BEEF CATTLE RESEARCH REPORT—1978

PROGRESS REPORT 234

UNIVERSITY OF KENTUCKY • COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION
DEPARTMENT OF ANIMAL SCIENCES • LEXINGTON

WELCOME!

Dear Beef Cattle Producer:

The Animal Sciences Department welcomes you to our 1978 Beef Cattle Research Day.

The oral presentations and the printed proceedings are planned to give you an overview of our basic and applied research in the area of beef cattle production. Some of the areas of research focus on immediate farm problems, and we hope will offer solutions that may be put into practice immediately. Other research results may await application in future years.

Our intent is to have a research program geared to improving the efficiency and profitability of beef cattle production. Conferences such as today's allow our researchers to interact with producers, sort out researchable problem areas and seek to strengthen our total program. We encourage you to express your views on the topics covered today and also on other areas of specific interest.

The state of Kentucky has the potential of markedly increasing the total beef production, beef production per acre or numbers of finished beef cattle. Experiences of the past emphasize the need for keeping growth in numbers and dollar returns to the producer in proper perspective. Those individuals staying abreast of current research information are in a better position to capitalize on the opportunities.

Sincerely yours,

Virgil W. Hays

Virgil W. Hays, Chairman
Department of Animal Sciences

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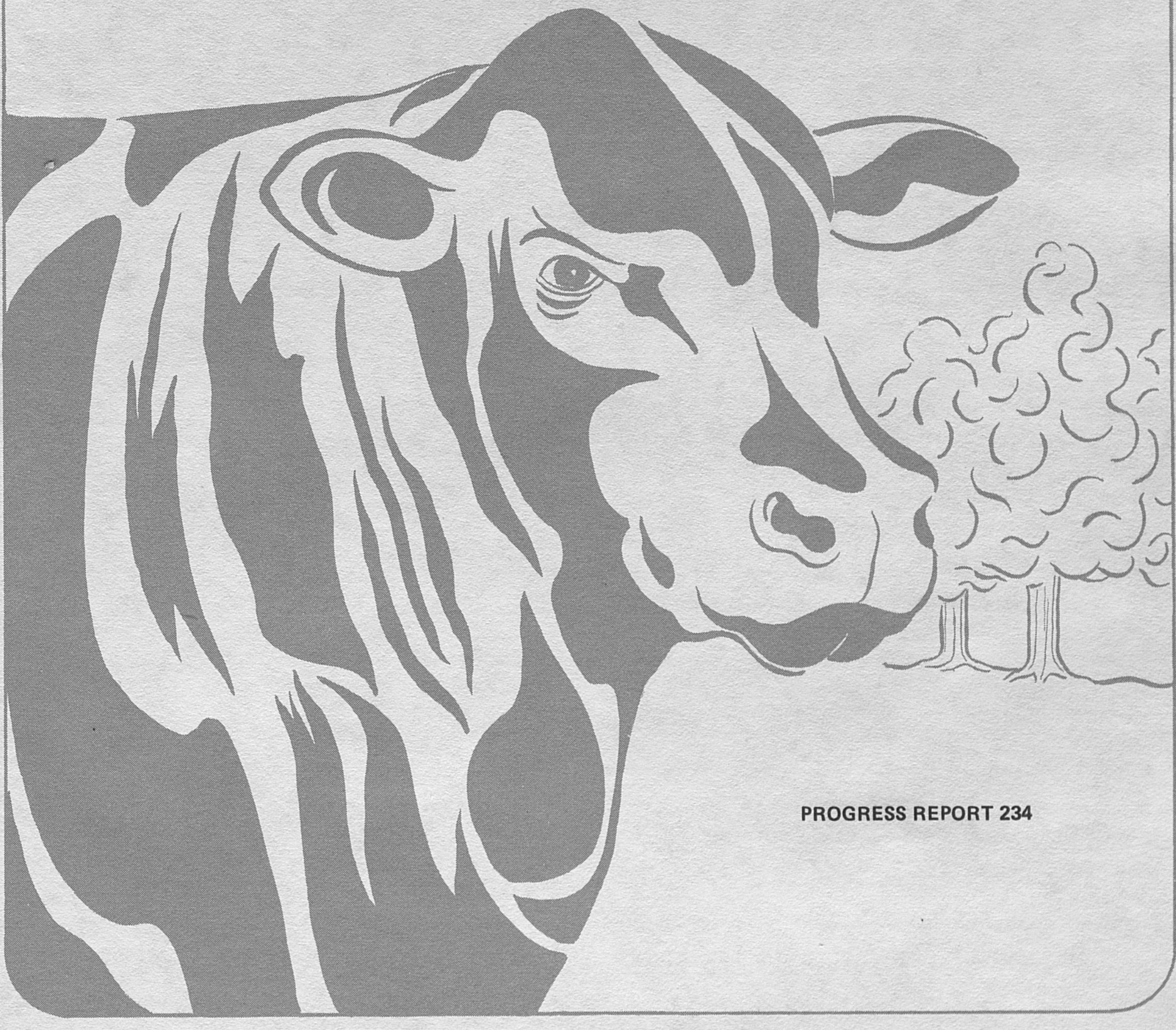

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BEEF CATTLE RESEARCH CONFERENCE

October 6, 1978

Seay Auditorium - University of Kentucky

9:00	Registration
9:30	Welcome—Charles E. Barnhart, Dean and Director, College of Agriculture
9:40	Beef Cattle Program at U.K.—V. W. Hays, Chairman, Department of Animal Sciences
10:00	Starch Utilization by Cattle—G. E. Mitchell, Professor, Department of Animal Sciences
10:30	Kind of Pasture and Creep Feeding for Beef Cows and Calves—C. W. Absher, Extension Professor, Department of Animal Sciences
11:00	Break
11:15	Models for Amino Acid Bypass—G. T. Schelling, Associate Professor, Department of Animal Sciences
11:45	Nutritional Factors Influencing Gain and Efficiency of Growing Calves—J. A. Boling, Professor, Department of Animal Sciences
12:15	Lunch - Courtesy of Elanco Products Company
1:30	Rumensin for Growing Cattle—N. W. Bradley, Professor, Department of Animal Sciences
2:00	Stability of Additives—R. C. Tucker, Associate Professor, Department of Animal Sciences
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3:15	Beef Research Needs—W. H. Hale, Professor, Department of Animal Sciences, University of Arizona, Tucson

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LEVELS AND EFFICACY OF MONENSIN FOR ANGUS COWS MAINTAINED ON SUPPLEMENTAL FEED IN DRYLOT

L. C. Pendlum, N.W. Bradley and J. A. Boling

One hundred and twenty purebred Angus cows averaging 4.5 years of age and 1,202 lb in weight were utilized to evaluate the efficacy of monensin on reproducing beef cows during the supplemental winter feeding period. Treatment groups consisted of: (1) control groups of cows offered corn silage as a source of winter feed, (2) cows fed corn silage (95% of control) and supplemented with 50 mg monensin per head daily, (3) cows fed corn silage (90% of control) and supplemented with 200 mg monensin daily, and (4) cows fed silage (90% of control) and supplemented with 300 mg monensin daily. Corn silage fed during the experiment analyzed 38.0% dry-matter and 7.9% crude protein on a dry-matter basis. Each treatment was replicated twice with 15 cows per replicate. The supplemental feeding period (147 days) for all groups of cows was conducted in drylots. Following this phase of the study cows were grazed on pasture (169 days) until the calves were weaned at approximately 205 days of age.

Dry matter intake and weight change of cows fed monensin is presented in Table 1. Average daily gain during the first 89 days of the supplemental feeding period was 0.20, 0.34, 0.29 and 0.13 lb for the control and the 50-, 200- and 300-mg monensin groups, respectively. This time period coincided with initiation of the study and continued until parturition. Average daily weight change during the entire supplemental period (147 days) for the control and the 50-, 200- and 300-mg monensin groups was -0.88, -0.83, -0.74 and -1.01 lb, respectively. It should be noted that the combined weight changes of the 200- and 300-mg monensin groups was almost identical to control groups (0 monensin) of cows. More importantly, a 9.3% decrease in dry-matter requirement was achieved during the supplemental feeding phase of the experiment owing to feeding 200 or 300 mg of monensin daily. Very little response relative to feed savings was observed when 50 mg of monensin per day was fed.

Table 1.–Weight Change and Dry Matter (DM) Intake of Cows Supplemented with Monensin.

	Monensin/Head Daily, Mg			
	0	50	200	300
Number of cows	28	30	30	30
ADG during first 89 days of supplemental period, lb	0.20	0.34	0.29	0.13
ADG during entire supplemental period (147 days), lb	-0.88	-0.83	-0.74	-1.01
Avg daily DM intake during supplemental period, lb	14.0	13.9	12.7	12.7
DM intake expressed as a percentage of control	100.0	99.3	90.7	90.7

Body weight changes during the pasture (169 days) and the combined supplemental and pasture phases (316 days) are presented in Table 2. During the pasture phase, cows fed 0, 50, 200 or 300 mg monensin per head daily had gains of 0.24, 0.25,

Table 2.–Body Weight Change of Cows During Supplemental, Pasture and Supplemental + Pasture Phases of Study.

	Monensin/Head Daily, Mg			
	0	50	200	300
ADG, lb				
Supplemental phase (Dec. 2 - Apr. 28)	-0.88	-0.83	-0.74	-1.01
Pasture phase (Apr. 28 - Oct. 14)	0.24	0.25	0.15	0.30
Combined phase (Dec. 2 - Oct. 14)	-0.28	-0.26	-0.27	-0.32

0.15 and 0.30 lb daily, respectively. As was observed during the supplemental phase of the study, the combined mean weight changes for cows offered either 200 or 300 mg monensin daily during the supplemental feeding period was very similar to that of control groups of cows offered no monensin during this period. Average daily weight changes across monensin levels during the combined supplemental and pasture phases were also very similar. This substantiates that a savings of feed owing to feeding 200 or 300 mg monensin during the supplemental winter feeding period can be achieved without affecting weight changes of cows that are subsequently grazed on pasture.

