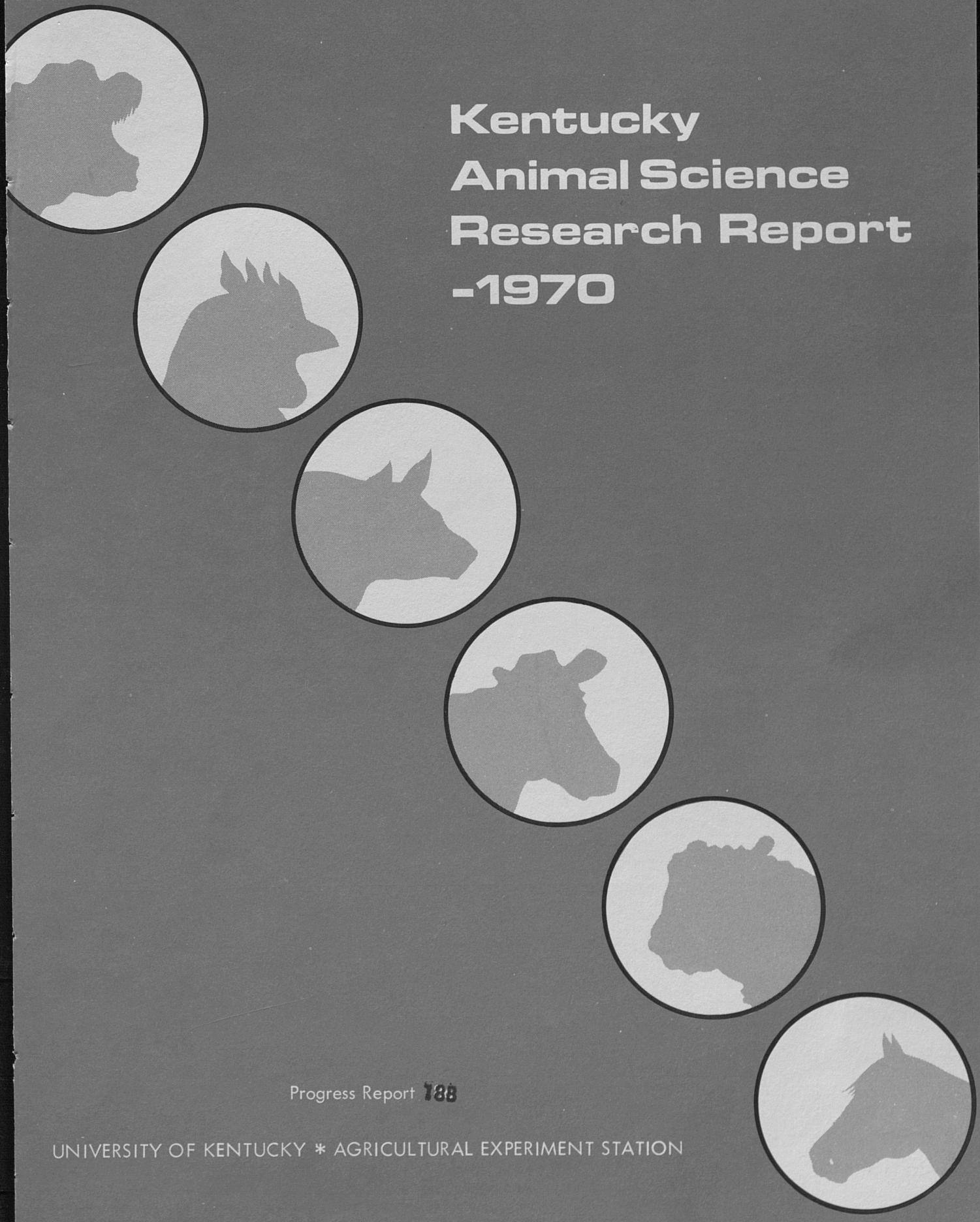

Kentucky Animal Science Research Report -1970

Progress Report 188

UNIVERSITY OF KENTUCKY * AGRICULTURAL EXPERIMENT STATION

PROGRAM

1970 ANIMAL AGRICULTURE DAYS

UNIVERSITY OF KENTUCKY

July 15, 1970 - Coldstream Farm, Lexington

9:00 - 11:30 a.m. - Visit research areas on the farm.

12:00 Noon - Barbecue lunch (Provided by Bluegrass Stockyards).

1:00 p.m. - Address: "Animal Agriculture in the 1970's" - Dr. L. S. Pope, Associate Dean for Administration, College of Agriculture, Texas A & M

July 17, 1970 - Western Kentucky Substation Farm, Princeton

9:00 - 11:30 a.m. - Visit research areas on the farm.

12:00 Noon - Barbecue lunch (Provided by Field Packing Company and Owensboro Milling Company).

1:00 p.m. - Address: "Animal Agriculture in the 1970's" - Dr. L. S. Pope, Associate Dean of Administration, College of Agriculture, Texas A & M

KENTUCKY

ANIMAL SCIENCES RESEARCH REPORTS

1970

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UNIVERSITY OF KENTUCKY

AGRICULTURAL EXPERIMENT STATION

DEPARTMENT OF ANIMAL SCIENCES

CONTENTS

NUTRITION (continued) Page

ANIMAL FOODS SECTION

EFFECT OF TEAT DIPPING ON THE INCIDENCE OF MASTITIS BY STAPHYLOCOCCUS AUREUS

W. M. Pyles and B. E. Langlois

Mastitis may be the most expensive disease of dairy cows, costing the average dairyman in Kentucky an estimated $1,270 a year owing to losses in production and cost of drugs for treatment. While complete elimination of mastitis from a herd is probably not possible, control is very possible.

This study was made to determine if a commercial test dip solution could be used to reduce the incidence of mastitis, especially that caused by Staphylococcus aureus.

Procedure

The university dairy herd was divided into two groups based on breed. Diagonally opposite teats of each cow were dipped with a commercial teat dip solution after each milking. The remaining two teats served as controls. Milk from the two treated quarters and the two control quarters of each cow were analyzed by the following tests: catalase test (CT), Wisconsin mastitis test (WMT), and direct microscopic leucocyte count (DMLC) and plating on blood plates and Baird-Parker agar. A total of 1,154 samples were analyzed between November 1967 and June 1969. Standard microbiological tests were used to identify isolates from plates.

Results

A sample was considered mastitis positive when at least one of the screening tests gave values greater than the following: catalase test - 29% O_2, WMT - 29 mm, DMLC - 1.5 million leucocytes/ml. Based on these screening test values, the samples were divided into mastitis positive and mastitis negative groups. The number of samples in each group is given in Table 1.

Table 1. — Distribution of Samples Based on Results of Catalase Test, Wisconsin Mastitis Test and Direct Microscopic Count

Source Samples	Mastitis Positive	Mastitis Negative
Control quarters	180	397
Treated quarters	159	418
Total	339	815

Of the 1,154 samples analyzed, 815 (70.6%) were found by screening tests to be mastitis negative. Use of the teat dip appeared to have a beneficial effect in reducing mastitis, since 46.9% of the mastitis positive samples were from treated quarters, while 53.1% were from control (untreated) quarters.

Staphylococcus aureus was found in samples classified both as mastitis positive and negative by the screening tests. The number of samples in each group found to contain S. aureus and the source of the samples are given in Table 2. The mastitis positive group was found to contain only three more samples containing S. aureus than the negative group. However, the number of S. aureus positive samples accounted for 55.2% of the samples in the mastitis positive group and only 22.6% in the mastitis negative group. In both groups, more S. aureus positive samples came from the control quarters than from the treated quarters.

The use of a teat dip after each milking appears to be useful in controlling mastitis.

Table 2. — Distribution of Staphylococcus aureus in Mastitis Positive and Mastitis Negative Samples

Mastitis Group	Positive		Negative	
Staph. aureus	Positive	Negative	Positive	Negative
Control quarters	96	84	102	295
Treated quarters	91	68	82	336
Total	187	152	184	631

EFFECT OF CHLORDANE AND HEPTACHLOR ON THE GROWTH OF STAPHYLOCOCCUS AUREUS

B. E. Langlois and Kay G. Sides

Previous work has shown that growth of Staphylococcus aureus was affected by certain organochlorine pesticides. This study was made to obtain more information concerning pesticide inhibition of S. aureus—in particular, inhibition caused by heptachlor and chlordane.

Procedure

Staphylococcus aureus was grown in a broth medium containing from 5 ug to 20 ug/ml of heptachlor, chlordane, gamma chlordane and nonachlor. The heptachlor used ranged in purity from 72 to 99.8%.

Growth was determined by standard plating methods, with analyses being made every 2 hr during the initial 12 to 24 hr period and then daily for the duration of the incubation period.

Results

Growth of Staphylococcus aureus in broth medium was affected by 5 ug/ml of the pesticides studied.

Results obtained in this study are shown in Table 1. All pesticides used caused a decrease in initial viable count, ranging from 8.3% (99% heptachlor) to 51.1% (gamma chlordane). Length of time that viable counts decreased ranged from 2 hr for nonachlor to 24 hr for chlordane.

No correlation was found between percent decrease in initial viable count and resulting generation time. Staphylococcus aureus had a generation time of 31.9 min in the control. Pesticides caused the generation time to increase. The lengthened generation time ranged from 40.6 min (nonachlor) to 357.5 min (chlordane). Gamma chlordane which caused the greatest decrease in initial viable count had one of the lowest generation times (42.3 min).

Growth of S. aureus in skimmilk was unaffected by the presence of up to 50 ug/ml of heptachlor or 10 ug/ml of chlordane.

Table 1.— Effect of Pesticides on Initial Viable Count and Resulting Generation Time of Staphylococcus aureus in Trypticase Soy Broth at 37°C

Pesticide[a]	Initial Viable count[b] (Log_{10})	Minimum viable count (Log_{10})[c]	Minimum viable count (hr)[d]	Viable count decrease (%)	Generation time[e] (Min)
Control	5.00	[f]			31.9
Absolute alcohol	4.97	[f]			34.5
Heptachlor - 72%	4.98	2.88	12	42.2	102.0
Heptachlor - 73%	4.96	3.03	10	38.9	139.5
Heptachlor - 74%	4.94	2.85	12	42.3	181.4
Heptachlor - 99%	4.93	4.52	4	8.3	160.5
Heptachlor - 99.8%	4.96	4.33	8	12.7	223.1
Heptachlor - purified	4.92	2.50	12	49.2	120.0
Chlordane	5.26	3.38	24	31.7	357.5
Gamma chlordane	5.05	2.47	10	51.1	42.3
Nonachlor	4.91	4.32	2	12.0	40.6

[a] Concentration of 10 μg/ml
[b] Count at 0 hr
[c] Lowest count obtained during incubation
[d] Time from 0 hr to reach minimum count and to enter logarithmic growth phase
[e] Values for calculating generation time obtained only from logarithmic growth phase
[f] No decrease in viable count

DEGRADATION OF ORGANOCHLORINE PESTICIDES BY BACTERIA

B. E. Langlois, Kay G. Sides and J. A. Collins

Recent interest has been focused on the mechanisms by which microorganisms degradate organochlorine pesticides to less harmful products, since many of these pesticides can persist for a long time in the environment.

This study was made to obtain more information concerning the mechanism of pesticide degradation by bacteria and to determine if degradation could occur in milk.

Procedure

Strains of Bacillus cereus, Bacillus coagulans, Bacillus subtilis, Escherichia coli, Enterobacter aerogenes, Pseudomonas fluorescens and Staphylococcus aureus were grown in trypticase soy broth, skimmilk and trypticase soy broth plus casein, containing up to 100 ppm of DDT, dieldrin, heptachlor and chlordane. After growth for 1 to 4 wk, an analysis of pesticides and metabolites was made by electron capture gas chromatography, paper chromatography and thin-layer chromatography.

Results

None of the bacteria studied were able to degradate any of the pesticides used in skimmilk or in trypticase soy broth plus casein.

Dieldrin, heptachlor and chlordane were not degradated by any of the bacteria in trypticase soy broth.

DDT was degradated by E. coli, E. aerogenes, B. cereus, B. coagulans and B. subtilis in trypticase soy broth. Degradation of DDT by E. coli and E. aerogenes was faster and more complete under anerobic conditions than under aerobic conditions. Bacillus degradated DDT under aerobic conditions and faster than any of the bacteria studied. The pathway for degradation of DDT was found to be as follows:

DDE → DDT → DDD → DDMU → DDMS

DDMS → DDNU → DDOH → DDA → DBP

FEEDING PHENOBARBITAL AND ACTIVATED CARBON TO ACCELERATE DIELDRIN RESIDUE REMOVAL IN A CONTAMINATED DAIRY HERD

D. G. Braund, B. E. Langlois, D. J. Conner[1] and E. E. Moore[1]

Pesticide residues in milk and dairy products represent a difficult situation for the dairy industry. Various state and federal agencies are constantly monitoring these products to ascertain the presence of pesticides and other adulterants. As a result of such monitoring, in March 1969, dieldrin was detected in cottage cheese in an adjoining state and traced to milk produced by a herd of 105 lactating cows in Kentucky. Consequently, sale of this milk, amounting to approximately 4,000 lb a day, was prohibited.

Thus, the following study was made to determine if feeding phenobarbital and activated carbon would accelerate removal of dieldrin residue from the above-mentioned herd.

Procedure

The presence of two bulk tanks on the farm permitted the separation of the herd in a control group of 55 cows and a treated group of 50 cows, and the entire milk production for each group was kept separated.

The diet for the control group consisted of pasture and concentrate of ground ear corn, protein supplement and vitamin-mineral supplement.

The treated group received the following in addition to the diet fed the control group: 5 g of phenobarbital per cow per day, fed in two equal doses with the concentrate during the a.m. and p.m. milking, and 2.0 lb of powdered activated carbon per day mixed with corn silage and consumed at evening feeding. The phenobarbital was fed for 24 days and the carbon for 67 days.

On the 26th day of the study carbon was given to the control group for the next 41 days and the drug was fed for three days.

Milk samples were analyzed periodically for residue level by electron capture gas chromatography.

Results

After one week of treatment residue level in milk from the treated group had declined 64% compared with 36% for the control group. The results obtained are shown in Fig. 1.

About 35 days were required for the residue level in the treated group to decrease to an acceptable limit or below. However, the level in the control group did not decrease below this limit until about the 50th day. To emphasize further the importance of the treatment it must be considered that these animals were fed phenobarbital 3 days and carbon for the last 24 days. The time undoubtedly would have been longer if treatment had not been administered to the control group.

Removal of dieldrin residue can be accelerated by feeding phenobarbital and activated carbon. Except under experimental conditions, however, the practice of feeding the drug to lactating dairy cows is not permitted by the FDA. Any dairyman finding pesticide contamination of his herd should contact his veterinarian, local health officer and FDA official before beginning treatment.

