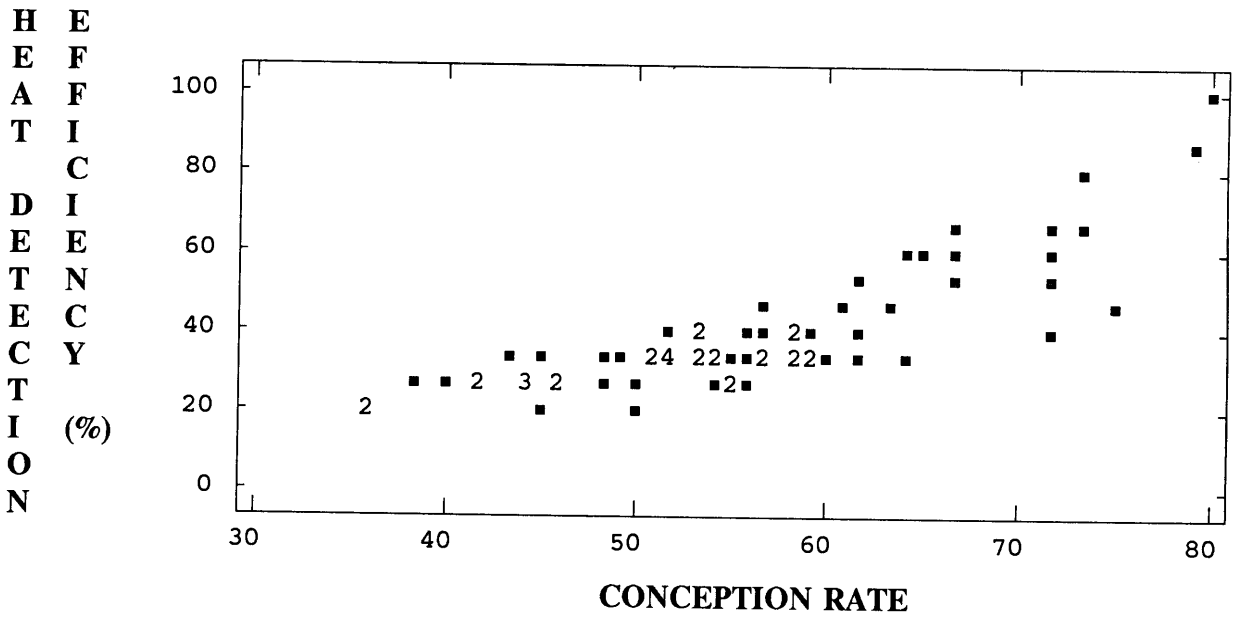

Figure 1. **Relationship between Heat Detection Efficiency and Conception Rate. Squares Represent Individual Herd Observations. Numbers Represent Multiple Observations.**

PREGNANCY RATES AND ENDOCRINE RESPONSES IN CATTLE AFTER ADMINISTERING AN INJECTION OF A GnRH AGONIST 11 TO 13 DAYS AFTER ESTRUS AND INSEMINATION

J. S. Stevenson, I. Rettmer, and L. R. Corah

Summary

Our objective was to determine changes in hormonal concentrations and pregnancy rates in dairy heifers after a single injection of a GnRH agonist given 11 to 13 days after estrus (day 0) and insemination. Pregnancy rates were 58% (11 of 19) in both treatment groups, whereas calving rates were nonsignificantly higher in heifers (58%) treated with the GnRH agonist than with saline (53%). Fertirelin acetate induced short-term release of LH, FSH, estradiol, and progesterone during 6 hr after injection, and concentrations in treated heifers were elevated (P<.05) above those of control heifers. Concentrations of progesterone were increased during 8 to 12 days after injection in only pregnant fertirelin-treated heifers, but serum concentrations of estradiol were reduced (P<.05) in both pregnant and nonpregnant heifers treated with the GnRH agonist compared to those of pregnant and nonpregnant control heifers given saline. The increases observed in pregnancy rates observed in our earlier study (1991 Cattlemen's Day, KAES Rep. Prog. 623, pp 22-24) might be associated with the increase in basal progesterone and the decrease in estradiol secretion resulting from the injection of the GnRH agonist once on days 11 to 13 after estrus and insemination.

(Key Words: Pregnancy Rates, Heifers, GnRH Agonist, LH, FSH, Estradiol, Progesterone.)

Introduction

Several studies have indicated improved pregnancy rate in cattle treated during the postinsemination period with various potent agonists (analogs that mimic the biological activity of the parent compound) of gonadotropin-releasing hormone (GnRH). GnRH is a naturally occurring small protein, composed of 10 amino acids (decapeptide), produced and secreted by the hypothalamus of the brain. Hypothalamic GnRH causes the release of the two pituitary gonadotropins, luteinizing hormone (LH) and follicle-stimulating hormone (FSH). Currently, two GnRH products, similar to the naturally occurring GnRH, are marketed: 1) Cystorelin® (gonadorelin diacetate tetrahydrate; SANOFI Animal Health, Inc., Overland Park, KS) and 2) Factrel® (gonadorelin hydrochloride; Fort Dodge Laboratories, Fort Dodge, IA).