MONENSIN BLOCKS AS A SUPPLEMENT FOR GRAZING HEIFERS

L. C. Pendlum, N. W. Bradley and J. A. Boling

Experiments in which monensin has been hand-fed to growing cattle on pasture indicates that rate of gain can be substantially improved owing to this additive. Hand-feeding is highly unpractical under these conditions; therefore, an alternate method of supplementing grazing cattle would be desirable. One possibility for refining this problem is the introduction of monensin through compressed blocks. To investigate this technique an experiment was conducted to evaluate the effect of compressed monensin blocks when fed to growing heifers on pasture.

Sixty-six Angus heifers averaging 531.2 lb were randomly assigned to 6 groups of 11 heifers each for a total of 90 days. One-half of the heifers were fed a control supplement consisting of a compressed block of carrier materials. The remaining groups were offered this same carrier material with monensin included in the block. All heifers were also fed 6.0 lb of cracked corn per head daily. Hay was fed *ad libitum* when adequate pasture was unavailable. The 6 pastures utilized consisted of Ky 31 fescue or Ky bluegrass with heifers being rotated weekly so that all groups of heifers would have equal access to all pastures.

Performance of the heifers is presented in Table 1. The average daily gain observed for heifers fed the control supplement block was 2.08 lb *vs* 2.28 lb for heifers fed a similar supplemental block which had monensin incorporated. Although pasture intake was not measured, the increased gain by the monensin-fed heifers was attained on a similar amount of supplemental feed. Based on the increased weight gain alone, however, feeding monensin as a compressed block seems to be a potentially effective method of introducing this additive to pasture-fed cattle.

Table 1.—Average Daily Gain and Supplemental Feed Intake of Grazing Heifers Fed Monensin Blocks.

	Treatment	
	Control	Monensin
No. heifers	32	33
Initial wt, lb	533.4	529.0
Final wt, lb	733.7	720.9
Feed intake, lb/head/day (air dry)	6.92	6.91
Cracked shelled corn, lb	6.00	6.00
Hay, lb	0.60	0.58
Supplement (monensin block), lb	0.32	0.33*
Average daily gain, lb	2.08	2.28

*Provided 100 mg monensin per head per day.

PERFORMANCE OF GROWING STEERS FED CORN SILAGE SUPPLEMENTED WITH SOYBEAN MEAL OR UREA WITH OR WITHOUT MONENSIN

L. C. Pendlum, J. A. Boling and N. W. Bradley

Numerous studies indicate that monensin is of extreme economic importance relative to feed savings in the growing-finishing beef industry. With the advent of increased human competition for feed grains, increased utilization of diets such as corn silage that contain a high percentage of roughage is evident. Corn silage is relatively high in energy; however, supplemental nitrogen must be provided to achieve maximal gain in feedlot cattle. Thus, the objective of this study was to evaluate soybean meal (SBM) and urea as supplemental nitrogen sources when fed with or without monensin as related to growth, feed intake and efficiency.

Ninety-six Angus x Hereford crossbred steers averaging 266 kg in weight were randomly assigned to 12 groups of 8 each in this study. The four diets were: (A) SBM plus no monensin, (B) SBM plus 200 mg monensin, (C) urea plus no monensin and (D) urea plus 200 mg monensin per head daily. Corn silage averaging 35.4% dry-matter and 7.85% crude protein on a dry-matter basis was fed to all groups of steers *ad libitum*. Ground shelled corn was utilized as a carrier for supplemental nitrogen and monensin in the four experimental supplements. The supplements averaged 94% dry-matter and 30% crude protein equivalent (N x 6.25) on a dry-matter basis. These were topdressed on the silage at a rate of 1.14 kg daily, divided into equal am and pm feedings. This provided 200 mg of monensin daily for steers fed supplements B and D. The steers were fed their respective diets for 106 days.

Performance of the steers during the study is presented in Table 1. Average daily gains of steers fed soybean meal was 0.99 *vs* 0.92 kg for steers fed the urea supplemented diets. Feed-to-gain ratios were slightly lower in the steers fed soybean meal when compared with those fed urea as a nitrogen supplement. Steers fed 200 mg monensin daily gained slightly faster and had a lower feed intake and a substantially improved feed-to-gain ratio when compared with steers not receiving monensin.

Table 1.–Average Daily Gain, Feed Intake and Efficiency of Steers During 106-Day Trial.

Main Effects	Nitrogen Source		Level/Monensin/day, Mg	
	SBM	Urea	0	200
No. steers	48	48	48	48
Initial wt, kg	297	293	292	299
ADG, kg	0.99	0.92	0.93	0.98
Total FI, kg*	6.41	6.34	6.64**	6.10
F/G*	6.48	6.89	7.15**	6.23

*Calculated on dry-matter basis.
**Main effect means differ significantly (P ⟨.05).

INFLUENCE OF FESCUE VARIETIES ON GRAZING STEERS DURING DIFFERENT SEASONS

S. Oshidari, N. Gay, J. A. Boling and W. Muir*

Fescue is one of the most important grass species in the U.S. because of its ability to grow under a wide-range of soil types and climatic conditions. Since the 1940's, fescue has been one of the most widely used grasses for forage, turf and conservation practices. It is especially prevalent in the southern United States. Tall fescue is the major forage grass of Kentucky, accounting for 2.4 million ha (5,928,000 acres) in pure or mixed stands. Fescue varies widely in quality depending on such factors as maturity of the plant, season of the year, moisture, and soil fertility. Results of research with cattle have been variable and frequently in conflict. The purpose of this study was to observe the response of growing steers grazing different varieties of fescue.

EXPERIMENTAL PROCEDURES

Four experimental varieties (selections) of fescue (Ky-31, Kenhy, G1-306 and G1-307) were randomly assigned to eight 1.6 ha (3.95 acres) pastures. Sixty-four crossbred yearling steers averaging 295 kg (649 lb) were randomly allotted to these eight pastures on March 1, 1977. Varieties G1-306 and G1-307 were fescue x ryegrass hybrids selected for perloline content, palatability, and other factors. Observations on average daily gain of steers and characteristics of the fescue were analyzed by season: spring (Apr. 1 to June 14), summer (July 7 to Aug. 1), and fall (Sept. 26 to Nov. 23). The spring season is the period when fescue growth and quality is considered to be at its optimum. The summer period is when quality, as measured by animal performance, is expected to be poorest. The fall period is characterized by a quality higher than summer but less than spring in improving animal performance.

*University of Azarabadegan, Tabriz-Iran.

MANAGEMENT OF PASTURES

All pastures were second year stands of pure fescue. Nitrogen was applied at the rate of 45 kg/ha (40.06 lb/acre) on March 23, and 45 kg/ha (40.06 lb/acre) on June 14, and 68 kg/ha (60.5 lb/acre)on August 15. (No P, K or lime in 1977.) An attempt was made to keep the forage at its optimum quality by rotational grazing and clipping. The stocking rate during the spring period was 5 steers/ha (2.01/acre). On June 14 all cattle were removed from the pastures owing to drought. On July 8 cattle were returned at the rate of 2.5 steers/ha (1.0/acre) and continued to August 11, at which time it was necessary to again remove them. Cattle were returned to the pastures on September 26 and remained until Nov. 23. Stocking rate was 2.5 steers/ha (1.0/acre) during the latter period.

MANAGEMENT OF CATTLE

Cattle weights were taken full and after an overnight shrink without feed or water at the beginning of this study. All cattle were implanted with DES and given routine vaccines. Periodic weights and ADG calculations were based on full weight. Blood samples were taken for PUN during the fall period. Cattle were maintained on a fescue lot with limited grazing available and self-fed fescue hay during the time they were removed from the pastures. Shade, water and plain salt were provided at all times. The data were analyzed using a split-plot type design with varieties as whole-plot units and seasons as the split-plot units. The analysis was based on the means over all steers within a pasture for each month within a variety.

RESULTS AND DISCUSSION

During the spring period, average daily gains were significantly higher on Ky-31 than on G1-307. Kenhy and G1-306 were intermediate to those two varieties (Table 1). During the summer period G1-307 was significantly lower than the other varieties. During the fall period, Kenhy and G1-306 were superior to Ky-31. Overall, ADG were 0.73 (1.6 lb), 0.64 (1.4 lb), 0.69 (1.5 lb) and 0.54 (1.2 lb) kg for Kenhy, Ky-31, G1-306 and G1-307, respectively. Total beef production for all seasons was 440 (392 lb/acre), 424 (377 lb/acre), 427 (380 lb/acre) and 354 kg/ha (315 lb/acre) for Ky-31, Kenhy, G1-306 and G1-307, respectively.

Table 1.–Average Daily Gains of Steers kg (lb).*

	Ky-31	Kenhy	G1-306	G1-307	Mean
Spring	0.87^{b} (1.9)	$0.77^{a,b}$ (1.7)	$0.79^{a,b}$ (1.7)	0.74^{a} (1.6)	0.79^{b} (1.7)
Summer	0.43^{b} (0.9)	0.58^{b} (1.3)	0.58^{b} (1.3)	0.20^{a} (0.44)	0.44^{a} (0.9)
Fall	0.49^{b} (1.1)	0.82^{b} (1.8)	$0.67^{a,b}$ (1.5)	0.56^{a} (1.2)	0.75^{a} (1.7)
Mean	0.64^{a} (1.4)	0.73^{a} (1.6)	0.69^{a} (1.5)	0.54^{a} (1.2)	

*Means with different superscripts are significantly different (P⟨.01).

Plasma urea nitrogen levels were 13.8, 13.5, 15.6 and 13.1 mg/ml for Kenhy, Ky-31, G1-306 and G1-307, respectively (Table 2). The values for G1-306 were significantly greater than for the other variables.

Table 2.–Plasma Urea Nitrogen (mg/100 ml).*

G1-306	15.55^{b}
Kenhy	13.85^{a}
Ky-31	13.51^{a}
G1-307	13.13^{a}

*Means with different superscripts are significantly different (P ⟨.01).