1/ Kentucky State Department of Health, Frankfort.

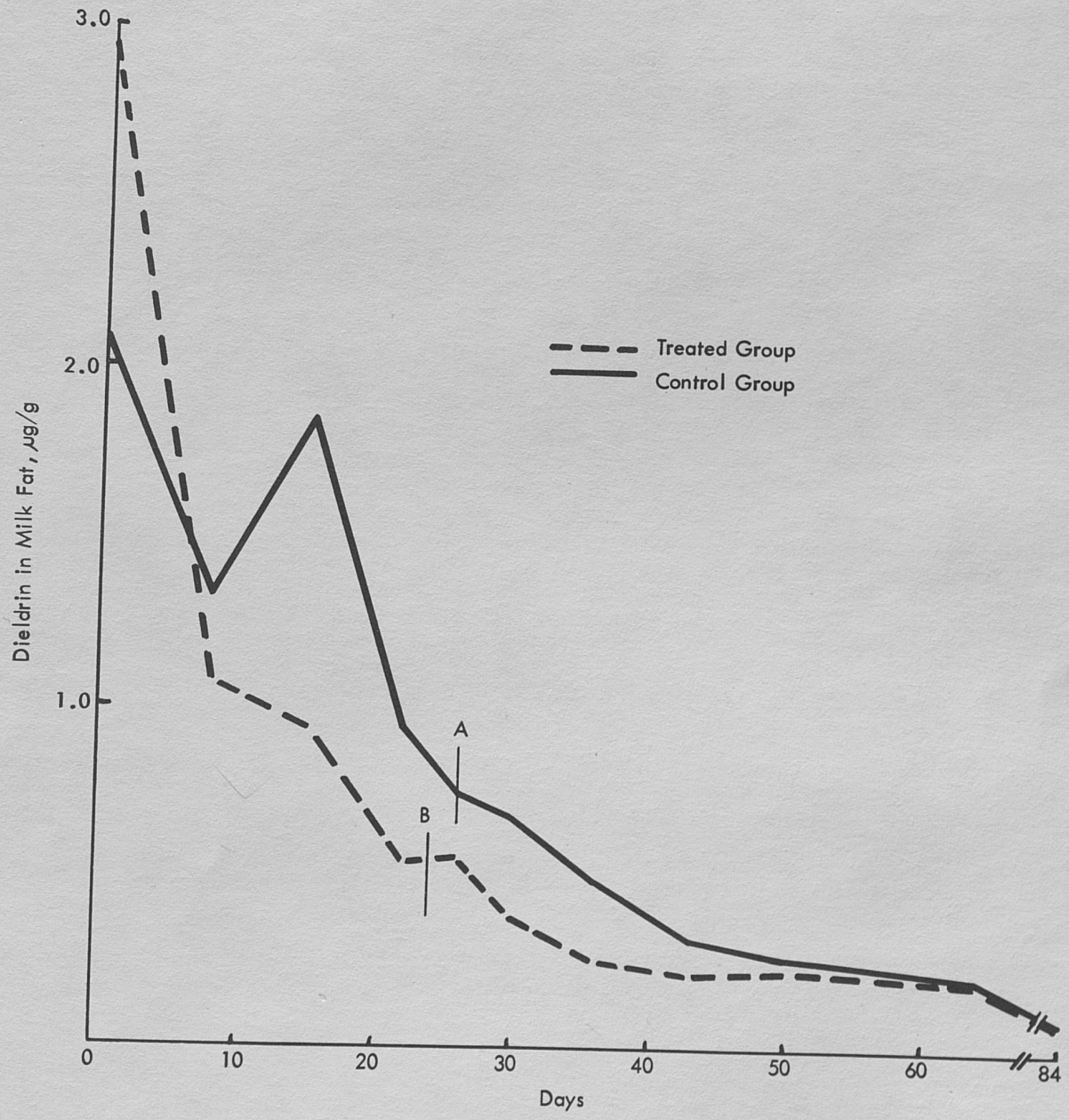

Fig. 1. Effect of feeding phenobarbital and activated carbon on dieldrin residue levels in herd milk. A. Feeding carbon to control group begun; drug fed for 3 days only. B. Drug feeding to treated group stopped.

MICROBIOLOGICAL EXAMINATION OF COCOA POWDER

D. A. Gabis, B. E. Langlois and A. W. Rudnick

Little information is available concerning the microbiology of cocoa powders used in the manufacture of chocolate milk. Previous work in our laboratory found that shelf-life of chocolate milk was significantly less than that of other milk products studied.

This study was made to determine the types and numbers of bacteria in cocoa powder and to classify them using numerical taxonomy.

Procedure

From 10 different manufacturers, 36 cocoa powders were obtained and examined. Both total aerobic counts and coliform counts were obtained by plating representative portions of the samples and counting colonies formed at 32°C after 48 and 24 hr, respectively.

Isolates were obtained from total aerobic count plates for use in identifying the species making up the microflora of cocoa powder.

Tests for identification were run on the isolates, and the results were coded and placed on IBM data cards. The isolates were compared with known species, and the isolates having the greatest similarity to those of known species were classified as being the same species.

Results

No coliform bacteria were found in the samples.

Total aerobic counts ranged from 100 to 27,000/g. Thirty-one samples (86.1%) had counts of less than 9,300/g. Of these 12 (39%) had counts less than 1,500/g. Based on the amount of cocoa powder added to make 100 gal of chocolate milk and the number of bacteria found, the theoretical number of aerobic bacteria added by cocoa powder would range from 6.8×10^5 to 1.3×10^8. This amounts to the addition of 2 to 324 bacteria per ml or 1,700 to 326,663 per qt of chocolate milk.

Bacillus and *Micrococcus* were the only genera comprising the microflora of the samples. All samples contained bacilli, but only none contained micrococci.

Of the 519 isolates identified, only 10 were of the genus *Micrococcus*, while the rest were of the genus *Bacillus*. *Micrococcus freudenreichii* comprised one-half of the micrococci species, with *M. luteus*, *M. colpogenes* and *M. agilis* comprising the rest.

Bacillus licheniformis comprised 45% of the total bacilli population, with *B. cereus*, *B. megaterium* and *B. subtilis* comprising an additional 40%. In all, 20 species of bacilli were identified.

EFFECT OF ANTIOXIDANTS ON RANCIDITY DEVELOPMENT IN DRY-CURED HAMS

Everett C. Lail, Jr., James D. Kemp and J. D. Fox

The use of antioxidants to retard oxidative deterioration in foods has increased tremendously in the last few days. Only a very small amount of work, however, has been reported concerning their use on dry-cured pork products. This research was designed to determine the effects of two food grade antioxidants, Butylated Hydroxyanisole (BHA) and Tenox 7 (a mixture of BHA, Propyl Gallate and citric acid in a propylene glycol and glyceryl mono-oleate base), on the rancidity development in dry-cured aged hams.

Forty-eight freshly skinned hams were dry-cured 2 days per 0.45 kg of fresh weight and then placed in salt equalization for one month. Half (24) were smoked and half (24) were not smoked. Eight hams in each group were then treated with BHA, 8 with Tenox 7, and 8 served as controls. External fat samples were removed prior to antioxidant application. Subsequent to antioxidant application fat samples

were taken at 2, 4 and 6 month's aging. Characteristics of the external fat were determined by iodine numbers, peroxide numbers, free fatty acid values and TBA values.

The results of the iodine numbers indicated the fat was firm. During aging iodine numbers increased during the first 2 months and then decreased during the remaining aging period. There were no significant differences in iodine numbers due to antioxidant treatments. However, the smoked hams had a significantly ($P < .01$) larger iodine number than did the unsmoked hams. The effect of antioxidants on peroxide numbers was significantly ($P < .01$) lower in the antioxidant-treated hams in the unsmoked group, whereas in the smoked group there were no significant differences. Free fatty acid content increased with age ($P < .01$) in both the smoked and non-smoked groups but at a slower rate in the antioxidant treated hams. The non-smoked hams had a significantly ($P < .01$) lower FFA value than the smoked hams. The antioxidant treatments resulted in significantly ($P < .01$) lower TBA values in both smoked and non-smoked groups. Smoking significantly ($P < .01$) reduced the TBA values.

From the results of this study, it is evident that both antioxidant treatment and smoking of dry-cured aged hams retarded rancidity development.

EFFECTS OF ANTEMORTEM INJECTION OF PAPAIN ON THE TENDERNESS AND QUALITY OF DRY-CURED HAMS

J. Bruce Smalling, James D. Kemp, and J. D. Fox

The dry-cured or country style ham is a savored meat item in Kentucky and other southeastern states. One of the major problems in its processing is the production of a uniformly tender product.

The use of papain, administered antemortem, has proven successful in the production of tenderized beef. This study was initiated to investigate the use of antemortem-injected papain in the production of tenderized dry cured hams.

Thirty-nine Hampshire and Yorkshire pigs, averaging approximately 95 kg, were randomly assigned to three treatment groups. Those in treatments I and II were injected with 0.33 and 0.44 cc of a papain enzyme solution, containing 60 mg papain per ml, per kg liveweight respectively. Treatment III was a control. The injection levels were determined on the basis of a preliminary trial using 0.22, 0.33, 0.44 and 0.55 cc of solution per kg of liveweight. The 0.22 and 0.55 cc levels were eliminated as they produced negligible change and overtenderness respectively.

The enzyme was injected into the vena cava 30 minutes prior to slaughter. Hams were dry-cured, using 8 kg of curing mixture per 100 kg of hams and held for 2 days per 0.45 of average weight. After curing, the hams were salt equalized 30 days, cold smoked and aged 12 weeks at 18°C and 65% relative humidity. The fresh picnic and loin from each hog were used for shear tests to ascertain the effectiveness of the enzyme.

At the completion of aging, the hams were cut and subjectively rated for color, firmness, aged aroma and general appearance. Slices were taken and subjected to sensory evaluations for flavor, saltiness, tenderness and overall satisfaction. Other center cut slices were subjected to shear tests on the biceps femoris, semimembranosus and semitendinosus muscles, using a Warner-Bratzler shear device.

Papain application did not significantly affect the change in ham weights during curing, salt equalization or aging. Post-aging quality appraisal scores were independent of treatment effects. The majority of the hams scored red in color, slightly soft to soft in firmness, moderately aged in aroma, and excellent to good in general appearance. Eight hams were noted as being noticeably mushy. Four hams had an unusual aroma. Histological and biochemical analysis of proteolytic activity during the 12-week aging period suggested that the softness encountered was not due to the activation of papain.

Taste panel scores favored the control hams for flavor, saltiness and overall satisfaction. Tenderness scores were higher, though not significantly for the treated hams. Shear tests on the fresh picnic and loin showed that the papain was effective when injected antemortem. Ham shear values were also significantly ($P < .01$) affected by the papain. Muscle quality appraisal scores were independent of treatment effects. The majority of the scores for firmness interacted with the papain to produce varied

tenderness between each muscle of the ham. Within the treated groups, the decreasing order of tenderness of the muscles tested was biceps femoris, semimembranosus and semitendinosus. Nested analysis of variance gave evidence that more variation in shear values was obtained from the muscle than the shear itself. Generally, it was concluded that the papain-treated hams were significantly more tender than the untreated, but this degree of tenderness was considered objectionable because of the somewhat mushy texture. Correlation analysis suggested that overall satisfaction and flavor were influenced by tenderness as determined organoleptically.

EFFECTS OF MUSCLE QUALITY ON CHEMICAL AND PHYSICAL PROPERTIES OF COUNTRY-STYLE HAMS

W. R. Henning, W. G. Moody, J. D. Fox and James D. Kemp

Much interest has been shown recently by packers concerning the economic loss from excessive shrinkage of pale, soft, exudative (PSE) pork. This study was conducted to compare selected physical, chemical and histological characteristics between extremely low quality and normal hams during curing and aging.

Approximately 200 pork carcasses were screened for pH values of the gluteus medius muscle 1 hr post-mortem. Those having a low pH were thought to be susceptible to PSE development, and those with a high pH were expected to be normal. When the carcasses were cut 24 hr post-mortem, the hams from 16 carcasses were visually selected for extreme PSE condition (Wisconsin quality score of 1) and 16 carcasses were selected as high quality (Wisconsin quality scores of 3 or 4). At approximately 40 hr post-mortem the pH values were again checked. At both 1 hr and 40 hr the pH values were significantly ($P < .01$) lower for the PSE hams.

After the hams were removed from the carcass, fresh samples were obtained from the biceps femoris of the right hams and analyzed for moisture, ether extract and total pigment. No differences were found in percentage of moisture or ether extract, but the low quality hams contained significantly ($P < .01$) less total pigment than the normal hams.

All hams were cured, held for salt equalization, smoked and aged for 4 months, using standard University of Kentucky procedures.

The biceps femoris of each right ham was sampled for chemical analysis and histological examination fresh, after salt equalization and after aging. Again, no differences were shown in moisture or ether extract but the water-binding capacity of the muscle was significantly ($P < .01$) lower for the low quality hams at all sampling times as shown in Table 1.

Results of the measurements of the histological sections of the biceps femoris stained with a succinic dehydrogenose stain are shown in Table 2. No statistically significant difference was shown in fiber size between groups, but the low quality hams showed a significantly ($P < .01$) higher white fiber to red fiber ratio.

The left hams were used for determination of relative weight loss and palatability. The shrinkage data are shown in Table 3. The low quality hams shrank significantly ($P < .01$) more at all stages throughout curing, salt equalization and aging. A trained sensory evaluation panel was unable to detect differences between the two groups and there was no difference in tenderness measured by a Warner-Bratzler shear device.

It is apparent from this study that much consideration should be given to the quality of pork, especially when processing by country-style curing methods.

Table 1. — Physical and Chemical Variables

Variable	Normal[a]	PSE[b]
Initial pH [e]	6.42	6.08
Final pH[e]	6.02	5.56
Expressible juices[c]		
fresh[e]	55.2	65.2
after salt eq.[e]	27.8	33.2
after aging[d]	22.7	28.4
Moisture, %		
fresh	74.8	74.9
after salt eq.	66.6	66.9
after aging	61.8	60.4
Ether extract, %		
fresh	3.62	3.17
after salt eq.	3.79	3.49
after aging	4.63	4.41
Myoglobin, mg/g	9.90	4.36

[a] Muscles uniformly grayish pink, moderately firm and dry

[b] Extremely pale, soft, exudative muscles equivalent to quality score 1 based on Wisconsin quality index.

[c] A relative measure of water binding capacity expressed as cm^2 of expressible juice on No. 2 filter paper when 2 g sample was subjected to 22.5 kg pressure for 5 min.