Several new GnRH agonists, available for experimental use only, are more potent (10 to 40 times) in their ability to release LH and FSH and potentially have other profertility applications in cattle. One of these agonists, fertirelin acetate, was utilized in this study under Investigational New Animal Drug Authorization #2996 issued by the U.S. Food and Drug Administration. The objectives of this study were to determine the effect of fertirelin acetate on pregnancy rates and changes in various hormones associated with fertility, including progesterone, estradiol, LH, and FSH, in dairy heifers.

Procedures

Holstein heifers (n=38) were maintained in dry lots at the KSU Dairy Teaching and Research Center during the fall of 1989 and spring of 1990 and fed once daily a total mixed diet containing 100 to 115% of all nutrients recommended by the National Research Council. Estrus in normally cycling heifers weighing more than 340 kg was synchronized by two injections of prostaglandin (PG) $F_{2\alpha}$ given (i.m.) 10 days apart. Following the second injection of $PGF_{2\alpha}$, heifers were

inseminated 12 to 16 hr after first detected estrus by one technician using semen from one sire. Heifers were assigned randomly to receive (i.m.) either saline (4 ml) or 200 µg fertirelin acetate (Ovalyse®, The Upjohn Company, Kalamazoo, MI) administered in 4 ml saline once between days 11 and 13 after estrus (day 0) and insemination. The majority of heifers (31 of 38) was injected on day 12.

Blood was collected from indwelling jugular catheters at 15 to 30-min intervals for 6 hr after the injection of the GnRH agonist to measure the acute effect of fertirelin acetate on concentrations of LH, FSH, estradiol, and progesterone. In addition, blood was collected by tail venipuncture beginning at estrus until 25 to 30 days after estrus to measure long-term changes in serum concentrations of estradiol and progesterone.

Results and Discussion

In our previous work, we demonstrated improved pregnancy and calving rates in beef heifers and suckled beef cows following one injection of either 100 or 200 µg fertirelin acetate on days 11 to 14 after insemination (Table 1). In the current study, pregnancy rates were similar in dairy heifers treated with saline or 200 µg fertirelin acetate (Table 1).

Concentrations of LH and FSH in serum during 6 hr after injection of saline or the GnRH agonist are shown in Figure 1. Serum LH increased (P<.01) to a peak of 19.2 ± 1.2 ng/ml in 118 ± 21 min and serum FSH increased (P<.01) to a peak of 2.5 ± .2 ng/ml in 128 ± 20 min after fertirelin acetate. No changes in either LH or FSH were observed after injection of saline.

Table 1. Pregnancy and Calving Rates in Cattle Given A GnRH Agonist Once on Days 11 to 14 after Estrus and AI

	Dose (µg)		
Item	0	100	200
	Virgin beef heifers[1]		
Pregnancy rates	86/204 43%	100/197 51%[a]	100/203 49%[a]
Calving rates	24/48 50%	31/47 66%	34/52 65%[b]
	Suckled beef cows[1]		
Pregnancy rates	36/51 71%	30/43 70%	34/51 67%
Calving rates	30/41 73%	32/36 89%[b]	31/38 82%[b]
	Virgin dairy heifers		
Pregnancy rates	11/19 58%	-	11/19 58%
Calving rates	10/19 53%	-	11/19 58%

[a]Different (P<.05) from control (0 µg).
[b]Different (P<.10) from control (0 µg).
[1]Cattlemen's Day (1991), KAES Rep. Prog. 623, pp 22-24.

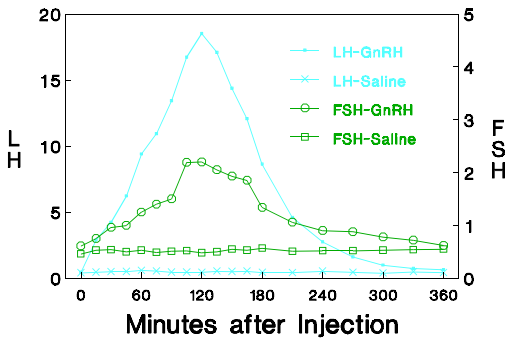

Figure 1. Concentrations of LH and FSH during 6 hr after Injection of a GnRH Agonist or Saline on Days 11 to 13 after Estrus (Day 0) and AI.

Short-term changes in serum concentrations of estradiol and progesterone were observed during 6 hr after treatment injections. Serum estradiol increased (P<.05) to a peak of 8.9 ± 1.6 pg/ml in 4.4 ± .6 hr, whereas concentrations of estradiol in serum after saline were unchanged (Figure 2).