Forage samples were taken periodically and each time cattle were removed or returned to pastures. Results of analysis of these data are shown in Tables 3, 4 and 5. Although not subjected to statistical analyses, the % NPN were 31.3, 26.3 and 23.7 for spring, summer and fall periods. These do not appear to be related to animal performance.

Table 3.–Crude Protein %*.

	Ky-31	Kenhy	G1-306	G1-307	Season $\bar{x}$
Spring	11.9^{a}	12.6^{a}	12.3^{a}	12.0^{a}	12.2^{a}
Summer	$14.9^{a,b}$	18.2^{c}	16.0^{b}	14.3^{a}	15.9^{b}
Fall	13.5^{a}	14.7^{a}	14.4^{a}	14.9^{a}	14.4^{c}
Variety $\bar{x}$	13.4^{a}	15.2^{b}	14.2^{a}	13.7^{a}	

*Means with different superscripts are significantly different (P⟨.01).

Table 4.–Acid Detergent Fiber %*.

	Ky-31	Kenhy	G1-306	G1-307	Season $\bar{x}$
Spring	35.9^{a}	35.9^{a}	35.4^{a}	35.9^{a}	35.8^{a}
Summer	34.7^{a}	33.3^{a}	39.6^{b}	36.3^{a}	36.0^{a}
Fall	34.7^{a}	34.3^{a}	35.4^{a}	34.4^{a}	34.7^{a}
Variety $\bar{x}$	35.1^{a}	34.5^{a}	36.8^{a}	35.5^{a}	

*Means with different superscripts are significantly different (P⟨.01).

Table 5.–Neutral Detergent Fiber %*.

	Ky-31	Kenhy	G1-306	G1-307	Season $\bar{x}$
Spring	66.3^{a}	66.1^{a}	60.6^{b}	60.9^{b}	63.5^{a}
Summer	68.9^{a}	65.5^{a}	66.3^{a}	67.1^{a}	66.9^{b}
Fall	65.7^{a}	67.2^{a}	67.2^{a}	66.0^{a}	66.5^{b}
Variety $\bar{x}$	67.0^{a}	66.3^{a}	64.7^{a}	64.7^{a}	

*Means with different superscripts are significantly different (P⟨.01).

INFLUENCE OF LACTOBACILLUS SP. FERMENTATION PRODUCT ON FEED INTAKE AND PERFORMANCE OF FINISHING STEERS

J. A. Boling, N. W. Bradley and N. Gay

The rate at which cattle begin to consume feed after entering the feedlot is of great concern to the cattle feeder. Many cattle entering the feedlot have been without feed or water for a considerable period of time, and are further stressed from the conditions of shipping and marketing. The following study was conducted to evaluate the influence of a non-viable fermentation product of *Lactobacillus sp.* (Culbac®) on feed intake and performance of finishing steers.

On the day prior to the initiation of the trial, the steers were weighed full at 9:00 a.m. and removed from feed and water. They remained in the corral area until 4:00 p.m. and were then driven on foot 1.1 mile to stand overnight without feed or water at a different holding area. On the following morning at 8:00 a.m. the steers were driven back to the initial corral, weighed shrunk and the trial initiated.

Ninety-six steers averaging 723.4 lb shrunk weight were randomly allotted to 12 pens of 8 steers each. The pens of cattle were then randomly assigned to four treatment groups, which contained three replicate pens of eight steers each per treatment. The four dietary treatments were: (A)—control diet which consisted of 20.0% cottonseed hulls, 69.0% cracked yellow corn, 9.7% soybean meal (44% crude protein), 0.7% ground limestone, 0.1% dicalcium phosphate, 0.5% trace mineral salt and vitamin A; (B)—control diets plus 1 pint of non-viable fermentation product of *Lactobacillus sp.* per ton of feed; (C)—2 pints per ton; and (D)—4 pints per ton. Feed intake was measured daily for the first 14 days and on a weekly basis for the remaining 84 days of the trial. Steers were fed 14 lb feed per head on day 1, 16 lb per head on day 2 and then offered feed *ad libitum* on day 3 and throughout the remainder of the trial.

Feed intake and performance data are presented in Table 1.

Average daily feed intake was increased for the first 14 days of the trial by all groups of cattle fed the additive. For days 15-28, increased intake was observed in steers in treatment groups C and D.

Table 1.—Feed Intake and Performance of Steers fed *Lactobacillus sp.* Fermentation Product.

	Treatment			
Item	A	B	C	D
Number of steers	24	24	24	23
Feed intake/steer, lb/day				
Days 1-14	16.4	17.0	18.3	17.2
Days 15-28	24.9	24.7	25.5	26.6
Days 29-56	28.8	28.1	29.4	29.1
Days 57-84	28.9	29.0	28.9	28.9
Days 1-84	26.1	26.0	26.7	26.6
Avg daily gain, lb	3.22	3.24	3.29	3.11
Feed/gain ratio	8.11	8.02	8.12	8.55

Feed intake was essentially the same for all treatment groups of cattle during the last 28-day period (days 57-84). When the average daily feed intake for the total trial is summarized (days 1-84), a trend toward increased feed intake was observed in steers in treatment groups C and D. However, it should be noted that most of the increased intake response was observed early in the feeding period. Overall average daily gain and feed efficiency was not improved by the feeding of the non-viable fermentation product of *Lactobacillus sp.* at 1, 2 and 4 pints per ton of the diet utilized in this study. The additive did aid in getting cattle on a higher level of feed intake earlier.

Further studies are needed with this product utilizing different types of diets, smaller cattle and stress conditions more closely resembling those normally encountered. The potential benefits of this or other similar products for young cattle in reducing morbidity and mortality following stress need investigation.

EFFECT OF SOME MANAGEMENT FACTORS ON COW HERD PRODUCTIVITY

N. Gay, S. Oshidari, J. A. Boling, N. W. Bradley and W. Muir*

One of the major concerns of cow-calf enterprise managers is rate of production. Both profit and genetic progress are largely determined by rate of reproduction. Since this trait is influenced to a great extent by environment or management factors such as plane of nutrition, it seems desirable to study them more critically. Wiltbank and others have shown that plane of nutrition influences both rate and time of conception among beef cows. Some questions remain as to the most effective time to adjust level of energy intake and the specific effects on different aged females. The study reported here was designed to determine, under practical conditions, the influence of energy supplementation on rate of reproduction.

MATERIALS AND METHODS

The experiment was a randomized complete block design with Hereford and Angus females reciprocally mated to Hereford and Angus sires (Table 1). Observations were made on 294 exposures during 3 years. Variables were energy level for the cow herd during calving and pre-breeding and creep feed for the calves. The study was conducted at the West Ky. Substation, during 1975, 1976 and 1977.

Table 1.—Design of Cow-Calf Management Study.

Cow Breed	Energy Level		Sire Breed	
			Angus	Hereford
Angus	Normal	Creep	6	6
		No Creep	6	6
	Supplementary	Creep	6	6
		No Creep	6	6
Hereford	Normal	Creep	6	6
		No Creep	6	6
	Supplementary	Creep	6	6
		No Creep	6	6

*University of Azarabadegan, Tabriz-Iran.

General management practices were: (1) calving in March and April; (2) breeding 63 days from May 20; and (3) weaning in November. The herd is maintained outside, year-round and rotationally grazed on fescue-clover pastures. Harvested hay is fed during snow cover or when winter grazing is inadequate. In mid-February the cow herd is divided each year on the basis of breed, age and weight into two groups. Treatment groups and feeding regime are shown in Table 2. Two weeks prior to calving, one group receives supplemental energy in the form of whole plant corn silage 6.8 kg/hd/day. Both groups receive 9 kg/hd/day of fescue clover hay. Normally, hay feeding starts January 1 and utilizes large round bales in circular racks. All cows have access to standing grass in limited quantity. No effort was made to measure growth or disappearance of the available forage. As the cows calve, the pairs were separated and fed hay (clover-fescue) *ad libitum*. The energy-supplemented group continues to receive corn silage in addition to *ad libitum* clover-grass hay. Both groups refuse hay in preference to growing forage by April 15. Owing to the facility's arrangement for feeding corn silage, early forage supply has favored the normal-fed group. The energy supplemented group continues to consume its allowance

Table 2.—Treatment Groups Pre-calving*.

Diet	Normal Energy	Supplementary Energy
Short pasture	*Ad lib.*	*Ad lib.*
Grass hay, kg DM	6.8	6.8
Corn silage, kg DM		3.2
Salt, mineral, vitamin mixture	*Ad lib.*	*Ad lib.*

*Post-calving, cow-calf pairs were separated and fed clover grass hay free choice.

of corn silage until the breeding season begins (May 20).

Energy groups are combined and assigned to two, multiple sire breeding groups on the basis of age, breed and previous treatment. Exposure to the bulls is 9 weeks. Bulls are rested and rotated within sire groups. Heifers are exposed at 14 to 16 months of age and kept with the cow herd following breeding. Their first assignment to energy groups is the last trimester of pregnancy. Cows and calves are weighed at 28-day intervals except during the calving season. Cows are examined for pregnancy by rectal palpation approximately 60 days post-breeding. Advanced stages of cancer eye, physical unsoundness, poor calf performance and failure to breed have been used as culling criteria. All open cows are culled.

Cow and calf management involving immunization and worming are consistent with current recommendations. All calves are weighed, identified and males castrated at birth. Creep feeding begins at the end of the breeding season (approximately July 23). Creep feed consists of a pelleted mixture combined 1:3 with shelled corn and fed to appetite. Calf weights are taken at 210 days when they are immunized and wormed and returned to their dams for 3 weeks. Following actual weaning (Nov. 15) all cows are managed as a group until mid February.

RESULTS AND DISCUSSION

Analysis by covariance based on individual performance showed that a positive weight gain during the breeding season was significantly associated ($P < .01$) with increased pregnancy rate within the normal energy group. Weight gains were not significantly related to pregnancy rate in the energy-supplemented group (Table 3). Overall, adding supplemental energy significantly ($P < .01$) increased pregnancy rate (0.90 vs 0.70%) (Table 4). Conception rate by cow age is presented in Table 5, which shows age and conception rate to be highly related in the normal management group.