[d] $P < .05$

[e] $P < .01$

Table 2. — Histological Measurements

Variable	Normal	PSE
White to red ratio[a]	1.47	2.02
White fiber diameter, μ	91.9	85.3
Red fiber diameter, μ	59.6	59.7

[a] $P < .01$

Table 3. — % Shrinkage During Curing

Time Measured	Normal	PSE
After curing[a]	4.72	7.70
After salt eq.[a]	14.81	18.47
After smoking[a]	16.07	19.72
After aging[a]	25.36	30.25

[a] $P < .01$

LAMB TENDERNESS AS DETERMINED BY DIFFERENT METHODS AND AT DIFFERENT TIMES AFTER COOKING

J. Bruce Smalling, Joe D. Fox and James D. Kemp

Tenderness is one of the most critical attributes of meat with regard to the overall acceptability by the consumer. The evaluation of tenderness is carried out several ways. The sensory evaluation technique is very often employed, but lacks the objectivity necessary to detect subtle differences in tenderness. Consequently, many devices have been developed to eliminate the subjective element in tests of meat tenderness. The purpose of this study was to: 1) compare the use of the standard Warner-Bratzler (W-B) shear device, the W-B shear cell mounted on an Instron testing instrument (model TM) and a Kramer shear cell similarly mounted; 2) study the effects of time on shear value made at 5, 15, 30 and 60 min and 24 hr after cooking and; 3) investigate and compare tensile strength in raw and cooked muscle.

Forty lambs were randomly selected. Carcasses were divided into three groups based on live weight at the time of slaughter; 36 kg, 45 kg and 54 kg. Fifteen carcasses in the 36 and 45 kg groups were allocated at random to the study of the three shear devices. Twelve carcasses remaining in the 45 kg weight group were used in the studies on tensile strength, and 13 in the 54 kg group were used for shear time studies. In all cases the semimembranosus muscle of the right leg was used.

Cores 1.27 cm in diameter were employed for the shear device and shear time experiment. Because of core to core variation the cores were removed from random locations within the muscle. To study tensile strength, slices were removed from both raw and cooked muscles both perpendicular and parallel to the orientation of the fibers of the muscle.

All samples were deep fat fried in cottonseed oil at 135°C to an internal temperature of 70°C. Cores used in the shear device study were taken after holding 24 hr at 4°C. Cores in the shear time study were removed at the time shears were made.

Results showed that significant differences existed between the shear values of the Instron W-B and the standard W-B. The Instron W-B values were not as variable as noted by lower standard deviations and were significantly greater than the standard W-B values. Coefficient of variation values were higher for the standard W-B followed by the Kramer and the Instron W-B. A significant correlation was found between the Instron W-B and the Kramer ($r = 0.75$; $P < .01$).

Shear time studies indicated that no significant differences existed in shear values made from 5 min to 24 hr after cooking. The 24 hr cores did have greater standards deviations within cores.

The tensile strength study gave evidence that fiber orientation had a significant effect on tensile strength determinations. Values for parallel fiber groups were higher. Standard deviation were not significantly different either with or without regard to fiber orientation. A significant correlation of $r = 0.94$ ($P < .01$) was determined between raw and cooked samples with perpendicular fiber orientation.

As a result of this study, it was found that the Instron W-B exhibits smaller inherent variation than the standard W-B. The Kramer device shows definite usefulness; however, when one is interested only in maximum shear values on a force per unit basis this device becomes less justified, especially because it requires more time to operate.

Shear time studies reveal that it makes no difference when shears are made provided consistency is observed.

More research is needed to investigate the potential in using raw samples for measuring tenderness with conventional instruments; especially by tensile strength. Stress must be placed on uniformity of the size and the shape of samples.

EFFECT OF CASTRATION, SLAUGHTER WEIGHT AND TESTOSTERONE IMPLANTATION ON FATTY ACID CONTENT OF OVINE ADIPOSE TISSUE

John D. Crouse, James D. Kemp and J. D. Fox

It is observed that ram lambs are trimmer, gain faster, require less feed and the flavor and juiciness of the meat are the equivalent of those of wether lambs. However, it has also been noted that ram adipose tissue is softer. The objectives of this experiment were to observe the effects of slaughter weight, castration and testosterone implantation on the fatty acid content of the subcutaneous and perinephric adipose tissue.

Seventy-six Hampshire sired crossbred lambs (46 wethers and 30 rams) were individually weaned at 18.1 kg (40 lb). Thirty rams and 30 wethers were assigned to 10 replications of 36.2, 45.3 and 54.4 kg (80, 100, 120 lb) individual slaughter weights. Sixteen wethers to be slaughtered at 45.3 kg were implanted at the base of the ear with a 50 mg testosterone propionate pellet. After 30 days, 8 of these lambs were reimplanted at the base of the opposite ear with an additional 50 mg pellet. Forty-eight hr after slaughter, back fat measurements were taken between the 12th and 13th rib, and subcutaneous and perinephric adipose tissue samples were taken. A 10 g sample of each adipose tissue was analyzed for relative quantities of myristic, palmitic, stearic, oleic, linoleic, and linolenic fatty acids by gas-liquid chromatography.

Fatty acid values and back fat thickness for the 45.3 kg rams, wethers and testosterone treated wethers are presented in Table 1. Myristic and linoleic fatty acid values were greater ($P < .01$) in rams when compared with wethers and testosterone treatments. Although quantities of stearic acid tended to be lower for this comparison, the difference was not statistically significant. No differences were observed between the 50 and 100 mg testosterone treatments, or in comparison of the wethers and the testosterone treatments. This would indicate that the hormone treatment had little effect on subcutenaous fatty acid deposition. Perinephric palmitic acid values differed ($P < .01$) between the 50 and 100 mg implanted wethers. Comparisons of back fat measurements were not statistically significant.

Table 1.— Fatty Acid and Back Fat Values for 45 kg Lambs[a/]

		Implanted				Implanted		
Sex Conditions	Rams	100 mg	50 mg	Wethers	Rams	100 mg	50 mg	Wethers
Backfat thickness, mm	7.6	10.4	7.7	9.7				
Fatty acid (%)		Subcutaneous Fat				Perinephric Fat		
Myristic	7.5	5.0	4.4	4.5	4.1	3.2	2.0	3.6
Palmitic	25.0	25.5	27.0	25.3	20.1	22.1	17.0	17.5
Stearic	11.7	13.3	12.3	14.7	23.9	28.7	28.7	27.8
Oleic	42.6	44.5	46.5	44.3	38.4	35.3	39.6	39.9
Linoleic	9.9	7.6	7.9	7.9	10.0	8.8	9.5	8.8
Linolenic	3.5	4.0	2.2	2.9	3.4	2.7	4.0	3.2

a/Values are mean percents relative to the six fatty acids quantitated.

Table 2 presents a summary of the data for the 36.2, 45.3 and 54.4 kg slaughter weight groups. A sex X weight interaction ($P < .05$) was observed for linoleic acid in the subcutaneous adipose tissue. As rams increased in weight, the relative quantity of linoleic acid decreased. However as wethers increased in weight this fatty acid increased in quantity. Slaughter weight had no significant effect on the fatty acid content of the subcutaneous adipose tissue; however, back fat measurements lineraly ($P < .01$) increased with slaughter weight. No interactions were observed for the fatty acids in the perinephric adipose tissue. However, as slaughter weight increased, palmitic acid increased ($P < .05$) and linolenic acid decreased ($P < .05$).

Table 2. — Fatty Acid and Backfat Values for 36.2, 45.3 and 54.4 kg Rams and Wethers[a/]

Weight group, kg	36.2	45.3	54.4	36.2	45.3	54.4
Backfat thickness, mm	6.7	8.6	12.0			
Fatty Acid (%)	Subcutaneous Fat			Perinephric Fat		
Myristic	4.5	6.0	5.0	2.9	3.8	2.4
Palmitic	24.3	25.0	24.7	18.8	18.8	21.8
Stearic	13.6	13.2	13.8	23.04	25.8	23.5
Oleic	45.3	43.6	44.6	40.3	39.1	40.3
Linoleic	9.1	8.9	8.8	10.5	9.4	8.9
Linolenic	3.7	3.2	3.0	5.8	3.3	3.2

[a/] See footnote on Table 1.

A summary of the data for rams and wethers is presented in Table 3. The subcutaneous adipose tissue of the ram lambs contained more short chained myristic acid ($P < .01$), more unsaturated linolenic acid ($P < .01$) and less saturated stearic acid ($P < .01$) than wethers. These relative values could possibly tend to make this tissue softer in rams than wethers. No significant sex effects were observed in the perinephric adipose tissue. The wethers contained more back fat ($P < .05$) than the rams; however, no sex X weight interactions were observed for back fat thickness.

Table 3. — Fatty Acid and Backfat Values for Rams and Castrates[a/]

Sex Condition	Rams	Wethers	Rams	Wethers
Backfat thickness, mm	8.1	10.1		
Fatty Acid (%)	Subcutaneous Fat		Perinephric Fat	
Myristic	6.4	4.0	3.3	2.9
Palmitic	24.4	24.9	20.2	19.4
Stearic	12.0	15.1	23.8	24.4
Oleic	44.6	44.4	39.0	40.8
Linoleic	9.1	8.7	10.3	9.6
Linolenic	3.7	3.0	4.8	3.4

[a/] See footnote on Table 1.

EFFECT OF CASTRATION, SLAUGHTER WEIGHT AND TESTOSTERONE ON LAMB CARCASS COMPOSITION AND PALATABILITY

J. M. Shelley, James D. Kemp, Winston Deweese and W. G. Moody

Recently there has been a definite trend toward the production of meat-type animals, lambs, like beef and pork, are no exception. Retailers and consumers are demanding heavier, meatier, trimmer carcasses. This study, therefore, was designed to study the effect of castration, slaughter weight and testosterone on lamb carcass composition and palatability.

Sixty crossbred lambs consisting of 30 rams and 30 wethers were slaughtered at 36, 45 and 54 kg. An additional 16 lambs were implanted with testosterone propionate (8 with 50 mg and 8 with 100 mg) and were slaughtered at 45 kg. Carcasses were chilled for 48 hr and weighed, graded and measured. The right side of each carcass was cut into wholesale and retail cuts which were then boned and trimmed for edible portion. The leg was separated into fat, muscle and bone. Palatability tests were conducted for flavor, juiciness, tenderness and overall satisfaction, and Warner-Bratzler shear tests were determined on rib roasts from the left side.

A significant sex-weight interaction was observed for percent retail cuts ($P < .05$), percent total bone ($P < .01$), tenderness ($P < .01$) and overall satisfaction ($P < .05$) of rib roasts. As weight

Table 1. — Live Animal and Carcass Traits - Means and Standard Deviations

Sex	No.	Slaughter Weight Group, kg	Live Weight, kg	SD	Average Daily Gain, g	SD	Cold Carcass Weight, kg	SD	Dressing Percent	Grade[a]	SD	cm^2	SD
Wether	10	36	35.5	0.9	289.9	35.7	17.4	0.7	48.8	12.4	1.3	13.6	1.4
Ram	10	36	35.8	1.2	295.9	25.6	17.3	0.6	47.4	11.8	0.8	14.3	1.1
Wether	10	45	44.4	0.8	291.0	29.0	22.5	1.1	50.9	12.4	1.2	14.8	.7
Implanted 50 mg	8	45	43.9	0.8	240.6	49.4	21.4	0.4	48.8	11.0	1.3	13.9	1.1
Implanted 100 mg	8	45	44.4	0.9	239.7	24.9	21.8	0.8	49.1	11.3	1.3	14.0	1.1
Ram	10	45	44.2	1.2	318.9	30.2	21.6	0.9	48.8	12.6	1.4	15.1	1.3
Wether	10	54	52.1	1.5	289.8	33.1	27.9	1.1	54.9	13.1	1.3	15.1	1.3
Ram	10	54	52.9	1.2	342.2	30.6	26.6	0.9	50.3	13.2	1.1	16.4	1.6

[a] 14 = Prime, 13 = Prime–, 12 = Choice+, 11 = Choice

Table 2. — Carcass Components and Palatability Characteristics

			Carcass Components				Palatability Characteristics						
Sex	No.	Slaughter Weight Group, kg	% Total Retail Cuts	% Total Edible Portion	% Total Fat Trim	% Total Bone	% Shrink	Tenderness[a]	SD	Overall Satisfaction[a]	SD	Warner-Bratzler Shear Values Kg/¼"	SD
Wether	10	36	88.1	68.6	10.8	20.4	14.1	7.6	0.4	7.6	0.3	2.9	1.1
Ram	10	36	89.0	70.9	8.5	20.3	14.7	6.2	1.0	6.8	0.6	5.1	1.4
Wether	10	45	85.0	64.8	15.0	20.0	16.4	7.8	0.5	7.7	0.4	1.9	1.3
Implants 50 mg	8	45	88.0	68.7	9.6	21.1	18.7	7.3	0.7	7.3	0.4	2.4	1.3
Implants 100 mg	8	45	86.4	67.5	13.5	18.8	18.6	8.1	0.3	7.7	0.1	1.1	0.5
Ram	10	45	87.2	66.8	12.8	20.1	16.4	7.4	0.5	7.4	0.5	3.5	1.1
Wether	10	54	81.5	63.4	19.8	16.7	18.9	7.9	0.4	7.6	0.3	1.3	0.7
Ram	10	54	86.9	66.4	13.8	19.6	17.3	7.5	0.4	7.5	0.3	2.4	0.8

[a] 9 = Excellent, 1 = Poor

increased, percent retail cuts and percent total bone decreased, but at a faster rate for wethers than for rams. Tenderness and overall satisfaction of rib roasts increased as weight increased but at a faster rate for rams than wethers.

Live animal and carcass traits are listed in Table 1 and carcass components and palatability characteristics in Table 2.

Wethers had significantly higher ($P < .01$) dressing percent, smaller ($P < .01$) shear values, and higher ($P < .01$) overall satisfaction scores. Rams had larger ($P < .05$) ribeyes, higher ($P < .01$) percent retail cuts, higher ($P < .01$) percent edible portion, higher ($P < .01$) average daily gains and more ($P < .01$) evaporative cooking loss from rib roasts.

As weight increased, there was a linear increase in grade ($P < .05$), total fat ($P < .01$), length of body ($P < .01$), ribeye area ($P < .01$), percent drippings ($P < .01$), tenderness ($P < .01$) and overall satisfaction of rib roasts ($P < .01$). Percent retail cuts ($P < .05$), percent edible portion ($P < .01$) and shear values ($P < .01$) decreased linearly as weight increased.

Ribeye area, percent wholesale cuts, percent retail cuts, percent total bone and flavor, juiciness, overall satisfaction and percent shrink from rib roasts were virtually the same for implants as controls. Average daily gain and carcass grade were higher ($P < .01$) for controls than implants. Percent total fat trim ($P < .05$) and shear values ($P < .01$) were less for implants.