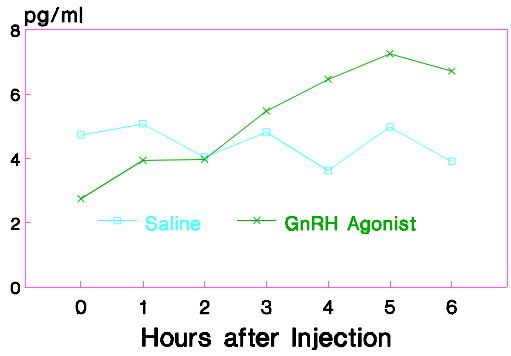

Figure 2. Concentrations of Estradiol in Serum during 6 hr after Injection of a GnRH Agonist or Saline on Days 11 to 13 after Estrus (Day 0) and AI.

Concentrations of progesterone in serum were higher (P<.05) after injection of fertirelin acetate than after saline, peaking at 11.8 ± 1.2 ng/ml at 215 ± 31 min after injection (Figure 3). This acute increase in progesterone probably resulted from stimulation of the small luteal cells in the corpus luteum by the GnRH agonist-induced LH release.

Concentrations of estradiol and progesterone in heifers that failed to conceive to the insemination 11 to 13 days before treatment are illustrated in Figure 4. Serum estradiol was lower (P<.05) in nonpregnant treated heifers than in nonpregnant control heifers from 2 to 7 days after injection. In nonpregnant control and fertirelin acetate-treated heifers, serum progesterone began to decrease 3 to 5 days after treatment (Figure 4) and concentrations of progesterone were similar among the two groups.

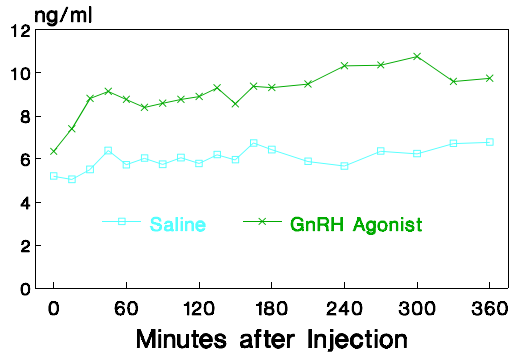

Figure 3. Concentrations of Progesterone in Serum during 6 hr after Injection of a GnRH Agonist or Saline on Days 11 to 13 after Estrus (Day 0) and AI.

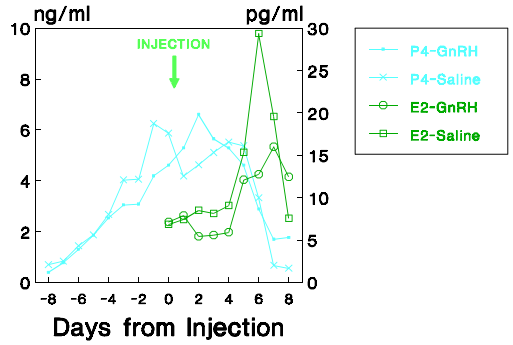

Figure 4. Average Daily Concentrations of Estradiol (E2) and Progesterone (P4) in Serum of Nonpregnant Heifers before and after Injection of a GnRH Agonist or Saline on Days 11 to 13 after Estrus (Day 0) and AI.

In pregnant heifers, concentrations of estradiol in serum were less for treated heifers (P<.05) than for control heifers during 8 of 12 days after injection (Figure 5). Pregnant heifers treated with fertirelin acetate had higher (P<.05) concentrations of progesterone in serum than pregnant controls from 4 to 12 after injection, except on day 7. The increase in progesterone in treated, pregnant heifers was likely due to LH-stimulated change of small luteal to large luteal cells, which required about 4 days to bring about the increase

in basal concentrations of progesterone after the injection of the GnRH agonist.

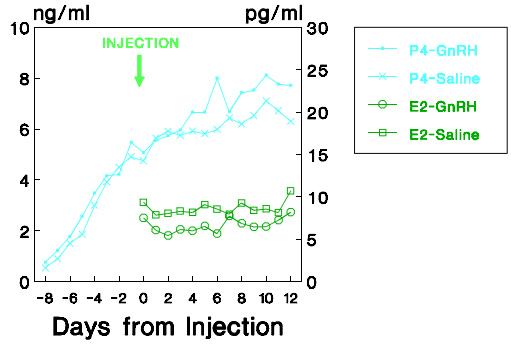

Figure 5. Average Daily Concentrations of Estradiol (E2) and Progesterone (P4) in Serum before and after an Injection of GnRH Agonist or Saline on Days 11 to 13 after Estrus (Day 0) and AI.

The findings of the present study support the proposed luteotropic effects of GnRH or one of its agonists following a midcycle injection, because progesterone secretion by the corpus luteum was increased not only shortly after administration of the GnRH agonist, but also for up to 12 days in pregnant heifers. This increase in progesterone could be viewed as further evidence for a luteoprotective effect (corpus luteum saving role) of the GnRH agonist, in addition to its attenuating effect (and antiluteolytic role or corpus luteum sparing role) on the secretion of estradiol. The luteoprotective and antiluteolytic properties of GnRH agonists might explain why increased pregnancy rates have been observed after midcycle injections in some studies. Developmentally retarded embryos might have been allowed additional time to establish the signals to initiate pregnancy in cattle.