Influence of supplemental energy on subsequent calving date is shown in Table 6. Dates are Julian. A 6-day earlier calving date was observed subsequent to providing additional energy. No breed x energy interaction was noted.

Table 3.–Pregnancy Rate by Weight Gains During the Breeding Season by Energy Level.

	Energy Level	
Weight Gains (kg)	Normal	Supplemented
-45.4	58	86
-45.4 to -22.7	67	100
-22.6 to 0	71	94
0 to 22.7	75	84
22.7 to 45.4	75	92
Mean $\pm$ SE	74 $\pm$ 3.4	90 $\pm$ 3.4

Table 4.–Pregnancy Rate (%) by Cow Breed and Energy Level.

	Energy Level	
Cow Breed	Normal	Supplemented
Angus	64.8	86.3
Hereford	83.3	93.2
Mean $\pm$ SE	75.7 $\pm$ 3.7	89.7 $\pm$ 3.7

Table 5.–Pregnancy Rate by Age and Energy Level (Percent).

	Energy Level	
Cow Age (Months)	Normal	Supplemented
<40	61	86
40-60	69	94
60-80	81	90
80-100	82	100
100-120	92	91
>120	74	78
Mean $\pm$ SE	74 $\pm$ 3.4	90 $\pm$ 3.4

Birth weights adjusted for sex and age of dam are presented in Table 7. No differences due to treatment of the dam were noted. Weight gains of calves during creep feeding, seen in Table 8, were positively influenced as expected. Breed x creep treatment interactions were present.

Table 6.–Influence of Cow Breed and Energy Level on Subsequent Birthdate of Calves.

Cow Breed	Energy Level Normal	 Supplemented	Mean
Angus	75.2	69.6	72.0±1.5
Hereford	82.1	75.3	78.2±1.4
Mean	78.7±1.6	72.6±1.4	

Table 7.–Birth Weights (kg) of Calves by Dam Breed and Energy Level*.

Dam Breed	Energy Level Normal	 Supplemented	Mean
Angus	30.4	29.9	30.0
Hereford	31.4	30.8	31.1
Mean	30.9	30.4	

*Adjusted for sex and age of dam.

Table 8.–Weight Gain (kg) of Calves During Creep Feeding by Cow Breed.

Calf energy	Dam Breed Hereford	 Angus	 Mean
Creep	66.0	67.7	67.0±1.1
No creep	54.3	60.1	57.0±1.2
Mean	59.9 ± 1.2	64.4 ± 1.1	

SUMMARY

1. Supplemental energy during the calving season and pre-breeding significantly improved conception rate and reduced average calving date.

2. Weight gains during the breeding season were related to conception rate only in the normal managed group.

3. The expected lower conception rates for first and second calvers was not observed in the energy supplemented group.

4. By culling and limiting the breeding season, 83% of the calf crop was born in the first 30 days of the calving season.

SOME ALTERNATIVE CATTLE FINISHING SYSTEMS FOR KENTUCKY

N. Gay, N. W. Bradley, C. A. Absher and J. T. Johns

Finishing cattle has been a relatively small enterprise in Kentucky in recent years. USDA estimates give the number of cattle on feed as being 50,000 head on Jan. 1, 1978 as compared with a total cattle population of 3,120,000 and a beef cow herd of 1,253,000 head. Some potential advantages for cattle feeding in Kentucky are: (1) the state is near beef consumption centers; (2) abundant forage and grain are available and (3) feeder cattle are readily available at favorable prices, especially during heavy runs. On the disadvantage side are: (1) relatively high risk; (2) climate factors can reduce gains and efficiency and (3) lack of understanding of feeding technology and business aspects of the enterprise.

The research reported here in detail is the result of one year's observations. Similar comparisons may vary from year to year in their outcome. These comparisons show that several possibilities exist for growing-finishing programs. Flexibility and limited capital investment are features of these systems. Cattle can be marketed at any time or not be fed at all, and the amount of investment does not cause large depreciation or interest costs to be a problem.

EXPERIMENTAL PROCEDURES

Yearling steers and heifers that had previously been on wintering studies were used in these comparisons. Cattle were assigned initially to two groups based on breed, weight, sex and previous treatment. They were predominately Angus or Angus x Hereford and weighed approximately 550 lb initially. Cattle in drylot were fed in fenceline bunks with a concrete apron and had access to a barn for shade. Grass and grain and forage-only groups were pastured together from April 1 to July 6 on excellent quality ladino-fescue. They were then divided into two groups, one being self-fed on a bluegrass pasture and the other remaining on the legume-grass pasture. Cattle from the drylot were all slaughtered after 181 days on feed. After 112 days (Oct. 26) on a self-feed of whole-shelled corn, 13 head of the grain-on-grass group were slaughtered. The remainder were slaughtered after 155 days (Dec. 8) and the results averaged with the first group. Cattle in the "forage only" group were continued on pasture to Nov. 9 at which time 12 head were slaughtered. The remaining 16 head were put on full feed for 92 days and then slaughtered.

RESULTS AND DISCUSSION

A summary of the results is given in Table 1. The drylot group contained 38 steers and 12 heifers. Heifers gained 0.6 lb/day less than steers

Table 1.–Finishing Systems Summary, 1977.

	Drylot	Grass and Grain	Forage Only	Forage and Limited time Grain
No. head	50	29	28	16
No. days	181	234	223	92
Avg Init. Wt	550	548	553	844
Avg Final Wt	939	967	811	1034
ADG	2.15	1.79	1.16	2.07
Avg Daily Ration				
Grain	6.1	15.5	-	1.40
Corn silage	19.0	-	-	5.3
Supplement	0.9	-	-	1.8
Pasture days	-	234	223	253
Carcass Wt	544	574	474	620
Grade*	10.9	11.1	10.5	10.00
Cost Estimates				
Animals	209.44	205.60	213.29	215.67
Feed	93.61	117.83	-	70.56
Pasture	-	35.43	30.41	40.18
Total	$303.05	358.86	243.70	326.51
Sales	$329.00	367.00	281.00	414.00
Actual Return	26.00	8.00	37.00	88.00
Overfeed & Past. Adj. for price changes	43.00	8.00	54.00	56.00

*Ch° = 13, Gd° = 10.

which accounts partially for the relatively low gains. Since only one-third of the drylot cattle graded choice at slaughter, it might be concluded that: (1) they were not fed long enough; (2) the ration did not contain enough grain, or (3) the cattle were too light initially. Performance of the grain-on-grass group was also disappointing. Apparently high temperature and humidity were involved in the poor performance since previous results have been more favorable. Again, it would seem that cattle should have been heavier initially since only 45% graded choice. Results of a previous study shown in Table 2 indicate that heavier cattle treated similarly graded one-third of a grade higher. It is expected that cattle weighing 650 lb, in medium flesh, when pastured from April 1 to July 1 and then self-fed 35-40 bu of corn, will reach the choice grade. Of interest is the fact that the "forage only" group slaughtered after 223 days on pasture graded 25% choice, 67% good and 8% standard. After 90 days on full feed, the remainder of this group graded 19% choice, 56% good and

Table 2.—Performance of Yearling Steers Grain-on Grass.

	1976	1977
Avg Beginning Wt. lb	644	550
Avg Ending Wt. lb	1,085	967
ADG, by period, lb		
Grass only	1.66	1.43
Self-feeding, corn	2.52	2.00
Total period	2.12	1.70
Corn fed (bu)/hd	37	38
Carcass		
Grade*	12.1	11.1

$*Ch^{\circ} = 13$, $Gd^{\circ} = 10$.

25% standard. Numbers were limited so the results suggest that further studies in this area are needed.

Under the conditions prevailing during 1977, the forage only or forage and limited grain groups were most profitable.

RESPONSE OF NEW FEEDER CALVES TO PASTEURELLA CHALLENGE, CYCLOSERINE TREATMENT AND ENERGY SUPPLEMENTATION

*R. F. Stroud, G. E. Mitchell, Jr., N. W. Bradley, R. E. Tucker and G. T. Schelling**

Bovine respiratory disease or shipping fever complex is a major problem usually associated with the transfer of feeder cattle to the feedlot. In its common form, it seems to be caused by a combination of the stresses of weaning, shipping and adaptation to new diets and surroundings with exposure to viral and bacterial infection. Efforts to minimize shipping fever losses have included management to minimize stress and exposure, vaccinations and treatment after the appearance of symptoms. The experiment reported here was designed to study the effects of adding supplemental energy to the feedlot ration on the development of shipping fever symptoms, and to evaluate the effectiveness of injected Cycloserine as a treatment in calves developing symptoms. *Pasteurella* challenge was used in an attempt to increase the incidence of shipping fever.

PROCEDURE

One hundred twenty steer calves, averaging 169 kg (371 lb) were weaned, loaded on trucks and immediately hauled about 200 miles to the University of Kentucky Coldstream Farm. Shortly after arrival each calf was individually identified, weighed, wormed, vaccinated for IBR, BVD, PI_3, Clostridia, blackleg and leptospirosis and injected with one million I.U. of vitamin A. Calves were assigned to 12 pens of 10 calves each. Alternate pens were designated to receive corn. One-half of the calves in each pen were designated to be challenged with *Pasteurella multocida.* Calves were randomly assigned to these treatment groups from outcome groups determined by weight.

All calves received corn silage *ad libitum* and 0.45 kg (1.0 lb) of 44% soybean meal per head per day. Calves in six pens also received 0.45 kg (1.0 lb) of ground shelled corn per head per day on days 1-3, 0.95 kg (2.0 lb) on days 3-5 and 1.36 kg (3.0 lb) per day to the end of the trial. Five calves in each lot were challenged with *Pasteurella multocida* by direct nasal introduction of 5 ml of culture in each nostril.