It can be concluded that wethers excelled in palatability characteristics over rams. Rams were more efficient gainers and yielded a trimmer, meatier carcass. As weight increased, carcass grade and palatability characteristics of rib roasts also increased. Percent retail cuts, percent edible and shear values of rib roasts decreased as weight increased. The implantation of 50 and 100 mg of testosterone propionate reduced the average daily gain and carcass grade. However, implants yielded more edible portion and less fat than the other 45 kg groups. Roasts from implants were more tender than those from the controls.

USE OF LIQUID NITROGEN TO HARDEN ICE CREAM

A. W. Rudnick, J. D. Fox, and I. J. Ross*

Liquid nitrogen as a coolant or cryogenic agent has been growing in popularity for the past several years. Its extremely low temperature (-320°F) and relatively low cost are its major assets in the quick freezing of some foods. It was thought, therefore, that it might be valuable in hardening ice cream.

Hardening of ice cream to a storage temperature of -20° F by conventional methods takes from 4 to 7 hr. Shortening of this time could prove valuable. However, subjecting ice cream to temperatures below -30° F leads to protein denaturation and a resulting shrinkage of the product in storage.

Quick freezing also tends to give a smoother bodied product. If hardening could be more rapid it is possible that the resulting product would be more pleasing to the consumer.

This study was undertaken to learn if using liquid nitrogen would speed hardening, improve texture and influence shrinkage of ice cream.

A standard 12% milk fat ice cream was prepared. Part of it was frozen in a batch counter freezer and part in a continuous freezer. The ice cream was drawn off into round quart containers equipped with thermocouples located at the outside surface, the mass average and at the center of the carton. Temperatures were recorded on a multipoint temperature recorder every 4 seconds for each location. Immediately after drawing from the freezer the cartons were immersed in a pool of liquid nitrogen and held for varying periods of time, then placed in a -20° F storage room.

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Holding times in the liquid nitrogen were based on temperatures reached. Some were held until the center (thus the entire package) reached -320° F. This took about 50 min. Some were held until the center reached -20° F, or about 24 min, and others were left in the liquid nitrogen until the mass average recorded the arbitrarily selected temperature of -110°F, or about 7 min. It took all samples from 4 to 6 hr to equilibrate up to -20° F.

After storage at -20° F for 7 days the samples were tempered to 5° F for 24 hr and examined for texture by experienced judges. There was no difference in this quality between the experimental samples and controls made from the same mix. After storage for 6 months at -20° F there was no evidence of shrinkage.

A sidelight was noted. When at the extremely cold temperature the ice cream was extremely brittle and broke into chunks. At storage at -20° F the chunks retained their identity. When tasted at temperatures below -10° F the ice cream tasted powdery but when allowed to warm to 5° F the chunks tasted normal. At the lower temperature there may be some protein dehydration.

THERMAL DIFFUSIVITY OF ICE CREAM AT CRYOSCOPIC TEMPERATURES

I. J. Ross*, A. W. Rudnick and J. D. Fox

Freezing of ice cream requires that the mix be chilled to 20 to 25° F in a swept surface heat exchanger and then placed in a cold room (-20° F) or chill tunnel (-30 to -40° F) for further chilling. Even with the best of heat transfer systems, it takes from 5 to 7 hr for the product to reach -20° F, the common storage temperature. This time can be reduced to minutes if the product is immersed in liquid nitrogen. To design efficient equipment a number of thermal properties of the product must be known. The objective of this study was to determine one of these properties—thermal diffusivity.

Ice cream mixes of uniform composition except for a variation in amounts of corn sugar were prepared. Corn sugar content varied from 0 to 50% of the sweetener used. These mixes were frozen in a standard swept surface continuous freezer and drawn into special containers at a uniform overrun. The special containers were cylinders of aluminum containing thermal couples at various locations. After allowing the cylinders of ice cream to equilibrate at -20° F, the outside aluminum shell was removed and the ice cream cylinder was immediately immersed in liquid nitrogen. A temperature history of the cylinder was measured by use of thermocouples and a recorder. Based on these data, thermal diffusivities were calculated for the temperature range of -20° to -320° F.

The estimates ranged from a low of 0.015 ft^2/hr at -20° F to 0.54 ft^2/hr at -320° F. It was determined that thermal diffusivity of the ice creams decreased with an increase in the percentage of corn sugar used in the mix. However, in the range of 0 to 50% corn sugar used, variation in thermal diffusivity was less than 2.5% of the average value for all concentrations tested. This difference is considered negligible.

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GENETICS AND PHYSIOLOGY SECTION

FREEZE VS. FIRE BRANDING AS A METHOD OF BEEF CATTLE IDENTIFICATION

F. A. Thrift and C. W. Absher

Over a 3-week period in April 1969, 200 Hereford females, ranging in age from 15 months to 10 years, were branded with their individual herd numbers on each side of the rib cage just behind the shoulder with either freeze or fire brands. The brands were evaluated for legibility on Jan. 14, 1970, using the following scoring system: 1 = no visible numbers; 2 = visible numbers, but illegible; 3 = incomplete numbers, but able to understand after study; 4 = easily recognizable numbers but with breaks or unbranded areas; 5 = instantly recognizable, complete unbroken numbers. Variations among brand scores were partitioned into age of cow, side of cow, type of brand and the two-way interactions between these three effects. Type of brand was the only significant ($P < .01$) source of variation influencing the brand scores, and the fire brands were more legible than the freeze brands. However, it should be stressed that neither type of brand was legible at the time of evaluation without first clipping the brands.

FERTILITY OF SOUTHDOWN RAMS FED A CHLOROHYDRIN (3-CHLORO-1, 2-PROPANEDIOL)

Jack L. Kreider and R. H. Dutt

Five mature Southdown rams of proven fertility were fed a chlorohydrin (3-chloro-1, 2-propanediol) daily in gelatin capsules at the rate of 25 mg/kg of body weight during a 25-day treatment period. Starting on the 12th day of treatment each ram was mated to three ewes, and starting on the 15th day after end of treatment each was mated to two ewes for fertility tests. All ewes were slaughtered the third day following mating, and their reproductive tracts were removed for detailed study of ova. After the oviducts were dissected from the tract, ova were recovered and examined for cleavage. In addition, the zona pellucida of each ovum was carefully examined for the presence of sperm cells.

Results of tests during and after rams had been treated are presented in Table 1. Of 17 ova recovered from ewes mated to the 5 rams during treatment, none was fertilized. In addition none of the ova contained any sperm in their zona pellucida. The induced infertility was temporary since fertile ova were recovered from ewes mated to all of the rams during the 3rd week after treatment. Of the 14 ova recovered during this test 12 were cleaved, and cleaved ova were recovered from at least one of the 2 ewes mated to each ram. When compared with fertility tests during the treatment period, the difference in fertility was highly significant ($P < .01$). Significantly ($P < .01$) more ova (69%) recovered from ewes bred during the post-treatment test contained sperm in their zona pellucida. There was no significant effect of the treatment on volume of semen and on sperm cell concentration. However, motility of sperm declined from 62% before treatment to 31% by the third day of the treatment period. Percent abnormal cells was significantly ($P < .01$) higher during and after treatment (19.2 and 17.2% versus 7.9% during pretreatment tests). There was no noticeable effect of the treatment on libido.

Table 1. — Result of Fertility Tests of Rams Fed 3-Chloro-1, 2 Propanediol for a 25-Day Period

Item	Fertility Test Period	
	Treatment[a]	Post-Treatment[b]
No. ewes bred	15	10
No. ova recovered	17	14
Ova fertilized, %	0	85.7**
Ova containing sperm cells in the zona pellucida, %	0	57.2**

a/ Breeding started the 12th day on treatment.
b/ Breeding started the 15th day after end of treatment.
**Significantly ($P < .01$) different from treatment test period.

The relatively rapid onset of infertility in rams and recovery of fertility by the third week after cessation of treatment, with no significant change in sperm concentration, indicate a post-testicular site of action of the drug.

USE OF THE ^{133}XENON WASHOUT METHOD TO MEASURE BLOOD FLOW RATE THROUGH THE RAM TESTIS

R. S. Sand, R. H. Dutt and D. F. Preston

An isotope washout technique based upon the disappearance of ^{133}Xenon from tissue has been adapted to study blood flow through the testes of rams. ^{133}Xenon is a radioactive isotope of an inert gas that is not absorbed or metabolized by the tissue and is 95 to 98% removed from the blood stream as it passes through the lungs the first time. One hundred-fifty microcuries of the isotope dissolved in 50 to 80 ul of 0.85% saline were injected into the center of the testicular mass. A scintillation detector, connected to a ratemeter and a stripchart recorder, was held in counting position in a styrofoam form fitted over the scrotum. Monitoring began as soon as the isotope was injected and continued until the count rate had declined to about one-fifth of the initial rate, usually a period of 10 to 20 min. Data from the stripcharts were plotted on semilog paper, and the time required for 50% of the injected activity to be removed from the testis was determined. This information was used in a standard equation to determine blood flow rate. An advantage of this technique to measure rate of blood flow is that surgical procedures for insertion of sensors are avoided.

Mean testicular blood flow rate, calculated from 16 observations on rams maintained at normal environmental temperatures, was 8.67 ml per 100 g of tissue per min. Repeated measurements on the same animal yielded similar blood flow rates, and when the arterial and venous vessels of the intact testis were ligated there was no decline in count rate of the injected isotope during a 30-min period after injection. Thus, the technique appears to be a valid method for determining blood flow.

The method was used to determine whether blood flow rate may change when testicular temperatures are increased. Experimental conditions studied were exposing rams to high environmental temperature of 32 C, 62 to 72% relative humidity for 7 days or local heating of the scrotum for 7 days with electric heating pads. Results of the study are shown in Table 1. Increasing testicular temperature by either method doubled the blood flow rate through the testis after 24 hours. However, after 7 days of exposure to increased temperatures, blood flow in the testis had decreased to about 50% of control values. These results lead to the hypothesis that the detrimental effects of increased temperature on spermatogenesis may be due to partial anoxia.

Table 1. — Changes in Blood Flow in the Ram Testis Following Heat Stress or Increased Testicular Temperatures

Treatment	Number of Rams	Before Treatment[a/]	Day of Treatment Period[a/]			
			1	3	5	7
Increased environmental temperature	4	8.6	16.7	9.3	4.2	3.8
Local heating of scrotum	4	9.0	24.0	16.1	5.7	5.6

[a/] Mean blood flow in ml per min per 100 g of tissue.

UNILATERAL CASTRATION AND ACCESSORY GLAND DEVELOPMENT IN RAM LAMBS

R. E. Renfro and R. H. Dutt

Androgens produced by the interstitial cells of the testes have a direct effect on accessory gland development in the male. Androgens also appear to exert some influence on body growth, since intact males usually will gain faster than castrates. In rats a very high correlation has been found between size of testes and the androgen-dependent glands, such as the accessory sex glands. Removal of one testis is a method of altering the size of the testicular mass and will provide data for comparing the effect on accessory gland development and on body growth.

The purpose of this experiment was to study the effects of unilateral castration in ram lambs. The experiment was designed to study ipsi- and contralateral effects of unilateral castration. Ninety-

Table 1. — Weight of the Testes and Accessory Sex Glands after Unilateral Castration of Ram Lambs

Treatment Group	Age at Slaughter, Days	Average Daily Gain, g	Weight, g								
			Testes			Seminal Vesicles			Bulbourethral Glands		
			Right	Left	Both	Right	Left	Both	Right	Left	Both
Control	163	209	128.0	122.7	250.7	3.74	3.78	7.52	0.99	1.06	2.05
Bilateral castrate	165	200	---	---	---	0.29	0.30	0.59[a]	0.10	0.10	0.20[a]
Right testis removed	164	204	---	209.1**	---	3.50	3.48	6.98	0.70	0.69	1.39*
Left testis removed	150	222	182.4**	---	---	3.48	3.57	7.05	0.80	0.70	1.50*
Unilateral castrates	157	213	182.4	209.1	391.5	3.49	3.52	7.02	0.75	0.69	1.44*

*Significantly ($P < .05$) different from controls.
**Significantly ($P < .01$) different from right and left control testes.
a/ Significantly ($P < .01$) different from all other groups.

four crossbred ram lambs (Southdown rams x Western cross ewes) were allotted on the basis of age into four treatment groups. Twenty-two ram lambs served as intact controls in group one, 18 were bilaterally castrated in group two, and in each of the third and fourth groups 27 were unilaterally castrated on the right or left side, respectively. The lambs were castrated at an average age of 25 days and, all were slaughtered at approximately 85 lb weight.

The data are summarized in Table 1. Castration had no significant effect on gain, since average daily gain was similar in all groups (bilateral castrate, 200; unilateral castrate, 213; and intact, 209 g). Compensatory growth ($P < .01$) occurred in the remaining testis when one was removed. Average weight of the single testis in unilateral castrates was 78% as much as the combined weight of both testes in intact males (195.8 vs 250.7 g). Unilateral castration significantly ($P < .05$) reduced average weight of the bulbourethral glands (1.45 vs 2.05 g for intact) but had no significant effect on weight of seminal vesicles (7.02 vs 7.52 g for intact). In bilateral castrates average weight of seminal vesicles (0.59 g) was 7.8% of that in intact males (7.52 g), and average weight of bulbourethral glands (0.20 g) was 9.7% of that in intact males (2.05 g). In right unilateral castrates average weights of the right and left seminal vesicles and bulbourethral glands were 3.50 vs 3.48 g and 0.70 vs 0.69 g, respectively. In left unilateral castrates average weights were 3.48 vs 3.57 g and 0.80 vs 0.70 g, respectively. These data thus do not show any significant ipsi- or contralateral effect of unilateral castration on accessory gland development in the ram.

INFLUENCE OF THE PHOTOPERIOD ON DURATION OF ESTRUS, LENGTH OF THE ESTROUS CYCLE AND OVULATION RATE IN EWES

R. H. Dutt, R. E. Renfro and T. P. Goerke

Length of the photoperiod through its effect on the pituitary gland has been shown to exert a major influence on the seasonal breeding activity in sheep. The purpose of the present study was to determine what effect altering the length of the daily photoperiod might have upon duration of estrus, estrous activity and ovulation rate on Western crossbred ewes. A total of 174 ewes maintained under different photoperiods were checked daily at 8:00 a.m. with aproned teaser rams during September, October and November. Photoperiods studied were (1) control (normal daily light conditions in an open barn), (2) continuous light (fluorescent lighting in an open pen which provided 10 foot-candles in corners and 40 foot-candles beneath lights 18 in. from the floor), and (3) restricted light (ewes were kept in a dark room equipped with fans for adequate ventilation). Dim light, controlled automatically, was turned on in the dark room from 7:30 a.m. to 9:30 a.m. while ewes were fed and checked for estrus. During the remaining 22 hours each day the room was without visible light. Pen size was similar for ewes kept under experimental light conditions, and all ewes were group-fed similar quantities of feed.