SIRE SELECTION CHARACTERISTICS OF KANSAS HOLSTEIN HERDS

E.P. Call

Summary

The current national sire summary program (USDA-DHIA) effectively ranks dairy bulls and provides an estimate of each sire's transmitting ability for milk and milk components. Dairy producers receive sire information semiannually and have access to active AI sires through artificial insemination (AI). Sire selection practices among Kansas Holstein herds vary considerably, with higher producing herds using more proved bulls with higher predicted transmitting ability (PTA). Because milk production is under genetic control, it would seem advisable for all herds to use AI exclusively and exercise considerable selection pressure from among the proved AI sires available.

(Key Words: Sire Selection, Genetic Gain, Artificial Insemination, Dairy Cattle.)

Introduction

Genetic progress can be made only by selecting above average (superior) animals to be parents of the next generation. In the case of milk production, only 25% of the variation among animals is genetic (h^2 approximately equals .25), which increases the need for thorough evaluation procedures to accurately identify and rank superior animals. Through artificial insemination (AI) in multi-herd situations, progeny testing of sires provides a method of evaluation with a high degree of reliability. An estimate of a cow's genetic potential is less accurate because of limited numbers of records and offspring. With culling rates approaching 30%, heifers need to be saved from cows below the genetic base simply to maintain herd size. Consequently, most of the potential genetic gain (>90%) must come from service sires.

Progress or change in the genetic base (genetic gain) is illustrated with the following formula:

$$\Delta_G = \frac{i\ r\ \sigma}{g}$$

where Δ_G is the change expected; i is the intensity of selection; r is the accuracy of estimating the true genetic merit of the parents; σ is the genetic variation; and g is the generation interval. Variation and generation interval are fixed values so emphasis must be placed upon selection of superior sires with high reliability and judicious culling of cows based upon economic merit.

Procedures

Kansas Holstein herds (N=551) cooperating in the Dairy Herd Improvement program (DHIA) were analyzed as to the sires used in the past as well as current service sires. The herds were categorized by average yearly production per cow (rolling herd average). It was assumed that all herds had access to proved sires. The average percentage of producing cows sired by proved bulls in each group varied from 26% in the low group to 88% in the highest producing group, whereas proved service sires currently used among the groups ranged from 34 to 78%. Unproven sires were considered to have a genetic base (MFP$) = 0 for calculating the superiority of service sires. The method used to evaluate proved sires was the USDA-DHIA sire evaluation program (predicted transmitting ability-PTA) which considers the economic value of milk, fat, and protein (MFP$). MFP$ is the most reliable

estimate of the superiority or inferiority of a sire's future daughters when bred to breed average (genetic) cows and serves as a means of ranking bulls (selection).

Results and Discussion

Table 1 presents the genetic merit of proved sires of producing cows in herds ranked according to yearly production per cow (rolling herd average). Although only a +35MFP$ difference exists among the production groups, there is a decided trend for higher producing herds to use more proved bulls either as proved service sires or as young AI sires that are later summarized. If all unproved bulls were considered to be MFP$ = 0, then the average genetic difference between the low and high groups would be +84MFP$.

Table 1. Genetic Merit of Sires of Producing Cows in Kansas Holstein Herds Grouped by Rolling Herd Average (RHA). 1991.

Rolling herd avg (milk)	No. of herds	Proved sires' avg MFP$	Cows w/ proved sires
(lb)		($)	(%)
12,707	54	+ 84	26
15,188	107	+ 84	46
17,022	172	+100	63
19,001	148	+107	72
21,061	70	+119	88

The merit of sires of producing cows is history, because genetic pattern is established at conception. Current selection practices of these herds are best illustrated in Table 2 by evaluating the MFP$ value for current service sires. As indicated, there is a linear relationship between yearly production per cow and MFP$ of proved bulls used within each production category. Even more striking is the percentage of proved service sires, ranging from 34% for the lowest to 78% for the highest group.

Table 2. Genetic Merit of Service Sires Used in Kansas Holstein Herds Grouped by Rolling Herd Average (RHA). 1991.

Rolling herd avg (milk)	Avg sires' merit: All* (MFP$)	Avg sires' merit: Proved (MFP$)	Cows bred to proved sires
(lb)	($)	($)	(%)
12,707	+ 61	+178	34
15,188	+ 97	+195	50
17,022	+123	+197	62
19,001	+133	+196	68
21,061	+156	+203	78

*Assumes unproved bulls' MFP$=0

The genetic potential of replacement heifers provides another evaluation of sire selection methods among herds of various productivities. Table 3 illustrates a similar pattern of sire selection as seen with the producing cows' sires and current service sires. Although the MFP$ value of proved sires varies little (+144 to +170), the percent of replacements sired by proved bulls increases markedly with rolling herd average. Again, the increase in overall merit of sires is linear, with a +91MFP$ difference between the low and high groups.