Rectal temperatures were taken daily during the first 14 days of the experiment and at 12-hr intervals during diagnosed sickness and or treatment. Calves with temperatures of 104°F or above were diagnosed "sick." Alternate "sick" calves within dietary and *Pasteurella* exposure treatments were assigned to receive Cycloserine or to remain untreated. If temperatures did not remain elevated for at least 24 hr, the sick diagnosis was considered false and treatment data for that animal eliminated from the results.

Sick animals assigned to the Cycloserine group were immediately given intramuscular injections containing 880 mg of Cycloserine per 100 kg (400 mg per 100 lb) of live weight. Injections were repeated at 12-hr intervals until a total of six injections had been given.

Blood samples were drawn from each calf as it was processed into the feedlot (before vaccinations), at the time it was declared sick, and 72 hr after it was declared sick. Samples were analyzed for IBR, BVD and PI_3 and glucose. Nasal swabs taken as each animal was declared "sick" and 72 hr later were tested for *Pasteurella multocida.*

Each calf was weighed individually on days 0, 7, 14, 28, 42 and 56. Total and average daily gains

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were determined for each period and for the total 56-day experiment for each treatment group.

Data were analyzed by conventional analysis of variance procedures.

RESULTS AND DISCUSSION

Seventeen of the 60 calves challenged with *Pasteurella multocida* had temperatures above 104°F. This compares with 15 of 60 unchallenged calves. However, at the time the calves were declared sick, 17 of 17 challenged calves and 0 of 15 unchallenged calves had nasal swabs positive for *Pasteurella multocida* and no other pathogenic organism was detected by general microbial evaluation. When treatment was terminated, incidence of *Pasteurella* in swabs was similar (6 of 13 challenged calves and 5 of 13 unchallenged calves). At the end of treatment, incidence of *Pasteurella* in challenged calves which had received Cycloserine was 5 of 9. Three of four untreated calves remained positive for *Pasteurella.*

Temperature data for calves declared "sick" are summarized in Table 1. All animals recovered regardless of treatment and it is apparent that changes in temperature were not appreciably altered by treatment. However, one calf in the untreated group later required antibiotic treatment to avoid an apparently imminent fatality.

Table 1.–Temperature Data for Sick Calves, (°F).

	Cycloserine	Untreated
Challenged with *Pasteurella*		
Number of steers	11	6
Avg beginning temperature*	104.6	104.9
Avg ending temperature**	102.8	102.8
Avg temperature reduction	1.8	2.1
Not challenged		
Number of steers	10	5
Avg beginning temperature*	104.3	104.3
Avg ending temperature**	102.5	102.5
Avg temperature reduction	1.8	1.8
All sick steers		
Number of steers	21	11
Avg beginning temperature*	104.5	104.6
Avg ending temperature**	102.7	102.7
Avg temperature reduction	1.8	1.9

*When diagnosed as sick and given first treatment.

**Taken 12 hr after sixth treatment (72 hr after diagnosis and first treatment).

Table 2 summarizes the gain data for the first 7 days. This is the period when the greatest stress was apparently present. Most calves were losing weight at this time. There was a strong indication that challenge with *Pasteurella multocida* enhanced weight loss and the effect approached statistical significance ($P < .10$ but $> .05$). There were also suggestions in the data that Cycloserine treatment and grain feeding reduced weight losses, but variation was such that the differences were not significant. For gain effects to have practical value it would be necessary for established differences to be maintained. As shown in the summary of gain to 56 days on experiment (Table 3), the data remained quite variable and the trends were either reversed or differences maintained at nonsignificant levels.

The blood glucose data summarized in Table 4 show higher than expected levels at the start of the experiment, dramatic reduction to normal ranges at the time the animals were diagnosed sick, and little evidence of change during the recovery period. The observed variations do not appear related to the treatments being studied.

Seventeen of the calves (10 treated, 7 untreated) eventually diagnosed as sick were positive for IBR at the time of arrival. Seven (4 treated, 3 untreated) were positive for IBR when declared sick and 4 (3 treated, 1 untreated) were still positive for IBR when declared well. Cases of IBR appeared randomly distributed. No other viral involvements were detected.

Despite an apparently effective challenge with *Pasteurella multocida* and the challenge of severe changes in weather, the bovine respiratory disease which was encountered in this experiment was too mild to permit a clear-cut evaluation of the effectiveness of Cycloserine. Thirty-eight percent of the calves had at least 2 consecutive days of temperatures above 104°F and all treated animals recovered within 3 days, but only 1 of the 11 untreated cases failed to recover without treatment.

Table 2.—Gain of Sick Calves (0-7 days).

	Cycloserine		No Cycloserine	
	Pasteurella	No Pasteurella	Pasteurella	No Pasteurella
Grain				
Number of steers	6	5	2	3
Avg daily gain, kg	-1.06	-0.31	-0.59	-0.43
(lb)	(-2.33)	(-0.69)	(-1.29)	(-0.95)
No Grain				
Number of steers	4	5	4	2
Avg daily gain, kg	-0.29	-0.34	-1.46	-0.71
(lb)	(-0.64)	(-0.74)	(-3.21)	(-1.57)

Avg of 20 Cycloserine-treated -0.54 kg (-1.18 lb) of 11 untreated -0.65 kg (-1.43 lb)

Avg of 16 Pasteurella-challenged -0.73 kg (-1.60 lb) of 15 unchallenged -0.23 kg (-0.50 lb)

Avg of 16 grain-fed -0.49 kg (-1.07 lb) of 15 non-grain -0.67 kg (-1.48 lb)

Table 3.—Gain of Sick Calves (0-56 days).

	Cycloserine		No Cycloserine	
	Pasteurella	No Pasteurella	Pasteurella	No Pasteurella
Grain				
Number of steers	6	5	2	3
Avg daily gain, kg	0.45	0.55	0.57	0.64
(lb)	(1.00)	(1.22)	(1.27)	(1.42)
No Grain				
Number of steers	4	5	4	2
Avg daily gain, kg	0.49	0.58	0.52	0.49
(lb)	(1.07)	(1.28)	(1.14)	(1.08)

Avg of 20 Cycloserine-treated 0.52 kg (1.14 lb) of 11 untreated 0.56 kg (1.23 lb)

Avg of 16 Pasteurella-challenged (1.09 lb) of 15 unchallenged (1.26 lb)

Avg of 16 grain-fed 0.50 kg (1.18 lb) of 15 non-grain 0.53 kg (1.16 lb)

Table 4.—Blood Glucose of Sick Calves (mg per 100 ml).

Cycloserine Response	Cycloserine	Untreated
Number of steers	18	4
Avg first day	95	86
Avg when diagnosed sick	55	50
Avg 72 hr later	56	52
Pasteurella Multocida Challenge	Challenged	Untreated
Number of steers	13	11
Avg first day	88	90
Avg when diagnosed sick	55	53
Avg 72 hr later	55	54
Grain Feeding	Grain	No Grain
Number of steers	10	14
Avg first day	92	94
Avg when diagnosed sick	55	54
Avg 72 hr later	58	52

BOVINE RESPIRATORY DISEASE IN PRE-CONDITIONED CATTLE

D. R. Lovell, G. E. Mitchell, Jr., N. W. Bradley, R. E. Tucker and G. T. Schelling

Over a period of years pre-conditioning programs combined with careful management have been reasonably successful in preventing outbreaks of bovine respiratory disease in calves raised and fed on Coldstream Farm. However, breaks do occur, especially when the calves are subject to extreme variations in weather. Two such breaks have provided an opportunity to compare an experimental treatment, injectable Cycloserine, with other treatments.

PROCEDURES

Trial 1—Twenty-three purebred Angus steer calves were vaccinated with a *Clostridium chauvoei, novyi* and *septicum* combination, a combination of *Pasteurella multocida, Pasteurella hemolytica,* IBR and PI_3 and were treated for grubs with poured-on Ruelene on Oct. 1, 1977. They were vaccinated again with *Pasteurella multocida* and *Pasteurella hemolytica* and wormed with injectable Tramisol on Oct. 14. The calves were weaned on Oct. 28 and self-fed a 40% roughage starter feed with high levels of Terramycin and Neomycin for 7 days then gradually changed to a feed containing 59% cracked shelled corn, 20% cottonseed hulls, 10% soybean meal, 5% alfalfa meal with extra vitamin A, 5% molasses, 0.5% salt and 0.5% bone meal.

After one steer from this group died on Dec. 4, temperatures were found to average over 104°F. Nine steers were randomly assigned to receive a series of six Cycloserine treatments (400 mg, per hundred pounds by intramuscular injection), and the remaining 13 steers were assigned to receive a combination of Azium, Tylan and Sulfabrome.

Trial 2—Twenty-six purebred Angus bull calves were vaccinated with *Clostridium chauvoei, novyi* and *septicum* on Oct. 1, castrated on Oct. 14 and weaned on Oct. 28. After weaning they were started on a self-fed high roughage diet and gradually changed to one containing 59% cracked shelled corn, 20% cottonseed hulls, 10% soybean meal, 5% alfalfa meal and vitamin A, 5% molasses, 0.5% salt and 0.5% bone meal. One calf was observed to be feverish (106.5°F) on Nov. 20 and received Sulfabrome and Terramycin for 3 days. Temperature returned to normal but the animal was found dead on December 9. The remaining 25 calves were checked and all found to have elevated temperatures. Eight of the calves were randomly assigned to receive 6 Cycloserine injections (400 mg per 100 lb body weight) at 12-hr intervals. Twelve remaining steers were treated with Combiotic and 5 were treated with both Penicillin and Azium.

Temperature data collected during these trials are reported here.

RESULTS

Trial 1—Average initial temperatures and temperatures 72 hr after the first treatment are recorded in Table 1. Average temperature declines for the period were 1.7°F for Cycloserine-treated steers and 1.5°F for steers receiving the combination. The difference in response was not significant. Both Cycloserine and the combination treatment

Table 1.—Temperature Data for Steers - Trial 1.