The ewes were placed under controlled lighting during the last week of September and the first week of October, after an estrous period for each had been established. Duration of estrus in hours was calculated by multiplying number of heat checks by 24.

Average duration of estrus for control ewes was 44.2 hr. Changes in the daily photoperiod had no significant effect on duration of estrus (46.8 hr for ewes under restricted light and 48.0 hr for ewes under continuous light). The light treatments also had no significant effect on length of concurrent estrous cycles (16.6 days for control, 16.9 days for ewes under restricted light and 16.8 days for ewes under continuous light). Neither light treatment interrupted estrous activity. Ovulation rate after two estrous periods under the light treatments was not significantly different from that of control ewes (1.66). However, ewes under restricted light had a significantly higher ($P < .05$) ovulation rate than ewes under continuous light (1.76 vs 1.52). The daily photoperiods used in this study had no significant effect on estrous activity, on duration of the estrous period or on length of the estrous cycle of ewes. Ewes maintained under restricted light for approximately 34 days during the breeding season had a higher ovulation rate than ewes under continuous light.

Table 1.— Duration of Estrus and Length of the Estrous Cycle for Ewes Maintained for Two Estrous Cycles under Different Daily Photoperiods

Item	Ewe Group		
	Control	Under Continuous Darkness for Two Estrous Cycles[a]	Under Continuous Light for Two Estrous Cycles
No. of ewes	58	58	58
Duration of estrus, hr			
Mean	44.2	46.8	48.0
SD	11.8	10.9	6.2
Length of estrous cycle, days			
Mean	16.6	16.9	16.8
SD	1.56	0.94	0.76

[a] Ewes in this group were maintained in constant darkness, except for a 2-hr period daily from 7:30 to 9:30 a.m., when they were fed and checked for estrus.

REPRODUCTIVE PERFORMANCE OF SYNCHRONIZED SPRING- AND FALL-BRED EWES

W. P. Deweese, R. H. Dutt, and D. G. Ely

In recent years, much research has been done on accelerated lambing programs. In such programs, ewes are often treated with hormones to cause them to lamb during summer and fall. This trial was designed to compare the reproductive performance of ewes bred in spring and fall following treatment with progestinated vaginal sponges and PMS.

One hundred and sixty-two yearling Southwestern crossbred ewes were randomly divided into two equal groups to compare the effects of medroxyprogesterone acetate (MAP) impregnated vaginal sponges and PMS on reproductive performance following spring and fall breeding. Spring-bred ewes were bred in April and May and fall-bred ewes in August and September. Each group was subdivided into five treatments: (1) control; (2) 40-mg MAP sponges; (3) 60-mg MAP sponges; (4) 40-mg MAP sponges plus 750 IU PMS; and (5) 60-mg MAP sponges plus 750 IU PMS.

The percent of exposed ewes that lambed, lambing rate, lambing percent, and days from end of treatment to conception in the five treatments of spring-bred ewes is shown in Table 1. Similar data for fall-bred ewes appear in Table 2.

Table 1.— Summary of Reproductive Performance of Spring-bred Crossbred Ewes During First Two Years in Production

Treatment	Control	Sponges Only		Sponges + PMS	
		40 mg	60 mg	40 mg	60 mg
No. ewes	54	27	26	26	28
No. ewes lambing	7	7	13	20	16
Lambing rate	1.1	1.4	1.1	1.5	1.6
Lambing %	14.8	37.0	53.9	115.4	92.6
Days from end of treatment to conception	21.9	8.0	6.2	5.6	3.1

Table 2. — Summary of Reproductive Performance of Fall-bred Crossbred Ewes During First Two Years in Production

Treatment	Control	Sponges Only 40 mg	Sponges Only 60 mg	Sponges + PMS 40 mg	Sponges + PMS 60 mg
No. ewes	50	25	28	22	27
No. ewes lambing	44	23	26	18	25
Lambing rate	1.5	1.6	1.5	1.6	1.5
Lambing %	132.0	144.0	139.3	127.3	137.0
Days from end of treatment to conception	18.6	9.7	9.3	19.1	9.2

Lambing rates were lower in the spring-bred ewes except in the treatment groups receiving PMS. Spring-bred ewes receiving sponges only or sponges plus PMS conceived in fewer days than did fall-bred ewes receiving similar treatments. However, in these groups 40.1% of spring-bred ewes lambed compared with 96.1% in the fall-bred group. PMS increased lambing rate only in the spring-bred ewes.

GENETIC, PHENOTYPIC AND ENVIRONMENTAL PARAMETER ESTIMATES FOR SEMEN TRAITS MEASURED ON YEARLING SOUTHDOWN RAMS

T. P. Goerke, F. A. Thrift and R. H. Dutt

Estimates of heritability of four semen traits measured on 173 yearling Southdown rams over a 12-year period were computed by paternal half-sib analysis of variance and regression of offspring on sire. Also, genetic,phenotypic and environmental correlations between the semen traits were estimated. Semen volume (VOLU), percent motile cells (%MOT), percent abnormal cells (%ABN), and sperm cell concentration (CONC) were the traits evaluated. Semen collections were made with an electroejaculator during three consecutive weeks in July of each year just prior to the beginning of the breeding season on August 1.

Heritability estimates and standard errors for each of the four semen traits are presented in Table 1. Heritability estimates for sperm cell concentration (0.07±0.18) and percent motile sperm cells (0.16±0.20) were relatively low. Since semen was collected using an electroejaculator, the moderately high heritability estimate for semen volume (0.43±0.23) may reflect variation in response to the electroejaculator by individual rams. The moderately high heritability estimate for percent abnormal sperm cells (0.42±0.23) would indicate the expression of genetic differences between sires relative to this trait during the season of the year (July) conducive to poor semen quality. Also, these results suggest that selection of rams with low percent abnormal sperm cells should increase semen quality.

Table 1. — Heritability Estimates and Standard Errors for Semen Traits

Trait	Heritability as Estimated by: Paternal Half-sib Analysis of Variance	Heritability as Estimated by: Regression of Offspring on Sire
CONC[a/]	0.07±0.18	-0.04±0.20
VOLU	0.43±0.23	0.43±0.23
%MOT	0.16±0.20	-0.04±0.18
%ABN	0.42±0.23	0.42±0.18

[a/] See text for abbreviations.

Genetic, phenotypic and environmental correlations between the semen traits are shown in Table 2. With one exception the genetic correlations are low to moderate in magnitude, and in all cases the standard errors are larger than the correlations. Of particular interest are the apparent favorable genetic relationships between sperm cell concentration and the percent motile and abnormal sperm cells. These results suggest that many of the genes responsible for increased sperm cell concentration are also

responsible for an increase in percent motile sperm cells and a decline in percent abnormal sperm cells. The phenotypic and environmental correlations suggest little relationship between semen volume and the other three semen traits. Also, the phenotypic correlations suggest that those rams with low sperm cell concentration or low motility tended to have a high incidence of morphologically abnormal spermatozoa.

Table 2. — Genetic, Phenotypic and Environmental Correlations Between Semen Traits

Traits		Phenotypic	Environmental
CONC-VOLU	0.21±1.15	0.09	0.07
CONC-%MOT	1.72±3.81	0.67**	0.52**
CONC-%ABN	-0.46±1.36	-0.46**	-0.54**
VOLU-%MOT	0.17±0.75	0.01	-0.07
VOLU-%ABN	0.01±0.51	0.01	0.01
%MOT-%ABN	0.03±0.80	-0.55**	-0.88**

**P < .01.

RELATIONSHIP BETWEEN SEMEN QUALITY AND EWE FERTILITY IN SOUTHDOWN SHEEP

T. P. Goerke, F. A. Thrift and R. H. Dutt

This study was initiated to determine the relationship between semen traits measured on yearling rams in July and the subsequent lambing performance of ewes to which these rams were exposed. Data were available on 32 rams, each of which had been exposed to approximately 20 ewes. Lambing performance of the ewes was measured as percent ewes lambing, lambs born per ewe exposed, lambs born per ewe lambing and lambing date. Semen collections were made with an electroejaculator during three consecutive weeks in July, just before the rams were exposed to the ewes on August 1. Semen volume (VOLU), sperm cell concentration (CONC), percent motile sperm cells (%MOT), and percent abnormal sperm cells (%ABN) were the semen traits evaluated.

Simple correlations between the sire semen traits and ewe lambing performance traits are presented in Table 1. A positive correlation existed between sperm cell concentration and each of the lambing performance traits with the correlation between concentration and lambing date being essentially zero. Under the collection methods employed in this study, semen volume did not seem to be related to any of the lambing performance traits. Correlations between percent motile sperm cells and the lambing performance traits indicated that an increase in percent motile sperm cells was accompanied by an increase in percent ewes lambing and lambs born per ewe exposed, while the average lambing date was earlier. The negative relationship between percent motile sperm cells and lambs born per ewe lambing (lambing rate) may be a reflection of the lower ovulation rate of ewes early in the breeding season and the higher conception rate early in the breeding season by those ewes exposed to rams with a high percent motile sperm cells.

Table 1. — Simple Correlations Between Sire Semen Traits and Ewe Lambing Performance Traits

Ewe Lambing Performance Traits	Sire Semen Traits[a/]			
	CONC	VOLU	%MOT	%ABN
Percent ewes lambing	0.25	0.02	0.27	-0.11
Lambs born/ewe exposed	0.24	0.01	0.07	-0.15
Lambs born/ewe lambing	0.12	-0.01	-0.14	-0.11
Lambing date	0.05	-0.05	-0.22	0.28

[a/] See text for abbreviations.

Correlations between percent abnormal sperm cells and the lambing performance traits indicate that as percent abnormal sperm cells increased, the percent ewes lambing, lambs born per ewe exposed and lambs born per ewe lambing declined, and the average lambing date was later. The apparent favorable relationships between semen quality of rams and the subsequent lambing performance of ewes to which these rams were exposed emphasizes the importance of ram fertility on the reproductive performance of the ewe flock and indicates the importance of semen evaluation of potential sires prior to their use in the breeding flock.

A STUDY OF CALVING INTERVALS IN KENTUCKY D.H.I.A. HERDS

D. Olds

Data for 36,276 calving intervals indicated that 60.9% of the cows had calving intervals of 12 months or less while 39.1% had intervals longer than 12 months (Table 1). The average interval was 382 ± 54 (s.d.) days. Since gestation periods are relatively fixed, the variability in calving intervals

Table 1. — The Frequency of Calving Intervals of Various Lengths in Kentucky DHIA Cows

Length of Calving Interval In Days	Months	No. of Cows	Percent of Cows
277-319	10	1,082	3.0
320-349	11	8,634	23.8
350-379	12	12,388	34.1
380-409	13	6,525	18.0
410-439	14	3,375	9.3
440-469	15	1,771	4.9
470-938	16 or over	2,501	6.9
	Total	36,276	100.0

is determined almost entirely by variation in days open (i.e. not pregnant) following calving. The average number of days open was 102 ± 54, of which 82 ± 34 was days from calving to breeding. Of the remaining 20 days, an average of 9 days were required for repeat breedings and 11 days were attributable to intervals longer than 21 days between services.

EFFECT OF BREEDING AT VARIOUS INTERVALS AFTER CALVING ON CALVING INTERVALS IN DAIRY CATTLE

D. Olds

Many writers for popular magazines and newsletters maintain that breeding cows at less than 60. days after calving not only results in lower conception rates but also causes embryonic deaths, abortions, and permanent infertility. The net effect, they assert, is that calving intervals would be longer for cows bred at less than 60 days than for those bred after that time.

As may be seen in Table 1, calving intervals were shortened by breeding at less than 60 days after calving. Regression coefficients indicated that each day that a cow was bred sooner than the average of 82 days, down to 35 days, resulted in a calving interval that was shorter by 0.9 days. It may also be estimated that 58% of the cows should have been in heat one or more times by 60 days after calving and that only 23 of these (or 40%) were bred at that time. Since the average interval from calving to breeding was 82 days, it is estimated that 40% of the cows could be bred an average of 20 days sooner without breeding any at less than 40 days. This should result in a reduction of the calving intervals by 18 days.

Table 1. — The Effect of Breeding at Various Intervals After Calving on Length of the Calving Interval

Days After Calving When Bred at First Service	No. Cows	Average Calving Interval (days)
1-30	713	342.8
31-60	7,726	353.4
61-90	16,807	373.9
91-120	7,359	400.4
121-150	2,279	430.7
151-180	774	461.0
181-210	317	495.5
211-240	149	521.3
241 or more	152	575.8
Overall	36,276	382.2

EFFECT OF BREEDING AT VARIOUS INTERVALS AFTER CALVING ON THE CHANCES FOR EVENTUAL CONCEPTION

D. Olds

Studies on 50,519 Kentucky DHIA cows, of which 2,723 were bred at 40 days or less after calving, indicated that, on the average, 68.8% of these early bred cows produced calves while 72.0% of those first bred at a later time eventually produced calves. As shown in Table 1, the percentage producing calves appeared to increase from 61.9 for cows bred at 11-20 days to 72.8 for those bred at 41-50 days and 73.7 for those bred at 71-80 days. On the average, 3.3% fewer cows became pregnant and produced calves if they were bred at 40 days or less after calving rather than later. However, such a trend was not apparent at 41 days or more after calving. It may be somewhat surprising that 28.2% of the cows producing one calf did not stay in the herds long enough to produce another calf. The data show that 5.8% of the cows were sold for dairy purposes and it may be estimated from other published studies that 4.7% were sterile, 5.5% aborted, 1.5% died, and 10.7% were sold because of low production.

Table 1. — The Effect of Breeding at Various Intervals After Calving on Eventual Conception

Days After Calving When Bred at First Service	No. Cows	Eventually Produced Calves (%)
1-10	34	67.6
11-20	194	61.9
21-30	824	69.2
31-40	1,671	69.4
41-50	3,248	72.8
51-60	5,754	73.1
61-70	8,043	73.4
71-80	8,254	73.7
81-90	6,590	73.2
91-100	4,792	72.3
101 or more	11,115	68.1
Overall	50,519	71.8

ESTRUS SYNCHRONIZATION OF SWINE WITH AIMAX, PMS AND HCG

G. L. Cromwell, R. H. Dutt, M. J. DeGeeter, T. W. Cathey,
and V. W. Hays

Two experiments involving 62 gilts were conducted to evaluate the efficiency of methallibure (AIMAX), pregnant mare serum (PMS) and human chorionic gonadotrophin (HCG) for synchronizing estrus in gilts.

In experiment 1, 48 crossbred gilts averaging 450 days of age at breeding were fed AIMAX at a level of 125 mg per day for 20 days (Table 1). Following withdrawal of AIMAX from the diet, 46 (95.8%) exhibited estrus. Of these 46 gilts, 45 (97.8%) exhibited estrus 6 to 11 days following AIMAX withdrawal, with an average of 8.96 days. Most of the gilts were given two natural services at 24-hour intervals, beginning at the onset of estrus. Of the 46 gilts that were bred, 45 (97.8%) farrowed an average of 11.14 total pigs and 9.70 live pigs per litter. Gestation length varied from 110 to 117 days, with an average of 113.5 days.