The genetic superiority of AI proved sires is apparent in Table 4, which compares the first evaluation of AI Holstein proved bulls with non-AI proved counterparts. The +95MFP$ advantage represents an additional $95 of milk per year for daughters of the average AI sire. Selection within the group of proved AI Holstein bulls could easily double the worth of the average daughter.

Table 3. Genetic Merit of Sires of Replacement Heifers in Kansas Holstein Herds Grouped by Rolling Herd Average (RHA). 1991.

Rolling herd avg (milk)	Avg sires' merit: All* (MFP$)	Proved (MFP$)	Heifers w/ proved sires
(lb)	($)	($)	(%)
12,707	+ 37	+144	26
15,188	+ 62	+158	39
17,022	+ 85	+163	52
19,001	+ 98	+166	59
21,061	+128	+170	75

*Assumes unproved bulls' MFP$=0

Table 4. Superiority of the Average Holstein AI Proved Bull Compared with Average Non-AI Proved Bull (First Evaluation). 1991.

Item	Predicted transmitting ability (PTA) Milk (lb)	Fat (lb)	Protein (lb)	MFP$ ($)
AI Bulls	+1111	+42	+33	+145
Non AI	+ 371	+15	+12	+ 50
AI	+ 740	+27	+21	+ 95

References

1. USDA-DHIA Animal Model Genetic Evaluations. National Cooperative Dairy Herd Improvement Handbook (H-2). 1989.

2. Mid-Year Summary - Kansas. Midstates Data Records Processing Center. Ames, Iowa. 1991.

KANSAS FARM MANAGEMENT ASSOCIATION DAIRY ENTERPRISE MANAGEMENT ANALYSIS

F. D. DeLano and L. N. Langemeier[1]

Summary

Actual dairy records from Kansas Farm Management Association farms over the past 4 yr showed an increase of from $17,900 to as much as $46,500 per farm for a 100-cow dairy herd, in favor of herds with higher milk producing cows. As total costs per cow increased, cost per hundred weight of milk produced per cow decreased for the higher producing herds compared with lower producing herds. In 1990, for every extra $1.00 spent on feed and other variable costs, the higher producing herds earned $1.40. This is a 40% return per dollar invested.

Introduction

Detailed dairy records from farms enrolled in the Kansas Farm Management Association program are analyzed each year using the K-MAR-105 mainframe computer to provide valuable information for each participating dairy farm. This detailed information is valuable to non-members for benchmark comparisons. Total dairy herd production expenses, along with production information, are made available on a per hundred weight (cwt) of milk sold and a per cow in the milking herd basis. This complete dairy herd enterprise analysis, along with DHIA records, provides the information these dairy farmers need to evaluate correctly their dairy program.

Procedures

Dairy farms keep monthly receipt and expense records in a manual account book or on a computer accounting program. Detailed crop production records, feed records, and inventories are completed each year under the supervision of Extension Agricultural Economists (Fieldmen).

Milk production is based totally on sales and does not include home use or milk fed to calves. The feed expense includes all feed consumed by the total dairy herd including pasture, value of stock fields, etc. Values are based on average farm market price for the current production year, inventory value, or actual purchase cost.

Results and Discussion

The dairy enterprise records from 87 dairy farms were analyzed by dividing the farms into herds with milk sales below and above 17,000 lb of milk per cow for 1990. High production per cow is very important for acceptable returns to the operator for management, labor, and equity capital.

Table 1 compares these two milk production groups. In 1990, the higher producing herds sold 3,984 lb more milk per cow (over 26% greater production), resulting in $628 more gross income per cow per year. Total feed cost per cow increased by $265 and other variable costs (direct production costs) increased by $184. The herds in the higher producing group returned $179 per cow per year more than the lower producing herds. For a 100-cow herd, this higher produc-

[1]Department of Agricultural Economics.

tion means $17,900 more income for family living, debt repayment, replacement of machinery and equipment, and other capital investments.

Table 2 provides information on all herds in the Kansas Farm Management Association program for the past 4 yr. Table 3 compares the difference in milk production, gross income, variable cost, and net returns between high and low producing dairy herds for the period 1987 to 1990.

Table 1. Kansas Farm Management Association 1990 Dairy Cow Enterprise Analysis (Comparison by Milk Sold Per Cow)

Factor	Under 17,000 lb		17,000 lb and over	
Production Data				
No. farms	32		55	
No. cows/farm	76		102	
Milk sold/cow, lb	15,105		19,089	
	Per Cow	Per CWT Milk Sold	Per Cow	Per CWT Milk Sold
Production Costs and Returns				
Milk sold	$2,078	$13.76	$2,624	$13.75
Livestock sales and other	315	2.08	397	2.08
Gross income	$2,393	$15.84	$3,021	$15.83
Feed Fed	$1,130	$7.48	$1,395	$7.31
Labor	101	.67	176	.92
Vet, supplies, marketing	236	1.56	317	1.66
Repairs, fuel, utilities	195	1.29	216	1.13
Other	105	.70	112	.59
Total variable costs	$1,767	$11.70	$2,216	$11.61
Return over variable cost	$626	$4.14	$805	$4.22