	Cycloserine	Tylan, Sulfabrome and Azium
Number of steers	9	13
Avg beginning temperature* °F	104.6	104.2
Avg ending temperature** °F	102.9	102.7
Avg temperature reduction, ± standard error °F	1.7 ± .37	1.5 ± .26

*When diagnosed as sick and given first treatment.

**Taken 12 hr after sixth treatment (72 hr after diagnosis and first treatment).

appeared effective in bringing temperatures under control.

Trial 2—As shown in Table 2, average initial temperatures were 104.9°F and higher for all three treatment groups with the temperatures for the calves to be treated with Cycloserine averaging almost a degree higher than calves assigned to the other treatments. Since post-treatment temperatures of calves on different treatments were similar, the reduction in temperature of calves treated with Cycloserine was greater. This difference in favor of Cycloserine treatment was significant ($P < .05$) when compared with the Penicillin-Azium treatment and highly significant when compared with Combiotic alone. The physiological significance of the differences is debatable because all calves recovered (all three treatments were effective using survival as the criterion). Nevertheless, these data indicate that Cycloserine was at least as effective as the other treatments tested.

Table 2.—Temperature Data for Bulls - Trial 2.

	Cycloserine	Penicillin plus Azium	Combiotic
Number of calves	8	5	12
Avg beginning temperature* °F	106.0	104.9	105.1
Avg ending temperature** °F	103.0	102.7	103.0
Avg temperature reduction, ± standard error °F	3.0 ± .28***	2.2 ± .64	2.1 ± .42

*When diagnosed as sick and given first treatment.

**Taken 12 hr after sixth treatment (72 hr after diagnosis and first treatment).

***Temperature reduction due to Cycloserine significantly greater than that due to Penicillin-Azium ($P < .05$) or due to Combiotic ($P < .01$).

SUMMARY

In treating two outbreaks of bovine respiratory disease, Cycloserine injections produced similar temperature reducing results to presently approved treatments. Cycloserine has not been approved for treating bovine respiratory disease, but these results suggest its usefulness if it is made available in the future.

MODIFICATION OF RUMINAL AMINO ACID DEGRADATION BY ANTIMICROBIAL AGENTS

T. O. Lindsey, G. T. Schelling, H. R. Spires, G. E. Mitchell, Jr., and R. E. Tucker

Many of the digestive processes which occur in the rumen such as cellulose degradation and urea utilization give cattle and sheep a distinct advantage over monogastrics in certain production situations. However, under intense feeding programs the modification of dietary nutrients by rumen microbes is often inefficient and undesirable. The modification of high quality dietary protein by the rumen microbial population is of particular concern. Amino acids introduced into the rumen as free amino acids or preformed dietary protein are rapidly degraded and are used by the rumen microorganisms as energy sources. Consequently, a large portion of the amino acids available to the host animal are those from microbial proteins synthesized by the rumen microbes from ammonia and carbon chains. The positive response of ruminants to post-ruminal infusion of amino acids and chemically mediated ruminal by-pass of protein indicates the inadequate quality of microbial protein and the desirability of increasing the amount of dietary protein and/or amino acids reaching the lower digestive tract of the ruminant.

One method of increasing the availability of dietary amino acids to the host animal is to limit the degradation of amino acids by the microorganisms in the rumen with chemical inhibitors. If this approach is successful, amino acids from dietary protein could perhaps be more efficiently utilized and the feeding of free amino acids to improve the balance of amino acids available to the animal would also be feasible. A series of studies was developed to evaluate the effect of several antimicrobial agents on amino acid degradation by rumen microbes. The initial experiment was conducted to screen a large number of antimicrobial agents for their effectiveness in preventing amino acid degradation in the rumen environment. The screening was conducted in the laboratory using rumen fluid from a donor animal. Starch, urea, 8 amino acids and graded levels of the antimicrobial agents were added to the *in vitro* systems. The disappearance of amino acids and the production of volatile fatty acids and ammonia were measured. The desired response for an effective antimicrobial agent would be a decreased disappearance of amino acids with decreased ammonia production and no detrimental effect on volatile fatty acid production.

Of the 11 compounds tested, several showed promising properties as total amino acid degradation inhibitors. Monensin was the most effective agent. When added to the *in vitro* system at 50 and 100 ppm, it depressed amino acid degradation to 25.8 and 16.9% of the control, respectively. Acetate and ammonia production were essentially unchanged while propionate production increased to 150% of the control. Bacitracin, chlortetracycline and erythromycin each reduced amino acid degradation to about 50% of the control and they also depressed volatile fatty acid production from 55 to 90% of the control and elevated ammonia production. 4-4′ dimethyl diphenyl iodonium chloride inhibited amino acid degradation, but it also severely depressed volatile fatty acid production. Streptomycin, zinc bacitracin, neomycin, capreomycin, penicillin G and D-cycloserine were only slightly effective or showed no effect on inhibiting amino acid degradation.

From the results of this screening procedure two antimicrobial agents, monensin and chlortetracycline, have been selected for further testing. Cattle feeding studies are presently being conducted to determine if the inhibition of amino acid degradation observed with these compounds in the laboratory can be demonstrated in the animal under feedlot conditions.

PLASMA AMINO ACID CONCENTRATIONS IN GERM-FREE AND CONVENTIONAL RUMINANTS

G. T. Schelling, G. Bruckner, G. E. Mitchell,Jr., and R. E. Tucker

Bacteria and protozoa have a major influence on the protein nutrition of cattle and sheep. In order to define this influence more precisely, facilities have been developed to maintain lambs and calves under sterile conditions which prevent the development of bacteria and protozoa in the digestive tract. The term "germ-free" is used here to refer to animals raised under these conditions. As a first step in evaluating possible differences in protein metabolism by germ-free and conventional ruminants, plasma amino acids have been determined when both groups were fed a milk diet which would not depend on microbial action for its utilization. Lambs were used in the first trial because they are cheaper and easier to maintain in the germ-free state than calves. An attempt will be made to verify important differences in calves.

Animals were obtained by sterile surgical procedures and maintained in microbial-free flexible film isolators (germ-free), or in the laboratory environment (conventional). The lambs in the isolators were protected from any contact with external microorganisms. The lambs in the laboratory environment established microbial populations in the digestive tract. The lambs were maintained for 60 days on milk diets, at which time jugular blood samples were taken at 0, 1.5, 3.0 and 4.5 hr following a 150-ml feeding of milk. The 0-time concentrations (μM per ml) of the essential amino acids for the gnotobiotic and conventional lambs, respectively, were: Thr, 0.61, 0.07; Met, 0.1, 0.03; Phe, 0.14, 0.05; Iso, 0.05, 0.06; Leu, 0.14, 0.11; Val. 0.18, 0.17; Lys, 0.06, 0.10; His, 0.06, 0.07; Arg, 0.03, 0.08. The concentrations of the non-essential amino acids for the gnotobiotic and conventional lambs were: Gly, 5.05, 0.51; Ser, 0.35, 0.07; Ala, 0.40, 0.17; Cit, 0.17, 0.09; Asn, 0.03, 0.02; Glu, 0.05, 0.08; Gln, 0.16, 0.27; Cys, 0.03, 0.05; Tyr, 0.06, 0.06; Orn, 0.07, 0.05. The total plasma amino acid and total essential amino acid concentrations for the gnotobiotic lambs were (μM per ml): 0 hr, 7.71, 1.37; 1.5 hr, 8.73, 1.63; 3.0 hr, 8.84, 1.56 and 4.5 hr, 9.45, 1.98. Those for the conventional lambs were: 0 hr, 2.09, 0.75; 1.5 hr, 1.77, 0.58; 3.0 hr, 1.78, 0.55; 4.5 hr, 1.73, 0.56.

The data supporting the following conclusions: (1) gnotobiotic and conventional lambs fed milk diets exhibit different plasma amino acid patterns, (2) gnotobiotic lambs have a plasma amino acid pattern which is not the same as milk-fed nonruminants, and (3) the plasma amino acid concentration response to feeding in gnotobiotic lambs is different from the response in conventional lambs. More studies of this type should improve our understanding of the influence of the microflora on the nutritional status of ruminant animals. It will be especially interesting to determine whether calves show differences similar to those observed in these lambs.

GROWTH AND EFFICIENCY OF STEERS FED OIL-COATED LYSINE

J. A. Boling, J. M. Evans and N. W. Bradley

Ruminal by-pass of high quality proteins has received much research emphasis recently. We have shown that lipid-coating of proteins reduces ruminal deamination and increases nitrogen retention in lambs. Oil-coating of a single amino acid and its influence on performance in cattle fed a diet in which all of the supplemental nitrogen is supplied by nonprotein nitrogen has not been demonstrated. In abomasal infusion studies with steers, we have demonstrated that the urea-supplemented diet (A) shown in Table 1 is deficient in lysine. The following study was designed to determine the influence of oil coating lysine on growth, efficiency and blood urea-nitrogen concentrations of steers.

Fifteen Angus steer calves averaging 204.6 kg shrunk weight were randomly allotted to three treatment groups. The steers were fed the experimental diets (Table 1) as follows: A- control diet in which all of the supplemental nitrogen was supplied as urea, B- the same diet supplemented with coconut oil treated lysine to provide 2.64 g lysine/kg diet, and C- the control diet supplemented with coconut oil treated lysine to provide 5.28 g lysine/kg diet. Steers were fed *ad libitum* in individual pens during the 63-day trial.

Table 1.–Composition of Diets Fed to Steers.

	Diet		
Ingredient, %	A	B	C
Cracked corn	65.30	64.30	63.30
Urea 281 (45% N)	1.20	1.20	1.20
Cottonseed hulls	30.00	30.00	30.00
Molasses	2.00	2.00	2.00
Ground limestone	0.80	0.80	0.80
Trace mineral salt	0.54	0.54	0.54
Sulfur	0.16	0.16	0.16
Lysine mix	-	1.00	2.00

Average daily gain, feed efficiency and plasma urea - N values are presented in Table 2. Feed intake by steers fed diet B was 8.98 kg/day and resulted in a daily intake of 23.7 g lysine. Steers fed diet C had an average intake of 8.42 kg/day which resulted in a daily intake of 44.5 g lysine. Feed efficiency was improved in steers fed both diets containing coconut oil treated lysine. However, efficiency was not improved by feeding the higher level of lysine (diet C) when compared with the lower level of lysine (diet B). In previous abomasal infusion studies, infusing more than 24 g lysine to steers fed the control diet used in this experiment did not result in a further improvement in nitrogen retention.