Table 1. — Estrus Synchronization of Gilts with AIMAX[a/]

No. gilts	48
Following AIMAX withdrawal, No. showing estrus on:	
day 6	3
day 7	5
day 8	10
day 9	7
day 10	13
day 11	7
day 12-21	1
No. gilts showing estrus	46
Av days to estrus	8.96
No. farrowed	45
Farrowing rate	
% of all gilts	93.8
% of those bred	97.8
Gestation length	
range, days	110-117
average, days	113.5
Av No. pigs born	11.14
Av No. pigs born alive	9.70
Av birth wt, lb	2.37

[a/] Fed at a level of 125 mg/gilt/day for 20 days.
[b/] Average of those showing estrus 6 to 11 days following AIMAX withdrawal.

In experiment 2, 14 Yorkshire gilts were fed 100 mg of AIMAX daily for 20 days. The gilts were injected with 1,000 IU of PMS on day 21 and 500 IU of HCG on day 25, and inseminated with fresh, extended semen 24 hr thereafter. Those gilts that evidenced estrus on day 25 were inseminated 6 hr after HCG administration.

All of the gilts exhibited estrus on day 25 or 26 (5 to 6 days after AIMAX withdrawal). Two of six gilts given two services at 24-hr intervals returned to estrus, and three of eight gilts given one service failed to conceive. Nine of the fourteen gilts inseminated (64.3%) farrowed an average of 8.77 total pigs and 7.33 live pigs. Gestation length varied from 112 to 116 days, with an average of 114.2 days.

EFFECT OF FEEDING LEVEL AT BREEDING ON REPRODUCTIVE PERFORMANCE OF SWINE

C. P. Moore, G. L. Cromwell, R. H. Dutt, V. W. Hays and J. R. Overfield

Thirty-six crossbred gilts were used to determine the effect of feeding level at breeding on ovulation rate and number of embryos at 28 days postbreeding. All gilts were fed 2.27 kg/day of a diet containing 3280 Kcal ME/kg and 15.0% protein. Feed was offered ad libitum to 12 of the gilts from the 7th day of their previous cycle to 24 hr postmating and to another 12 gilts for 24 hr postmating. All gilts were mated at the onset of estrus and 24 hr thereafter. Compared with those of the control gilts, the number of corpora lutea and embryos at 28 days was increased by the 24-hr ad libitum feeding (13.82 vs. 14.73 corpora lutea, 12.18 vs 13.18 embryos) and was further increased by the longer period of ad libitum feeding (16.09 corpora lutea and 14.63 embryos).

In a second experiment, 70 Yorkshire, Hampshire and crossbred gilts were fed 2.27 kg of feed daily and mated at the onset of estrus and 24 hr later. Approximately one-half of the gilts were fed an additional 2.27 kg of feed following the first mating or were offered feed ad libitum during the 24-hr interval between matings. Litter size at farrowing was slightly less in gilts fed the higher level at breeding (9.03 vs 9.89 total pigs; 8.18 vs 8.74 live pigs).

In a third experiment 34 crossbred gilts were given two feeding levels (2.27 kg/day or ad libitum) for the first 14 days of a 28-day breeding period. All gilts were field mated. Of the 17 gilts fed 2.27 kg at breeding, 17 (100%) farrowed an average of 10.7 pigs, whereas 14 of the 17 gilts (82%) fed the higher level at breeding farrowed an average of 9.7 pigs.

REPRODUCTIVE PERFORMANCE OF PROTEIN-DEFICIENT SOWS

Alan J. Svajgr, V. W. Hays, G. L. Cromwell and R. H. Dutt

Diets of equal energy were calculated to contain 2% (low) and 17% (high) protein and fed at a rate of 1.82 kg/day to crossbred gilts from 15 days after breeding to farrowing. The sows were allowed 5% (low) or 17% (high) protein diets ad libitum during a 14-day lactation period and individually fed 2.7 kg of the same diet following weaning.

Average weight changes (kg/day) from weaning to slaughter were 0.08 (high) and -0.13 (low). Sows were checked daily for estrus, mated naturally and slaughtered 28 days after breeding. Sows returning were slaughtered during the estrus period. The sows not showing estrus, all of which were in the low-protein group, were slaughtered 34 days after weaning.

Estrus occurred in all of the high-protein sows but in only 56% of the low-protein sows, the difference being highly significant ($P < .005$). The average interval from weaning to estrus was 4.5 days for the high- and 9.5 days for the low-protein sows ($P < .001$). The percent of sows pregnant of all sows was 41.2 for those fed high protein and 33.3 for those fed low protein and of sows showing estrus, 41.2% of the high- and 60.0% of the low-protein sows. These differences were not statistically ($P < .05$) significant. Average ovulation rates were reduced significantly ($P < .005$) in sows fed low-protein diets (16.9 vs 21.8); however, percent embryo survival was similar for the two groups. Ovaries of the sows fed low protein and not showing estrus were inactive, containing only small immature follicles and no corpora lutea. The uterus was regressed in size as compared with that of cycling sows.

This experiment demonstrates that an extended protein deficiency in the sow will significantly depress reproductive efficiency by causing inactive ovaries or lengthening the post-weaning interval to estrus and lowering ovulation rate.

NUTRITION SECTION

INCORPORATION OF RADIOACTIVE SULFUR INTO RUMEN MICROORGANISMS AS A MEASURE OF PROTEIN SYNTHESIS

C. L. Streeter, C. O. Little and G. E. Mitchell, Jr.

In vivo measurements of microbial protein synthesis in the rumen are variable because of the heterogeneity of rumen contents. However, accurate in vitro determinations of microbial protein synthesis can be made gravimetrically using nonprotein nitrogen sources after precipitation of the protein with tungstic acid. A series of in vitro incubations was conducted to determine if the incorporation of radioactivity from 35-sulfur sodium sulfate into rumen microorganisms could be used to measure protein synthesis.

Gravimetric determinations were used as a reference for microbial synthesis with washed cell inocula for all fermentations. Several fermentations were run to optimize 35-sulfur incorporation into protein. Twenty-four-hour incubations in sealed flasks with tungstic acid as a protein precipitant gave the most dependable comparisons between 35-sulfur incorporation and protein synthesis. Other experiments with added stimulatory factors for cellulose digestion showed that increased cellulose digestion was accompanied by increase of protein synthesis measured by 35-sulfur incorporation or precipitable protein.

When soy protein was used as an in vitro nitrogen source, the sulfur in the soy protein, owing to dilution, decreased the percentage of added 35-sulfur incorporated into protein. However, valid comparisons could be made for microbial protein synthesis when protein and nonprotein nitrogen sources were used if excesses of unlabeled sulfur were added to the ferment to minimize the dilution by sulfur in the soy protein. Gravimetric measurements of microbial synthesis were not reliable for the soy protein nitrogen source, because protein hydrolysis proceded faster than protein synthesis. From these preliminary experiments, it seems feasible to use the extent of 35-sulfur incorporation into microbial protein as an instrument for determining in vivo microbial protein synthesis.

VITAMIN E LOSSES FROM THE DIGESTIVE TRACT OF STEERS FED CORN OIL

N. E. Alderson, G. E. Mitchell, Jr., C. O. Little and R. E. Tucker

Extensive pre-intestinal disappearance of vitamin A has been demonstrated in cattle and sheep. Other work has shown that pre-intestinal losses of both vitamin A and vitamin E increase with increasing dietary corn levels. While no apparent differences in pre-intestinal losses of vitamin A have been shown in cattle and sheep fed added cottonseed oil or starch, increased requirements for vitamin E in poultry, rats and calves fed unsaturated fat have been reported. This suggests that intake of polyunsaturated fatty acids might have a major influence on vitamin E requirements for ruminants. The experiment reported here was designed to study possible changes in pre-intestinal losses of vitamin E when unsaturated fat was substituted for starch in steer diets.

Procedure

Six mature steers fitted with permanent abomasal fistulas were fed 5 kg daily of a balanced corn, alfalfa hay and soybean meal ration in a switch-back experiment. Seven % added starch was used as a control and was compared with 7% added corn oil. Animals were treated on the 14th day of the preliminary period with 5,000 IU of vitamin E and 20 g of chromic oxide. Treatment was reported 7 days later. Abomasal samples were taken before each treatment and 24 hr after treatment and were analyzed for vitamin E and chromic oxide.

Vitamin E losses were estimated using weighted averages of ratios of vitamin E to chromic oxide in abomasal contents 24 hr after treatment with vitamin E.

Results and Discussion

Disappearance of vitamin E was significantly greater for steers fed the control diet (36.4%) than for steers fed the diet with corn oil added (23.4%). The data confirm previous observations of pre-intestinal disappearance of vitamin E. The addition of corn oil appeared to increase the amount of vitamin E reaching the small intestine. This indicates that any detrimental effect of unsaturated fat on vitamin E utilization in ruminants cannot be attributed to increased ruminal destruction of the vitamin.

VITAMIN A TURNOVER IN THE LIVER OF NON-PREGNANT COWS

K. E. Webb, Jr., J. A. Boling, G. E. Mitchell, Jr.,
N. W. Bradley and C. O. Little

Studies to estimate the stability and rate of replacement for vitamin A in non-pregnant cows were conducted with radioactive vitamin A acetate. Six cows were intravenously injected with 1.14 mc of 11-12 ^{3}H-vitamin A acetate (specific activity 213 uc/mg) and one million units of unlabeled vitamin A. The cows were fed 908 g of shelled corn and 4.5 kg of grass hay per day. The ration was supplemented with sufficient vitamin A to maintain the liver stores. A period of 37 days was allowed for the labeled vitamin A to be stored in the liver and reach stability. Vitamin A turnover was then estimated from the disappearance of the labeled vitamin A in the liver at 21-day intervals for 190 days.

The average time required for one-half of the labeled vitamin A to be replaced was 221 $\pm$ 16.6 days. Levels of labeled vitamin A in the blood were consistent with continuous turnover of vitamin A stores in the liver. These data on mature cows are consistent with earlier data obtained with steers, which suggests that vitamin A stores turn over less rapidly in mature animals than in young growing animals.

INFLUENCE OF CORN OIL ON PRE-INTESTINAL DISAPPEARANCE OF VITAMIN A IN STEERS

R. D. Long, G. E. Mitchell, Jr. and C. O. Little

The close association of fat with metabolism of fat-soluble vitamins suggests that addition of dietary fat might influence loss of vitamin A before it reaches the normal site of absorption in the small intestine. In previous studies with wethers, about two-thirds of the administered vitamin A failed to reach the small intestine. The amount of this disappearance was not affected by adding 7% corn oil to the diet. This study was conducted to investigate the possible influence of corn oil on pre-intestinal vitamin A disappearance in steers.

Six steers with permanent abomasal cannulas were each fed 2.5 kg twice daily of a ground mixed basal ration containing cracked corn, alfalfa hay, soybean meal, molasses, dicalcium phosphate, ground limestone and salt with either 7% corn starch (control) or 7% cottonseed oil added. A 2-week preliminary period was followed by two recovery trials at 1-week intervals. Treatments were then reversed and the entire procedure repeated, yielding 12 determinations for each treatment. Pre-intestinal disappearance of vitamin A was estimated by collecting abomasal contents 24 hr after administration of 1,000,000 IU of vitamin A acetate and 20 g of chromic oxide in separate gelatin capsules. The change in ratio of chromic oxide to vitamin A from the ratio administered was used to estimate the percentage of administered vitamin A reaching the abomasum.

In agreement with the previous results obtained with wethers, major pre-intestinal disappearance of vitamin A was observed; but the extent of disappearance (69.4% for the control diet and 70.2% for the cottonseed oil diet) was not affected by cottonseed oil addition. It is concluded that moderate amounts of cottonseed oil added to ruminant diets have little influence on pre-intestinal vitamin A losses.

CREEP FEEDING SPRING CALVES ON KENTUCKY BLUEGRASS-LADINO CLOVER OR FESCUE-LADINO CLOVER PASTURE

N. W. Bradley, D. R. Lovell and J. A. Boling

A long-term study has been initiated to observe the effects of creep feeding spring and fall born calves on either bluegrass-ladino clover or fescue-ladino clover pastures. Sixty cows were allotted to the spring calving group. The first year's progress report of the pre-weaning gains of the spring-born calves on the two kinds of pasture and receiving creep or no creep feed is presented in Table 1. This is a long-term continuing project, and the results should be considered as a preliminary progress report. Additional data will be presented as they are collected and summarized.

Table 1. — First-year Data for Creep Feeding Spring Calves on Bluegrass-Ladino and Fescue-Ladino Clover Pastures, 1969.

	Bluegrass		Fescue	
	No Creep	Creep	No Creep	Creep
No. calves	15	15	15	15
Av daily gain, lb	1.87	2.11	1.45	1.82
Av feed/calf daily, lb[a]	----	2.93	----	2.90

[a] Calves were weaned at an average age of 206 days and received creep during the last 172 days.

RECOVERY OF CHROMIC OXIDE FROM THE GASTROINTESTINAL TRACT OF HEIFERS

P. R. Utley, J. A. Boling, N. W. Bradley and R. E. Tucker

The incomplete recovery of chromic oxide in many digestibility studies has stimulated interest concerning possible avenues of chromic oxide loss. The objectives of this study were: (1) to observe whether chromic oxide was absorbed from the gastrointestinal tract by the use of labeled chromic oxide, and (2) to determine the digestibility of dry-matter, crude protein and crude fiber using the total collection and indicator ratio methods for calculating digestibility coefficients.

Six Angus heifers were fed a ground ear corn ration containing 0.2% unlabeled chromic oxide. The heifers were fed this ration free-choice for a 30-day period. They were then placed in metabolism crates and fed 6.6 lb of the ration for the remainder of the experiment. A 7-day preliminary period was followed by a 9-day total excreta collection period. On day 1 of the total collection period, each heifer was dosed with 146 uCi of $^{51}Cr_2O_3$. Blood was sampled via jugular puncture and urine collected using urinary catheters at pre-determined intervals for subsequent counting. Feces were also collected, weighed and sampled for counting and for dry-matter, crude protein and crude fiber analyses.

Radioactivity was not detected in the blood or urine of the six heifers, indicating no absorption of chromic oxide. Coefficients of apparent digestibility for dry-matter, crude protein and crude fiber were not significantly different ($P < .05$) when calculated by the total collection and chromic oxide ratio methods. Recovery of unlabeled chromic oxide was 98.0% as measured by the colorimetric method.