Table 2. Kansas Farm Management Association Dairy Cow Enterprise Analysis (1987-1990)

	Per Dairy Cow			
Factor	1987	1988	1989	1990
Production Data				
No. farms	69	75	66	87
No. cows/farm	85	91	90	92
Milk sold/cow, lb	16,404	17,561	18,151	17,969
Production Costs and Returns				
Milk sold	$2,061	$2,121	$2,407	$2,471
Livestock and other	358	410	426	374
Gross income	$2,419	$2,531	$2,833	$2,845
Feed fed	$1,068	$1,197	$1,431	$1,321
Labor	80	87	115	154
Vet, supplies, marketing	249	258	276	293
Repairs, fuel, utilities	166	174	181	211
Other	107	109	128	111
Total variable costs	$1,670	$1,825	$2,131	$2,090
Return over variable costs	$749	$706	$702	$755

Table 3. Difference in Milk Production on Returns of High Producing Dairy Cows Compared to Low Producing Dairy Cows (1987-1990)

	High Producers Over Low Producers			
Factor	1987	1988	1989	1990
	----Per Cow----			
Milk sold, lb	+4,509	+3,864	+4,369	+3,984
Gross income	+$737	+$530	+$576	+$628
Total variable cost	+$272	+$270	+$343	+$449
Returns above variable cost	+$465	+$260	+$233	+$179
Returns/100 cow dairy	+$46,500	+$26,000	+$23,300	+$17,900
Return/$1.00 spent	$2.71	$1.96	$1.68	$1.40

STABLE FLY CONTROL AT KANSAS DAIRIES WITH PARASITIC WASPS

G. L. Greene

Summary

Fly parasites are being sold to Kansas dairies without documentation of their effectiveness. Research with parasitic wasps has shown that certain parasite species naturally attack stable flies in Kansas. The most efficient and predominate species is *Spalangia nigroaenea*, which was available from one commercial insectory for research tests. That species was cultured from Kansas and occurs naturally in Kansas dairies. If parasites are used to reduce stable flies, *S. nigroaenea* is the parasite to use during May-July when the stable fly populations are highest. Dairy people purchasing fly parasites should beware of poor emergence, non-adapted species, claims of one parasite for all fly species, and cost per parasite. Stable flies irritate cattle by their feeding habit. Adult flies attack cattle legs to secure blood meals necessary for them to mature and lay eggs. That feeding disturbs the cattle to the point of reducing milk production and feed conversion efficiency and results in kicking at milking. Studies on this pest are being conducted to develop efficient and economical control methods for Kansas dairies.

(Key Words: Fly Control, Parasitic Wasps.)

Relative Populations of Flies and Parasites in Dairies

Two species of flies occur in Kansas dairies, house flies and stable flies. The stable fly, by taking blood meals, causes cattle to bunch together, stamp, switch their tails, and reduce feeding time. House flies cannot bite, because they have only sponging mouth parts and feed on free-standing liquids or solids that they can dissolve with saliva. The house fly is only a nuisance, whereas the stable fly causes economic loss by reducing milk production.

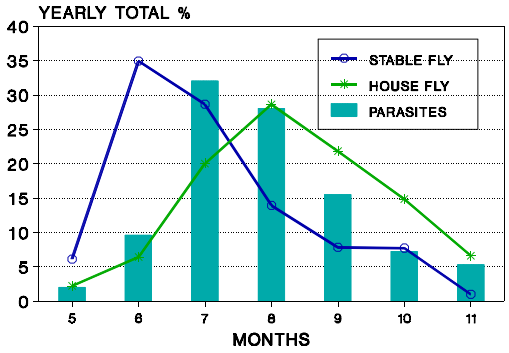

Figure 1. Relative Seasonal Populations of House Flies, Stable Flies, and Fly Parasites during 1982-89, from Four to Ten Confined Cattle Locations in Kansas.

Typical seasonal cycles of fly populations in Kansas are shown in Figure 1. Stable flies are abundant during the spring, then typically decline in number in conjunction with hot dry conditions during July. High stable fly populations may occur for 16 weeks in cool wet summers or during cool wet periods in late summer. House fly populations are low until July; reach peaks in August; then decline with dry, cool, fall conditions. They are numerous in early September and are real pests in vehicles when cool weather begins. They are attracted to the warmth in pickup cabs and are common on the sides of buildings. House flies may be only a public relations problem.

Natural populations of fly parasites in Kansas peak during July (bars, Figure 1) when the total fly numbers are highest, then decline. Winter mortality of parasites reduces the early spring populations. The delay in development of

parasite populations in May and June leaves them ineffective on stable fly populations. Spring releases of commercially reared parasites may be a good method to improve control of stable flies, which are numerous during May and June.

Natural and Commercial Fly Parasites

We have conducted several releases of commercially and laboratory-produced parasites in Kansas. In only 2 of 12 cases have we recorded fly reductions or increased parasitism of fly pupae as a result of these releases. Three things that must be improved to obtain repeated success with parasite releases are:

1. use of parasite species adapted to Kansas conditions;
2. improved rate of parasite emergence from fly puparia;
3. reduced contamination of commercial cultures by less effective species of parasites.