Table 2.–Growth, Efficiency and Blood Urea-Nitrogen in Calves Fed Oil-Treated Lysine.

	Diet		
	A	B	C
Number of steers	5	5	5
Initial wt, kg	205.0	204.9	203.7
Avg daily gain, kg	1.11	1.11	1.04
Feed/day, kg	9.42	8.98	8.42
Feed/gain ratio	8.52	8.13	8.18
Plasma Urea-N, mg/100 ml*	6.16	5.84	8.36

*Average of blood samples taken on days 42 and 62.

Plasma urea-N was slightly reduced in steers fed diet B when compared with those fed diet A. However, this could possibly be due to the small reduction in feed intake of steers fed diet B when compared with the control steers (diet A). The increase in plasma urea-N in group C suggests that the steers were not utilizing the lysine consumed in excess of that consumed by steers fed diet B for protein synthesis, thus resulting in deamination and subsequent urea synthesis. These data suggest that feeding an oil-coated single amino acid known to be deficient at the tissue level results in improved efficiency in steers. Further studies are needed with different types of lipids and diets designed to enhance nitrogen utilization by the ruminant.

PANCREATIC AMYLASE SECRETION BY GROWING STEERS

R. W. Van Hellen, G. E. Mitchell, Jr., G. T. Schelling and R. E. Tucker

Cattle consuming mainly pasture and other roughage do not need to digest much starch. When grain is introduced into the diet, starch digestion becomes more important. Bacteria and protozoa in the rumen are able to ferment starch rapidly and were once thought to digest it almost completely. However, research results at Kentucky and other stations have shown that much of the starch in corn and milo passes through the rumen undigested. Efficient digestion of this starch depends on action by the enzyme amylase, which is secreted by the pancreas. Since amylase secretion is normally limited in cattle, increased amylase secretion is part of the adaptation they must make when fed high levels of grain. The experiments reported here are part of a continuing effort to determine how the amount of amylase secreted by the pancrease of cattle is controlled. If this effort is successful, it should aid in developing safer methods of introducing grain into ruminant diets as well as promoting more efficient grain utilization.

Previous Kentucky research with sheep has shown an increase in amylase activity as the amount of starch in the diets increased. Few experiments have been conducted with cattle. In one study, the pancreas from cattle on pasture and cattle on high-grain diets were removed at slaughter to determine the amylase content and to relate it to the amount of starch in the diets. There was more amylase in pancreas from the grain-fed steers, suggesting that they had adapted to the increased starch in their diets.

PROCEDURES

The present study involved 140-180 kg (308-396 lb) growing steers with re-entrant cannulas surgically placed into the pancreatic duct. This allowed collection of the enzyme secretions while 20% or 80% grain (ground corn) diets were fed. Flow of pancreatic enzymes into the small intestine was normal when collections were not being made.

During the pancreatic juice collections, jugular catheters were used to collect blood. This was done at hourly intervals beginning 2 hours before the morning feeding and continuing through the evening feeding. Plasma insulin and plasma glucose concentrations were determined and related to the amylase enzyme data to determine if the steers were adapting to the grain level in their diets.

RESULTS AND DISCUSSION

Table 1 summarizes results of 16 within-steer comparisons between 20% and 80% grain diets. Plasma glucose was approximately 6% higher when the steers received the 80% grain diets. Specific amylase enzyme activity was increased approximately 35% when steers received the 80% grain diets compared with when they received the 20% grain diets. The secretion rate from the pancreas increased approximately 26% on the 80% grain diets. When these facts are all combined (that is, the increased amylase enzyme activity and the increased flow rate in response to the 80% ration), there was a 2.5 fold increase in total amylase output in response to the 80% grain ration.

Table 1.–Amylase Secretion and Blood Gluclose and Insulin in Steers*.

	20% Conc.	80% Conc.	
Glucose (mg %)	79.6	84.6	NS
Amylase (mg Starch dig./mg protein	3.31	5.47	P ⟨.05
Sec. Rate (3cc Time^{-1})	1.28	1.75	P ⟨.05
Total Amylase (Amylase/Sec. Rate)	6.76	16.17	P ⟨.05
Insulin (μ units/ml)	12.44	8.14	P ⟨.05

*Means of 16 within animal comparisons.

Plasma insulin levels (Table 1) were significantly lower when the steers received the 80% grain diets. In light of the increased plasma gluclose levels, the decreased insulin levels may indicate an inability of the young growing steers (receiving 2.5 kg starch/day) to secrete sufficient insulin to control glucose levels.

Overall, these results suggest that cattle fed high-grain diets have the ability to adapt to the increased starch, bypassing the rumen into the small intestine by increased amylase enzyme activity and increased flow rate from the pancreas.

Studying the relationships of plasma glucose and plasma insulin with amylase enzyme secretion from the pancreas suggests a high association between glucose and amylase with the 20% grain diet, and a high association between insulin and amylase with the 80% grain diet. Further research is needed to determine the significance of these associations.

BLOOD SERUM CALCIUM AND MAGNESIUM CHANGES IN STEERS INTRAVENOUSLY AND INTRAMUSCULARLY INJECTED WITH VITAMIN D_3

J. A. Boling and J. M. Evans

The potential role of vitamin D as related to the metabolism of magnesium has not been studied thoroughly in the ruminant. This experiment was conducted to determine the influence of intramuscular and intravenous administration of vitamin D on serum calcium and magnesium concentration with time post-injection.

Twelve Angus steer calves averaging 354 kg in weight were randomly allotted to the following three treatment groups: C- control group; IV- each steer was intravenously injected by jugular puncture with 2 million IU of vitamin D_3 (cholecalciferol); and IM- each steer was intramuscularly injected with the same quantity of vitamin D_3 as steers in the IV group. Each steer was individually fed 6.36 kg per day of the diet shown in Table 1. The steers were initially bled on day 0 prior to injection and subsequently on days 1, 2, 3, 7, 11, 15, 19, 25, 32, 41, 46, 53 and 60 post-injection.

Table 1.–Composition of Diet Fed to Steers.

Ingredient*	Percent
Cottonseed hulls	20.0
Cracked yellow corn	69.0
Soybean meal (44% CP)	9.7
Ground limestone	0.7
Dicalcium phosphate	0.1
Trace mineral salt	0.5

*Chemical analysis - 89.3% dry matter, 10.6% crude protein, 0.32% calcium, 0.23% phosphorus and 0.10% magnesium.

Intravenous injection of vitamin D_3 resulted in a significant ($P < .05$) increase in serum calcium concentration on days 2 and 3 of the study. Intramuscular injection did not result in the peak response in blood calcium that was observed from IV injection. However, overall blood calcium values were evaluated from both methods of vitamin D administration. Serum calcium values across all sampling times for the three treatment groups were: C - 9.30, IV - 9.46 and IM - 9.46 mg/100 ml.

Serum magnesium concentrations were significantly ($P < .05$) depressed on days 1, 2 and 3 by IV vitamin D administration. The lowest serum magnesium value in the IM was not observed until day 11. Overall serum magnesium values for the three groups were as follows: C - 2.55, IV - 2.35 and IM - 2.48 mg/100 ml.

Serum calcium-to-magnesium ratios were significantly ($P < .05$) changed at specific times for both the IV and IM groups of steers when compared with the control group of steers. Overall calcium-to-magnesium ratios were: C - 3.67, IV - 4.11 and IM - 3.87 and were significantly ($P < .05$) different from each other. The mechanism(s) by which vitamin D exerts its influence on magnesium metabolism in the ruminant remains to be determined.

MODIFICATION OF RUMINANT METABOLIC FECAL NITROGEN BY DIETARY FIBER LEVELS

G. T. Schelling, E. D. Cooper, G. E. Mitchell, Jr., and R. E. Tucker

Metabolic fecal nitrogen (MFN) is that fraction of nitrogen in the feces which does not result from undigested dietary nitrogen. It results from secretions by the body and represents nitrogen which must be replaced by dietary nitrogen. Reliable MFN measurements are of interest because they can be used (along with several other measurements) for the determination of maintenance protein requirements. The factorial method for determining maintenance protein requirements was introduced many years ago, and is the sum of (a) MFN, (b) endogenous urinary nitrogen, and (c) nitrogen losses from the body surface. The British Agricultural Research Council has used the method for more than a decade and the National Research Council has adopted the method for the current revision of their publication, Nutrient Requirements for Beef Cattle. While the factorial method is becoming more widely used, there is still the problem of limited data on MFN values for various dietary conditions.

Another point of interest pertaining to MFN is the nearly five-fold difference between ruminant and nonruminant species. The factors causing the large increase in ruminant MFN have not been elucidated. There have been indications that the higher fiber content of typical ruminant diets is a major contributing factor, although other factors such as residual microbial nitrogen and the more complex anatomy of the digestive tract could also be involved. It was the purpose of this work to specifically study the effect of fiber level on MFN.

The effect of dietary fiber level on MFN from sheep was studied by feeding purified diets containing either 3 or 50% finely ground purified cellulose. Yearling wethers weighing about 50 kg were fed diets containing graded levels of nitrogen (N) in order to determine MFN by extrapolation to zero N intake. Cellulose and starch were the major energy sources and urea was the sole N source. Fecal N excretions for the 3% cellulose diets with 0.33, 0.67 and 1.00% N were 0.346, 0.345 and 0.340 g N/100 g dry matter intake. The comparable values for the 50% cellulose diets were 0.418, 0.497, and 0.439. Extrapolation of these data indicated that the MFN values were 0.344 and 0.430 g N/100 g dry matter intake for the 3 and 50% cellulose diets. These values are significantly different ($P < .01$). These data indicate that while nonabrasive fiber level does affect MFN, the deletion of fiber from the diet of ruminants does not result in a MFN value as low as the typically reported value of 0.10 for nonruminants.