EFFECTS OF CHLORMADINONE ACETATE (ESTROSTAT) ON PREWEANING AND POSTWEANING GROWTH RATE OF BEEF HEIFERS

N. W. Bradley, J. A. Boling, D. R. Lovell and A. W. Young

The decreased demand for feeder heifers relative to feeder steers may be attributed to the fact that heifers gain at a slower rate than steers and that many heifers are pregnant at the time they are

purchased for finishing in the feedlot. A further undesirable characteristic of open heifers is the occurrence of estrus and consequent disturbances in the feedlot.

Information on the effects of injections of a progestogen in heifer calves during the latter part of the preweaning phase would be of much interest to the beef cattle industry. The effect of progestogen treatment during this phase of the heifers development on rate of gain would be equally as informative as its effect on estrus suppression and consequent prevention of pregnancy.

Relatively more research has been conducted on the use of progestogens for heifers during the feedlot phase. The possible benefits of improved rate of gain and decreased disturbances during the feedlot phase are appealing to feedlot operators.

Another likely use of progestogens of more interest to operators of beef brood cow herds would be the effects of treatment with progestogen early in a heifer's life to suppress estrus on development of her reproductive system and subsequent breeding efficiency. Knowledge that estrus could be suppressed without harm to breeding values of heifers at a later time would simplify herd management and result in improved efficiency in the operation of beef brood cow herds. The objective of this study was to observe the influence of Estrostat on the pre-weaning and post-weaning growth of heifers and their subsequent breeding efficiency. Only the pre- and post-weaning data will be presented in this report.

Forty-eight beef type heifers of the Angus breed born during February, March and April/1968 were used in this study. At about 4 months of age the heifers were selected on the basis of uniform appearance and weight and were identified with ear tags and permanent ear tattoos. All heifers were weighed and allotted at random to experimental treatments as follows:

16 heifers - Controls
32 heifers - Injected with 125 mg. of Estrostat at 4 months and 6 months of age

Observations for estrus were not made during the pre-weaning phase, but herd bulls were running with the cows and calves during the period from the time the heifers were injected until they were weaned. At 8 months of age the 48 heifers were weighed and weaned, at which time the pre-weaning phase of this study was terminated.

At weaning the heifers were moved immediately to dry lot and fed a ration of corn silage free choice, plus 3 lb ground shelled corn and 1 lb soybean meal per head daily. They also had free access to steamed bone meal and salt. Each of the three groups of 16 heifers shown in Table 1 were subdivided so that the heifers were fed in six lots of eight heifers each. Heifers designated as Group 1 in Table 1 continued to serve as control animals during the growing phase. Heifers designated as Group 2 were treated with 250 mg Estrostat at weaning and 70 and 140 days post-weaning. Heifers designated as Group 3 were treated with 250 mg Estrostat at weaning and 98 days post-weaning. Observations for estrus were made twice daily during the growing phase. A heifer was considered to exhibit estrus if she stood while being ridden by other heifers. After the heifers had been in the feedlot for 196 days they were weighed following an over-night shrink, and the feedlot phase of the study was terminated.

Table 1.— The Effects of Estrostat on Preweaning Growth Rate of Heifer Calves from 4 to 8 Months of Age (120 Days).

	Treatment		
Item	Group 1 Control	Group 2 125 mg Estrostat	Group 3 125 mg Estrostat
Number	16	16	16
Initial wt, lb	300	269	294
Final wt, lb	440	418	436
Av daily gain, lb	1.17	1.24	1.18

Table 1 shows weight gain data for the 48 heifers from 4 to 8 months of age or 120 days just prior to weaning. Rate of gain was not different for the three groups of heifers. No observations for estrus were made during the pre-weaning period, but herd bulls were running with the cows and calves. During

the post-weaning phase of this study three heifers, two in the control group and one assigned to the 98-day treatment, delivered live calves. If one assumes a normal gestation period and calculates from the calving dates, the control heifers were bred about 31 and 51 days before weaning and the heifer assigned to the treatment group was bred about 12 days before weaning.

Table 2 shows weight gain data for the feedlot phase. Estrostat treatment had little effect on the gain of the heifers over the entire 196-day feedlot phase. However, this is not unexpected since these heifers were not sexually mature at the start of the feedlot phase, as was indicated by the lack of observed estrus in the control heifers during the first 112 days of the feedlot phase.

The effects of Estrostat on growth rate during the first part of the feedlot phase when the heifers were not exhibiting estrus and later when they were cycling are apparently different. Estrostat did not increase rate of gain when the heifers were not cycling (0-112 days). However, rate of gain was increased 21 and 14 percent, respectively, by Estrostat treatments 2 and 3 when the control heifers started to cycle (112-196 days). The gain increase produced by the two Estrostat treatments during the final 84 days of the feedlot phase was significant ($P < 0.05$).

Table 2.— Performance of Heifers in the Feedlot (196 Days).

	Treatment		
Item	Control	Estrostat at 0, 70 and 140 days	Estrostat at 0 and 98 days
Feedlot phase - 0-112 days			
Number	14	16	15
Av Init wt, lb	435	418	434
Av final wt, lb	611	571	602
Total gain	176.4	153.5	167.5
Av daily gain	1.58	1.37	1.50
Feedlot phase, 112-196 days			
Number	14	16	15
Av init wt, lb	611	571	602
Av final wt, lb	703	681	705
Total gain	91.1	109.8	103.2
Av daily gain	1.08[a/]	1.31[b/]	1.23[b/]
Feedlot phase, 0-196 days			
Number	14	16	15
Av init wt, lb	435	418	434
Av final wt, lb	703	681	705
Total gain	267.5	263.3	270.7
Av daily gain	1.37	1.34	1.38

[a, b/] Means on the same line with different superscript letters differ significantly ($P < .05$).

Rate of gain was rather low for all groups of heifers, and this may be due partly to a rather low energy ration. During the feedlot phase the heifers were fed 1.5 lb soybean meal, about 3 lb ground shelled corn, and corn silage on a free choice basis.

Table 3 gives results for twice-a-day observations for estrus during the 196-day feedlot phase of the study. Injection of 250 mg of Estrostat at 70-day intervals completely suppressed estrus during the entire feeding period. The 98-day injection interval appeared to be a little long for complete estrus suppression since 33% of heifers on this treatment exhibited estrus.

These data indicate that heifers injected with Estrostat gained equally as well as control heifers. Injection with 250 mg Estrostat at 70-day intervals during the postweaning phase of the study was the most effective in suppressing estrus. The breeding efficiency and reproductive phase of this study are in progress and will be reported at a later time.

Table 3.— Observation of Estrus During the Feedlot Phase (196 Days)

Treatment	Heifers[a/]	Number Observed Showing Estrus			
		0 Time	1 Time	2 Times	3 Times
Control	14	1	7	5	1
Estrostat at 0, 70 and 140 days	16	16	0	0	0
Estrostat at 0 and 98 days	15	10	5	0	0

[a/] Three heifers calved and were not included in the results.

NITROGEN METABOLISM AND WATER INTAKE OF STEERS

P. R. Utley, N. W. Bradley and J. A. Boling

Restricting the water intake of steers has been reported to result in increased nitrogen retention However, restriction of water intake was accompanied by a decrease in voluntary feed intake. The objective of this study was to observe the influence of restricted water intake on nitrogen metabolism in steers fed two levels of nitrogen and a constant daily feed intake.

Twelve Angus steers were assigned to a replicated 2 x 2 factorial experiment. Water was offered free choice or 60% of free choice and the ration fed contained either 80 g or 60 g of nitrogen. The rations were a ground ear corn-urea mixture formulated so that 8.8 lb contained either 80 g or 60 g of nitrogen. The steers were fed 8.8 lb of their respective ration in two equal increments twice daily. The steers were placed in metabolism crates for a 12-day preliminary period, followed by a 7-day total collection period.

Nitrogen retention tended to increase owing to water restriction at both levels of nitrogen intake. Urine osmolality (mOsm/kg H_2O) and specific gravity were significantly increased ($P < .05$) owing to water restriction at both levels of nitrogen intake. Within level of nitrogen intake, water restriction resulted in a significant increase ($P < .05$) in serum urea concentration. Total serum protein and blood hematocrit levels were not significantly influenced by water restriction.

PLASMA NITROGEN COMPONENTS IN THE YOUNG CALF

J. A. Boling, N. W. Bradley and J. C. Willard

This study was designed to observe the plasma nitrogen components and free amino acid patterns in newborn male and female calves. Twenty-five Angus calves were bled via jugular puncture 36 to 48 hr after birth. The blood was collected in heparinized tubes, centrifuged, and the plasma frozen for subsequent analyses.

Total plasma protein, free amino nitrogen and plasma urea nitrogen were not significantly different ($P < .05$) between the groups of bull and heifer calves. Total plasma protein averaged: 7.94 and 8.13 g/100 ml, free amino nitrogen: 80.14 and 83.36 ug/ml, and urea: 10.50 and 9.11 mg/100 ml for the bulls and heifers, respectively. Total plasma amino acids averaged 289.4 um/100 ml for the bulls and 293.7 um/100 ml for the heifers. The essential amino acids represented 40.87% of the total amino acids measured in the males and 40.17% in the females. Tryptophan was not measured in this study. Plasma amino acid patterns were established for each group of calves. Subsequent studies will be directed towards understanding the changes in nitrogen metabolism associated with growth of the bovine.

ADJUSTMENT OF STEERS TO DIFFERENT SUPPLEMENTAL NITROGEN SOURCES

A. W. Young, J. A. Boling, N. W. Bradley
and C. O. Little

Several studies related to the adaptation of the ruminant to urea suggest that the utilization of urea improves with the length of time fed. Other workers have indicated in similar studies that nitrogen balance increased with length of the feeding period. The objectives of this study were to observe the changes in nitrogen fractions reaching the abomasum and plasma urea and free amino acids with length of the feeding period.

Seven steers were fitted with permanent abomasal cannulae. The steers were randomly divided into two groups and fed a ground ear corn ration supplemented with either soybean meal or urea. The rations were calculated to be isocaloric and to contain 11% crude protein. Each ration had 0.22% chromic oxide added to quantitate the nitrogen reaching the abomasum. The experimental design was a single reversal or switchback. Each experimental period was preceded by a 3-week preliminary period. For the first 2 weeks, the steers were fed 4 lb of ground ear corn and 6 lb alfalfa hay. During the week prior to the initiation of the trial, the steers were fed only ground ear corn. During the experimental periods the steers were fed either 9 or 11 lb of their respective ration. Blood and abomasal samples were collected at predetermined intervals during the 70 days of each experimental period.

The overall means for abomasal protein and non-protein nitrogen, expressed as a percentage of total abomasal nitrogen, were not significantly different ($P < .05$) between rations. Since no significant ration effects were observed, overall regression coefficients were calculated for the nitrogen fractions reaching the abomasum. Protein nitrogen in the abomasum increased by 0.10% per day of the feeding period. Purine-pyrimidine nitrogen also showed a slight increase with length of the feeding period. Negative regression coefficients were observed for total abomasal nitrogen (g/day) and for non-protein nitrogen, free-amino nitrogen and bound-amino nitrogen when expressed as a percentage of total abomasal nitrogen. Plasma urea N (mg N/100 ml) was higher in steers fed the urea ration at the end of the feeding period. Total plasma amino acids (um/100 ml) and total essential amino acids increased with length of the feeding period. Total plasma non-essential amino acids decreased during the same time interval. Of the parameters measured in this study, no differential adaptation to the two supplemental nitrogen sources were observed.

SUPPLEMENTAL NITROGEN SOURCE AND PHYSICAL FORM OF SHELLED CORN IN CORN SILAGE RATIONS FOR FINISHING STEERS

J. A. Boling, N. W. Bradley and R. E. Tucker

Preceding reports have indicated that the gains of steers were lower when the steers were fed corn silage rations supplemented with a simple urea supplement and a small amount of grain than those whose rations were supplemented with soybean meal. The objective of this study was to compare the performance of steers fed corn silage rations supplemented with soybean meal or urea and the physical form of the corn was either cracked or finely ground.

Sixty yearling Angus steers averaging 765 lb were randomly allotted to 4 treatment groups. The steers were fed in lots of 5, with each treatment having 3 replicate lots. The steers were fed 8 lb of the respective supplement shown in Table 1 plus 40 lb of corn silage per head daily as follows:

Treatment 1. SBM - cracked corn
" 2. SBM - ground corn
" 3. Urea - cracked corn
" 4. Urea - ground corn

The performance and carcass data are shown in Table 2. The average daily gains were similar for all 4 groups of steers. All groups of steers graded from high good to low choice. Dressing percentage, marbling score, ribeye area and fat over the 12th rib were also similar for all groups of steers. The physical form of the corn appeared to have little influence on the utilization of nitrogen. The depression in gain observed by feeding urea in other studies was not evident in this experiment.

Table 1. — Composition of Supplements Fed with Corn Silage

Ingredient	Supplement	
	SBM	Urea
	(percent)	
Shelled corn	74.67	93.70
Soybean meal (44%)	22.22	---
Urea 281	---	2.89
Dicalcium phosphate	0.66	1.11
Gr. limestone	0.78	0.63
Plain salt	1.67	1.67

2,000 IU vitamin A added per lb of supplement.

Table 2. — Performance and Carcass Data of Steers Fed Different Nitrogen Sources and Physical Forms of Shelled Corn With Corn Silage[a/]

	Soybean Meal		Urea	
	Cracked Corn	Ground Corn	Cracked Corn	Ground Corn
No. steers	15	15	15	15
Initial wt, lb	758	774	765	763
Av daily gain, lb	2.14	2.18	2.12	2.12
Carcass data:				
Dressing, %	62.69	62.00	60.54	63.40
U.S.D.A. grade[b/]	11.00	11.93	11.07	11.36
Marbling[c/]	4.36	5.00	4.33	4.43
Ribeye area, sq. in.	12.68	12.17	11.97	12.36
Fat thickness, in[d/]	0.47	0.48	0.44	0.49

[a/] The feeding period was 133 days.
[b/] High good = 11, low choice = 12.
[c/] Slight = 4, small = 5.
[d/] Measured at 12th rib.

PHYSICAL FORM OF ROUGHAGE AND SUPPLEMENTAL NITROGEN SOURCES IN STEER FINISHING RATIONS

J. A. Boling, N. W. Bradley, P. R. Utley
and J. R. Overfield

The feeding of roughage in various physical forms and levels in steer finishing rations has been the subject of rather extensive research. The level of added roughage to finishing rations has been quite variable. In many instances, all-concentrate rations are fed successfully. The objective of this study was to observe the performance of steers fed 20% ground or long alfalfa hay in ground shelled corn base rations supplemented with soybean meal or urea.

Fifty-six yearling Angus steers averaging 770 lb were randomly allotted by weight to 4 treatment groups. Each treatment group had two replicated pens of seven steers each. The steers were fed the rations shown in Table 1 as follows.