Parasites Adapted to Kansas Dairies

The naturally occurring fly parasites in Kansas are different species than those being sold commercially. Samples from feedlots and dairies have shown which parasites are present and the incidence at which they occur (Figure 2). Fly pupae produce an average of 38.9% live parasites, and additional fly pupae are killed by parasites that do not produce a live parasite. With that percentage killed under natural conditions, it should be possible to hold fly numbers below damaging levels, if we could double the parasite-induced mortality to 78% with parasite releases of locally adapted parasites.

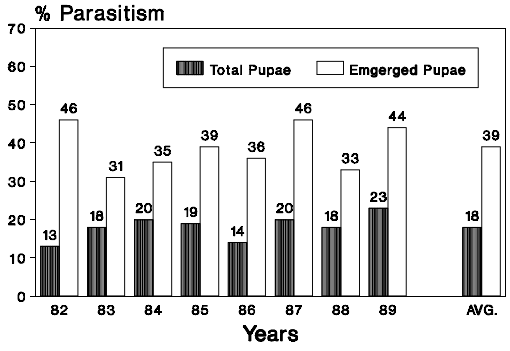

Figure 2. Fly Parasite Emergence from Fly Pupae Collected from Several Fly Environments during 1982-89.

The two main groups of pupal parasites occurring naturally in Kansas are *Spalangia* (49%) and *Muscidifurax* (51%). For the *Spalangia* genus, *S. nigroaenea* (75%) dominates the natural populations. The *S. cameroni* (25%) populations never contributed over 30% of a sample and were often absent at dairies. The *Muscidifurax* consisted of two species, *M. raptor* and *M. zaraptor*, which are difficult to distinguish. *M. raptor* was approximately 21% and *M. zaraptor* 79% of the *Muscidifurax* emerging from fly puparia.

Muscidifurax zaraptor were predominantly (92%) from house fly pupae, compared to 8% from stable fly pupae. This parasite might be the choice for house fly control. Because it is among the major commercial parasites sold (it is easy to rear), the control of house fly pupae is probably greater than the control of stable fly pupae where commercial parasites are being released. Even so, some of the highest house fly populations have been seen in dairies where *M. zaraptor* were being released. Possibly, the numbers of parasites released were too low or the release method inadequate to control house fly populations. The appropriate parasite species for stable fly control appears to be *S. nigroaenea* rather than *M. zaraptor*, which attacks few stable fly pupae.

S. endius, *M. zaraptor*, and *Nasonia vitripennis* have been sold and released in

feedlots but seldom retrieved from fly pupae. This demonstrates that these species have not established in our feedlot environment and probably are not adapted to the conditions present. Supplying a mix of parasite species is like putting water and gas on a fire, hoping one will work. You really need to know what species will control flies before spending money for parasites. Recent studies with a Kansas strain of *S. nigroaenea* releases and natural populations in Kansas dairies strongly indicate that species is adapted for stable fly reduction.

Parasite Emergence

Commercially sold fly parasites arrive at the dairy in the form of parasitized house fly pupae. Parasite emergence from pupae must occur, if releases are to effectively reduce fly numbers. Emergence has never been high, averaging 50 to 60% from the best material we have released

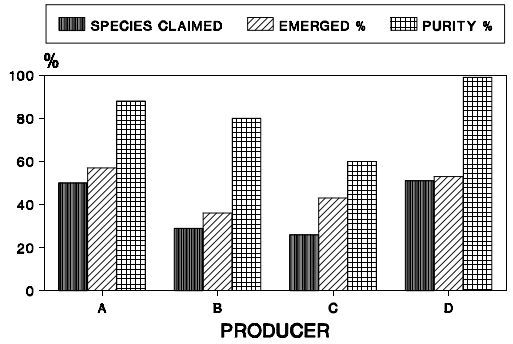

Figure 3. Purity and Emerged Percentage of Commercially Produced Fly Parasites Used for Field Releases.

(Figure 3). The best emergence for an entire season (20 to 26 weekly releases) was 57% in 1987. The poorest emergence for an entire season was 36% in lot C in 1986. Emergence ranged between 10 and 80% for weekly samples, resulting in a season average of about 55% for lot A. *S. nigroaenea* has been in commercial culture for 1 year, compared to 20 for other species. Therefore, emergence may be a problem until commercial rearing is stabilized.

For most parasite species, a live parasite will emerge from 50 to 60% of the fly pupae exposed to ovipositing females. This means that even with the best rearing conditions, the buyer will receive half as many parasites as fly pupae delivered. When you price parasites, you should make sure the quotation is for live parasites not fly pupae, which may or may not produce a live parasite. If we consider that males constitute 30 to 40% of the live parasites, it is apparent that only 35 of each 100 pupae received provide a potential fly pupal killer (live female parasite). Fortunately, that 35% will prevent numerous flies from emerging. Each female parasite will kill 15 to 50 flies and produce 15 to 45 second generation parasites.