EFFECT OF AGE ON PLASMA NITROGEN CONSTITUENTS IN EWES FED TWO LEVELS OF PROTEIN

J. M. Evans and J. A. Boling

Few data are available on the fundamental aspects of aging in the mature ruminant. Cattle and sheep are very similar in many aspects of digestion and metabolism. Therefore, sheep were utilized as a model for the measurements taken in the following studies. The objectives were to determine plasma free amino acid, urea and ammonia nitrogen concentrations in young (1-year-old) and old (8-year-old) ewes fed a diet containing 10% protein in trial 1 and 20% protein in trial 2.

Six 1-year-old and six 8-year-old ewes averaging 46 and 58 kg, respectively, were used in these studies. Each ewe was initially injected with 500,000 IU vitamin A, 75,000 IU vitamin D, 50 mg d-α-tocopherol acetate and 5.48 mg sodium selenite to insure comparable vitamin status among animals. Feed intake was based on metabolic body weight ($W_{kg}^{.75}$) in an attempt to standardize for differences in body weight. Each animal was fed 46.5 g feed/$W_{kg}^{.75}$ during trials 1 and 2. Composition of the diets fed are presented in Table 1.

Table 1.–Composition of Diets Fed to Ewes.

Ingredient	Protein level Diet A	Diet B
	%	%
Cracked yellow corn	78.0	49.5
Soybean meal (45% CP)	5.6	34.0
Cottonseed hulls	15.0	15.0
Trace mineral salt	0.5	0.5
Ground limestone	0.9	1.0

In trial 1, the animals were fed the diet containing 10% protein (diet A), with half the calculated feed intake level being fed twice daily. Following a 2-week adjustment period, the ewes were subsequently fed for 10 days at 12-hour intervals. On the tenth day, jugular blood samples were collected at 2, 4, 6, 8 and 10 hr after the morning feeding for plasma free amino acid, urea and ammonia nitrogen analyses. In trial 2, the ewes were adjusted to the diet containing 20% protein (diet B) for a 2-week period, and then subjected to a 10-day treatment period following the feeding schedule previously described. Jugular blood samples were also collected and prepared as described.

In trial 1, plasma tyrosine, valine, glutamic and aspartic acids were higher in young ewes, while citrulline and serine were higher in the old ewes. In trial 2, plasma isoleucine, tyrosine, methionine, alanine, leucine, valine, glutamic acid, phenylalanine, lysine and arginine were higher in young ewes, while citrulline was higher in the old ewes, suggesting a differential age-related response to higher dietary protein. Plasma total, essential, nonessential, the ratio of essential to nonessential and branched-chain amino acids did not differ by age in trial 1, while all these values except nonessential amino acids were higher in young ewes in trial 2. Plasma urea nitrogen was higher in old ewes in both trials. No age difference occurred in plasma ammonia in trial 1, while old ewes had lower plasma ammonia in trial 2. The decreased plasma amino acid concentrations and elevated urea levels in old ewes at both levels of protein intake suggest increased amino acid catabolism, perhaps reflecting age differences in cellular amino acid metabolism.

ESSENTIAL FATTY ACID DEFICIENCY IN RUMINANTS

G. Bruckner, G. E. Mitchell, Jr., R. E. Tucker,
G. T. Schelling and K. K. Grunewald

Essential fatty acids have been known to be required in the diets of monogastric animals for many years. The fatty acids which meet these requirements have 18 or 20 carbons and 2 or more double bonds between carbons (are unsaturated). Bacteria in the rumens of cattle and sheep are very active in hydrogenating (saturating) the double bonds of unsaturated fatty acids in the diet. As a result, the fat in beef and lamb is low in unsaturated fatty acids, and little attention has been given to possible essential fatty acid requirements of cattle and sheep. Recent interest in by-passing the rumen with unsaturated fat has focused attention in this area and reminded us of the lack of information on essential fatty acid requirements in ruminants. Gnotobiotic or "germ-free" procedures provide a method of separating microbial effects from physiological effects on the host animal. So far the work has been limited to lambs because of the limited size of the gnotobiotic isolators. This experiment was designed (1) to determine physiological effects of eliminating essential fatty acids from lamb diets and (2) to determine how microorganisms might affect availability and utilization of linoleic acid (the most widely available essential fatty acid for monogastric animals).

PROCEDURE

The design of the experiment was a 2 x 2 factorial with gnotobiotic and conventional lambs fed diets with and without linoleic acid. Lambs obtained by sterile cesarian or hysterotomy techniques were delivered into and housed in sterile film isolators (7 lambs) or in standard metabolism stalls (8 lambs) for 60 days. None of the lambs received colostrum. The lambs were fed skimmed cows' milk with 6% hydrogenated coconut oil and vitamins A, D and E added with or without 0.32% of total calories as linoleic acid. The diet was homogenized, bottled and autoclaved. It was fed to appetite 3 or 4 times daily.

OBSERVATIONS

1. Gnotobiotic lambs gained significantly faster and more efficiently than conventional lambs. Failure to permit the lambs to have colostrum probably increased this effect.
2. Lambs supplemented with linoleic acid gained faster than unsupplemented lambs, especially if they were housed in isolators.
3. Linoleic acid deficiency increased heart, brain, adrenal and kidney weights of gnotobiotic lambs. It did not affect organ weights in conventional lambs.
4. Hematocrit values declined an average of 7% during the experiment but were not affected by treatment.
5. Susceptibility of red blood cells to hemolysis was not altered by treatment.
6. Although essential fatty acids were used in the synthesis of prostaglandins, levels of PGE, $PGF_{1\alpha}$ or $PGF_{2\alpha}$ in plasma were not affected by treatment.
7. Tri/tetra fatty acid ratios in the livers were evaluated as indications of essential fatty acid status. If ratios above 0.4 are considered indicative of essential fatty acid deficiency (Holman, J. Nutr. 7:405, 1960), these values give several interesting indications:
   - (a) Since all values were above 0.4 the essential fatty acid requirement of lambs may be above 0.32% of calories.
   - (b) Lack of linoleic acid in the diet resulted in a 5- to 10-fold increase in tri/tetra ratios with the greatest effect in gnotobiotic lambs.
   - (c) Tri/tetra ratios were consistently lower in conventional lambs than in gnotobiotic suggesting a beneficial influence of microflora on essential fatty acid status.

SUMMARY

Comparisons of gnotobiotic and conventional lambs fed with or without linoleic acid give strong indications that ruminants have a physiological requirement for essential fatty acids. Gastrointestinal microorganisms seem to have a major influence on that requirement. Owing to conflicting effects on deficiency indicators and general performance parameters, further work is needed to define the role of the microorganisms more precisely. Extension of these observations to calves is also needed.

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ADDITIONAL INFORMATION
AVAILABLE AT YOUR
COUNTY EXTENSION OFFICE

The following topics concern beef production in Kentucky. For information relating to a topic see your local Extension Agent for Agriculture.

BREEDING, SELECTION AND REPRODUCTION

Learn the Modern Cowboy Lingo
Preweaning Evaluation of Growth Rate
Postweaning Evaluation of Growth Rate
Artificial Insemination for the Beef Cattle Herd
Double Muscling in Beef Cattle
Developing Replacement Heifers
Coping With Calving Difficulties
Applied Genetics
A Controlled, Seasonal Cattle Breeding Program

NUTRITION

Nonprotein Nitrogen in Beef Cattle Rations
Feeding and Management of the Beef Female
Nutrient Requirements of Beef Cattle
Choosing a Protein Supplement
Balancing Rations for Beef Cattle

PRODUCTION MANAGEMENT

Individual Identification of Cattle
Diethylstilbestrol in Beef Production
Implants for Improving Growth Rate and Feed Efficiency
Feeding, Managing and Vaccinating Dairy and Orphan Beef Calves
Management of the Commercial Cow-Calf Herd for High Calf Crop Percentage
Management of the Beef Cow at Calving Time (Prior, During, After)
Castration and Dehorning

BUSINESS MANAGEMENT

Beef Cows as Community Assets
Farm Manure

FORAGES

Grazing Systems
Recommended Crop Varieties for Kentucky
Soil Sampling - How to and What for
Double-Cropping
Grain and Forage Crop Guide for Kentucky
Liming Acid Soils
Renovating Grass Fields
Producing Small Grains for Grain and Silage
Growing Red Clover
Season of the Year Affects Nutritional Value of Tall Fescue
The Effects of Weather on Hay Production
Bermudagrass - A Summer Forage
Orchardgrass
Fescue
Hay Feeding Systems
Quality Hay Production
Establishing Forage Crops
A Beef Forage System
Salvage Feeds for Beef Cattle
The Importance of Forage Quality
Alfalfa

HERD HEALTH

Beef Health and Management Calendar
Stomach Worm Disease of Cattle
Infectious Bovine Rhinotracheitis
Preconditioning Feeder Calves
Anaplasmosis in Cattle
Blackleg in Cattle
Oak Acorn Poisoning
Bovine Respiratory Disease (BRD) (Shipping Fever Complex)
Grass Tetany in Beef Cattle
Metabolic Disorders of Dairy Cattle
Foot Rot in Beef Cattle
Beef Tuberculosis
Pinkeye
Forage Related Disorders
Control of Beef Animal Insects
Livestock Insects

EQUIPMENT AND FACILITIES

Beef Corral Essentials
Wind Chill
Making and Using A Cattle Backrubber
Plans for Beef
A Mineral Feeder

MARKETING

Tips on Custom Processed Beef
Shrink and Its Importance to Cowmen and Cattle Feeders
Buying Beef for Home Freezers

BACKGROUNDING AND FINISHING

Conditioning Cattle for Growing or Finishing
Backgrounding Lightweight Calves
Producing Slaughter Beef with Grain on Pasture