Contamination

Only the desired species of parasites should emerge from parasitized fly pupae delivered to the dairy. Too often, less than 80% of the emerging parasites are species adapted to Kansas. For lot D (1989 release of *S. nigroaenea* produced in our laboratory), the purity was good, with only two parasites out of 585,000 being contaminants. Contaminants of commercial parasites are often *S. endius* or *Nasonia vitripennis*, neither of which reproduce in our conditions. Commercial insectaries rearing several species of parasites have difficulty rearing pure fly parasite colonies, and the parasite species are the least competitive in the commercial parasite colonies.

Commercial production of *S. nigroaene*a has resulted in pure colonies when the rearing facility has been isolated from other parasite production buildings. When purchasing *S. nigroaenea*, it might be prudent to be sure they are produced in facilities isolated from other fly parasite species.

Economics of Fly Parasites

The cost of parasites for a dairy is un- known at this time, but predictions can be made (Figure 4). Experience from parasite releases during 1991 suggests that 100+ *S. nigroaenea* per animal per week may be needed to reduce stable flies to

an acceptable level. Costs are based on $1.00/1,000 parasites, which was a common price during 1991. The average dairy size of 140 cattle was used to calculate average costs. The sanitation condition of the dairy and weeks of fly breeding greatly influence the number of parasites needed. Stable flies reduce following dry hot weather, requiring fewer weeks of parasite release. Using parasites for house fly reduction during late summer adds to the cost and would result in the 24 weeks of release. The costs shown in Figure 4 are meant only as a guide, and each dairy will have different costs, based on its individual characteristics.

The return from the parasite cost is questionable, because we do not have accurate data on the milk loss of dairy cattle caused by stable flies. Those data are badly needed, yet estimates of loss and irritation to animals and milkers are tremendous at times.

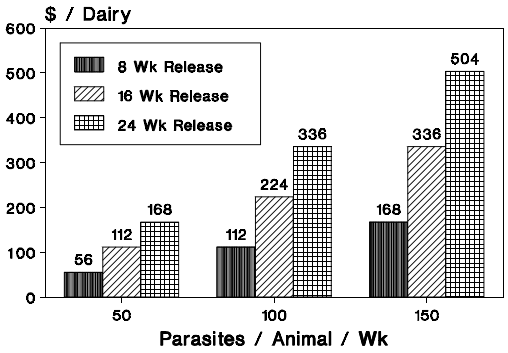

Figure 4. Cost Estimates for Fly Parasites Purchased to Control Flies at an Average Size Dairy Milking about 70 Cows.

ACKNOWLEDGMENTS

Appreciation is expressed to the following organizations for their support of dairy teaching, research, and extension at Kansas State University:

Alteca Ltd., Manhattan, KS
Associated Milk Producers, Inc., Wichita, KS
Babson Brothers, Chicago, IL
Bio-Zyme, St. Joseph, MO
Cardinal Detecto Company, Webb City, MO
Chek-Tech, St. Louis, MO
Chr. Hansens Bio Systems, Milwaukee, WI
Clay Equipment Company, Cedar Rapids, IA
DeKalb Seed Company,
Hoechst-Roussel Agri Vet, Sommerville, NJ
Hoffmann-LaRoche, Nutley, NJ
Iowa Limestone Company, Des Moines, IA
Jet-Pro Co., Atchison, KS
Kansas Agricultural Experiment Station, Manhattan, KS
Kansas Artificial Breeding Service Unit (KABSU), Manhattan, KS
Kansas Grain Sorghum Commission, Topeka, KS
Kansas DHIA, Manhattan, KS
Livestock and Meat Industry Council (LMIC), Manhattan, KS
Mid-America Dairymen, Inc., Kansas City, MO
Midwest Grain Prod., Inc., Atchison, KS
Milk Specialties, Inc., Dundee, IL
Monsanto Company, St. Louis, MO
National By-Products, Des Moines, IA
SANOFI Animal Health, Overland Park, KS
The Upjohn Company, Kalamazoo, MI

Appreciation is expressed to Eileen Schofield, Associate Editor of the Kansas Agricultural Experiment Station for editing; to Valerie Stillwell, Carol Porter, and Dianna Loomis for typing the contents of this publication; to Ed Call for the photography; and to Fred Anderson for the cover design.

The following Departments at Kansas State University are recognized for their cooperation and contribution to our dairy research program:

Agricultural Economics
Anatomy and Physiology
Laboratory Medicine
Statistics
Clinical Sciences
Entomology

Contribution No. 92-175-S, from the Kansas Agricultural Experiment Station, Kansas State University, Manhattan 66506. When brand names of products are mentioned in a Kansas State University publication, no endorsement or criticism of similar products not named is intended.

KSU KANSAS STATE UNIVERSITY

Agricultural Experiment Station, Kansas State University, Manhattan 66506-4008

Report of Progress 640 October 1991