Treatment 1. Ration A - ground hay.
" 2. Ration A - long hay.
" 3. Ration B - ground hay.
" 4. Ration B - long hay.

The alfalfa hay in treatments 1 and 3 was ground, using a ½-inch screen, and was mixed with the remaining ingredients of the ration. When long hay was fed in treatments 2 and 4, the quantity of hay fed was adjusted daily according to concentrate consumption. The steers were fed these rations for 111 days.

Table 1. — Composition of Rations

Ingredient	Ration A	Ration B
	(percent)	
Gr shelled corn	76.22	78.53
Soybean meal (44%)	2.70	---
Urea 281	---	0.35
Alfalfa hay	20.00	20.00
Gr. limestone	0.08	0.06
Dicalcium phosphate	---	0.06
Plain salt	1.00	1.00

1,000 IU supplemental vitamin A added per lb of feed.

The growth and carcass data are presented in Table 2. The average daily gains were similar for all groups of steers. The daily feed intake was slightly lower in the urea-ground hay group than for the other three groups of steers. The mean carcass grades of all groups of steers were low to average choice. Grinding of the alfalfa hay resulted in no apparent improvement in gain when the steers were supplemented with soybean meal or urea.

Table 2. — Feedlot Performance and Carcass Data of Steers Fed Different Supplemental Nitrogen Sources and Physical Forms of Alfalfa Hay[a/]

	Soybean Meal		Urea	
	Gr. hay	Long hay	Gr. hay	Long hay
No. steers	14	14	14	14
Initial wt, lb	771	773	776	770
Av daily gain, lb	2.67	2.63	2.62	2.61
Av daily feed, lb	25.6	26.0	23.8	26.6
Carcass data:				
Dressing, %	65.97	65.11	65.04	65.33
U.S.D.A. grade[b/]	12.6	12.0	12.5	12.7
Marbling score[c/]	5.3	4.9	5.4	5.3
Fat thickness, in[d/]	0.64	0.66	0.60	0.64
Rib eye area, sq in	12.7	12.5	12.1	12.2

[a/] Feeding period was 111 days.
[b/] 12 = low choice, 13 = av choice.
[c/] Slight = 4, small = 5, modest = 6.
[d/] Measured at the 12th rib.

SOYBEAN MEAL AND UREA IN STEER FINISHING RATIONS

J. A. Boling, N. W. Bradley, P. R. Utley
and J. R. Overfield

Recent reports have indicated that the gains of steers were less when the steers were fed rations in which all of the supplemental nitrogen was added as urea as compared with the gains of those whose rations were supplemented with natural preformed protein. This experiment was designed to compare the gains and carcass characteristics of steers fed ground shelled corn rations supplemented with soybean meal or urea and fed 10% long alfalfa hay as the roughage source.

Twenty-eight yearling Angus steers were randomly allotted by weight to two treatment groups. The steers were fed in lots of 7, with each treatment replicated twice. The rations fed for 111 days are presented in Table 1. The quantity of long hay fed each day was adjusted according to daily concentrate intake.

Table 1. — Composition of Rations

Ingredient	Ration	
	1-SBM	2-Urea
	(percent)	
Gr shelled corn	83.97	87.91
Soybean meal (44%)	4.60	---
Urea 281	---	0.59
Alfalfa hay	10.00	10.00
Gr limestone	0.43	0.40
Dicalcium phosphate	---	0.10
Plain salt	1.00	1.00

1,000 IU supplemental vitamin A added per lb of feed.

The performance and carcass data are presented in Table 2. The average daily gains of steers fed the soybean meal supplemented ration were slightly greater than for those fed the urea supplemented ration. Daily feed intakes were similar for both groups. The steers in both treatments graded slightly above low choice. The carcasses of the urea-supplemented steers had a slightly higher degree of finish as evidenced by the measurement of fat over the 12th rib.

Table 2. — Performance and Carcass Data of Steers Fed Rations Supplemented with Soybean Meal or Urea

	Ration	
	SBM	Urea
No. steers	14	14
Initial wt, lb	769	767
Av daily gain, lb	2.41	2.33
Av daily feed, lb	23.73	23.65
Carcass data:		
Dressing, %	65.68	65.69
U.S.D.A. grade[a]	12.1	12.4
Marbling score[b]	4.9	4.9
Fat thickness, in[c]	0.57	0.68
Rib eye area, sq in	12.9	12.6

[a] 12 = low choice, 13 = av choice
[b] Slight = 4, small = 5
[c] Measured at 12th rib

CONDITIONING STEER CALVES FOR THE FEEDLOT

N. W. Bradley, J. A. Boling, P. R. Utley
and J. R. Overfield

Several studies have been conducted concerning the handling of steer calves as they arrive at the feedlot from purchasing points. Shipping fever and respiratory complications are often prevalent during this time of stress. This experiment was designed: (1) to compare the short-term growth rate and feed

efficiency of steer calves while fed various antibiotic-sulfa drug combinations for a 28-day period and (2) to evaluate the effect of these orally fed antibiotic-sulfa drug mixtures on the incidence of apparent disease conditions.

One-hundred and forty-four Angus steer calves averaging 355 lb were randomly allotted to 6 groups of 24 steers each. Each treatment group was replicated twice, resulting in 12 steers per pen. The steers were offered corn silage free-choice plus 1 lb of soybean meal (44% crude protein) per steer daily containing the following antibiotic or sulfa drug mixtures:

1. Control (no antibiotic or sulfa drug).
2. Chlortetracycline* + Sulfathiazole, N.F., to provide 350 mg chlortetracycline and 350 mg sulfathiazole/steer daily.
3. (Chlortetracycline + sulfamethazine)** to provide 350 mg chlortetracycline and 350 mg sulfamethazine/steer daily.
4. Chlortetracycline* + Sulfamethazine, U.S.P., to provide 350 mg chlortetracycline and 350 mg sulfamethazine/steer daily.
5. Chlortetracycline* to provide 350 mg chlortetracycline/steer daily.
6. Sulfathiazole, N.F., to provide 350 mg sulfathiazole/steer daily.

The steers also had free access to steamed bone meal and salt.

The steers were observed at frequent intervals for signs of shipping fever and other complications. When the rectal temperature of a steer was observed to be between 103° and 104° F, the animal was treated with injectable oxytetracycline. If the initially observed temperature was 104° F, or more, the steer received injectable oxytetracycline and was bolused with sulfabromethazine.

A summary of the study is presented in Table 1. The average daily gains were not significantly different ($P < .05$) for the six groups of steers. However, the gains in all treated groups tended to be slightly greater than the gains for the control group. The number of steers requiring treatment with oxytetracycline and/or sulfabromethazine was similar for all groups. One steer in group 5 died because of fibrous pneumonia.

Table 1.— Summary of Conditioning Study with Steer Calves[a/]

	Treatment					
	1	2	3	4	5	6
No. steers	24	24	24	24	24	24
Av daily gain[b/]	1.72	2.06	1.93	2.01	1.79	1.81
Soybean meal, lb	1	1	1	1	1	1
Corn silage, lb/day	16.6	16.9	16.9	17.3	15.6	16.6
No steers treated	3	5	3	3	4	4
Mortality[c/]	0	0	0	0	1	0

[a/] 28-day feeding period.
[b/] Means were not significantly different ($P < .05$).
[c/] Post-mortem examination revealed lesions typical of fibrous pneumonia.

WINTERING YEARLING STOCKER STEERS WITH LIMITED PROTEIN AND ENERGY SUPPLEMENTS

J. A. Boling, N. W. Bradley and D. R. Lovell

This study was the second experiment in a series designed to study the utilization of surplus standing Kentucky bluegrass forage by stocker steers. The steers were fed limited protein and energy supplements during the grazing period, which was from December to April.

*NOPCO CTC "50".
**Aureo S-700.

One hundred yearling Angus steers averaging approximately 706 lb were randomly allotted to four groups. The treatment groups were:

1. Grass range only.
2. Grass + 1 lb soybean meal (49% crude protein)/steer/day.
3. Grass + 3 lb ground shelled corn/steer/day.
4. Grass + 1 lb SBM + 3 lb corn/steer/day.

The range grazed during this experiment was 302 acres of predominantly Kentucky bluegrass sod. The pasture was subdivided, and the groups of steers were rotated among plots weekly to insure consumption of similar forage. Salt and steamed bone meal were provided for the steers free choice. Each steer was injected with 1 million IU of vitamin A at the initiation of the experiment and also on day 56. The steers were fed 16 lb of low quality grass hay/steer daily only when the grass was completely covered with snow. The grazing period was from December 4 to April 9 (126 days).

The gains of steers are presented in Table 1. During the experiment, there was only one day in which the grass was completely covered with snow. Each steer in all groups was fed 16 lb of low quality grass hay on this day. The groups of steers fed the limited protein and energy supplements separately had significantly ($P < .05$) greater average daily gains than those steers grazing the grass range only. The steers fed the combination of protein and energy (1 lb SBM + 3 lb corn) had greater ($P < .05$) daily gains than the other three groups of steers. These data indicate that steers can be maintained and make limited gains on standing bluegrass range. The steers responded similarly to limited protein and energy supplementation. The greatest average daily gains resulted from feeding the combination of the protein and energy supplements.

Table 1.— Performance of Steers Wintered on Kentucky Bluegrass Plus Limited Protein and Energy Supplements[1/]

	Grass Only	1 lb SBM	3 lb Corn	1 lb SBM + 3 lb Corn
No. steers[2]	25	24	25	25
Initial wt, lb	706	706	707	703
Final wt, lb	720	745	751	774
Av daily gain, lb[3]	0.11[a]	0.32[b]	0.36[b]	0.57[c]

1/ Each steer was fed 16 lb of hay during the experiment.
2/ One steer died in the soybean meal group.
3/ Means on the same line bearing different superscript letters differ significantly ($P < .05$).

WINTERING BEEF COWS ON GROUND EAR CORN

D. R. Lovell, D E Douglas, N. W. Bradley and J. A. Boling

Cattlemen for many years have tried to discover the most economical method of wintering brood cows while maintaining a level of nutrition that would not fatten the cows or cause them to lose excessive weight. The major cost of beef production is providing feed during the winter months and more economical methods of adequately wintering cattle must be found in order to maximize profits.

It has generally been accepted that hay alone is usually adequate nutritionally and economically for wintering dry cows. However, in recent years cattlemen often experience a hay shortage or else feel that hay is too expensive to buy. In many years when hay is scarce, grain is often cheaper than roughage. High costs of labor and equipment which are necessary for storing hay may cause cattlemen to use other feeds. This experiment was designed to determine the value of feeding ground ear corn alone to dry and lactating beef cows from January to April.

Twenty-four Hereford and twenty-seven Shorthorn cows were used in this experiment. The Hereford cows were from the West Kentucky Substation herd. These cows had been culled from the herd because of reproductive problems or poor production. Eight of these cows were pregnant and seven of them calved while on test.

The 27 Shorthorn cows were from the Coldstream Farm herd. Ten of these cows had calved in the fall and had calves by their side when the study began on January 8. Thirteen of the Shorthorn cows were pregnant, and 10 of these calved while on test.

The cows were divided into two groups, one being the lactating group, the other group consisting of the dry cows. All cows that calved were moved into the lactating group after calving except for those that had dead calves at birth. These cows remained in the dry cow group.

The dry cows were fed 8 lb of ground ear corn per cow daily beginning January 8 and ending April 2. The lactating cows received 14 lb of ground ear corn per cow per day during the same period. It was estimated that these rations would allow the cows to lose approximately 0.5 lb of body weight per head daily or 42 lb per cow during the winter. All cows were provided steamed bone meal and salt fortified with vitamin A free choice.

Individual weights were taken on each cow at the beginning of the study, January 8, and every 28 days thereafter, including the 84-day weight on April 2 which was the final weight. They were scored by visual appraisal as to condition (thin, medium and fat) by a committee of three scorers at the beginning and end of the test period.

The dry cows were run on a 17.1 acre plot beginning on January 8. This area had been used for feeding 35 heifer calves and yearlings up to this date, and most of the pasture growth had been consumed; however, the cows grazed considerably and apparently got some grass even though it was very short. The lactating cows ran on a 25.3 acre plot which they had glazed since early fall. All visible forage had been consumed by January 8.

The dry cows did not receive any hay during the winter. They were allowed to eat only grass without any supplemental feed until the beginning of the test. The lactating cows received hay fed in a normal manner from fall until the test period began, after which they were fed only grain.

The cows were hand fed each morning during the study. They had access to a self feeder containing steamed bone meal and salt with vitamin A mixed in the salt at a level so that each ounce of salt contained 60,000 IU of vitamin A. The cows consumed an average of 1 ounce of salt per head per day during the test.

A total of four cows lost their calves during the study. It was theorized that these death losses were more a result of using cows with a history of reproductive problems rather than being associated with the experimental treatments.

Table 1 shows the weight loss of each group of cows and their beginning and ending condition scores.

In Table 1 the dry cows were the cows that were dry at the end of the test and the lactating cows were the cows that had calves by their side at the end of the study.

Table 1.— Weight Changes and Condition Scores

	No. of Cows[a/]	Initial Wt, lb	Final Wt, lb	Loss per Cow, lb	Initial[2] Score	Final Score
Dry	26	959	912	47	2.11	2.15
Lactating	23	1,097	987	110	2.60	2.40

[a/] One cow in each group died during the experiment.
[b/] Condition scores: thin = 1; medium = 2; fat = 3.

Condition scores were similar even though the cows lost weight. The dry cows lost 47 pounds, while their condition scores stayed about the same. This is probably because included in the dry group were four cows that had lost calves, so a cow could lose weight due to calving but not lose any actual body tissue. The lactating cows lost an average of 110 lb. However, included in the lactating cow's weight loss is the loss incurred as a result of calving.

The calves were allowed access to a grain creep. The 10 calves that were born in the fall gained an average of 1.78 lb per head per day during the study. The calves that were born during the experiment were doing satisfactorily and were in good physical condition at the end of the test. The cows also appeared to stay in good physical condition, and it was evident that the cows were showing signs of estrus and were cycling at the end of the test.

Table 2 shows a more accurate measure of actual tissue gains and losses that were not associated with the weight of the calf or the fluids and placental membranes lost during calving.

In Table 2 the 28-day period in which calving took place is omitted. The dry cow group includes all the cows that were dry at the beginning of the test. These cows were terminated on the weigh day before they calved. If they did not calve they were terminated on April 2. The wet cow group includes the cows that were lactating at the beginning of the test, and the other cows calved during the test had their beginning on the weigh day after they calved and all wet cows were terminated on April 2. The cows that lost their calves were terminated on the weigh day before calving and were then designated as dry cows.

Table 2— Weight Changes of Cows Not Including Loss Due to Calving.

Group	Initial Wt, lb	Final Wt, lb	Loss per cow, lb
Dry	960	933	27
Lactating	1,063	1,033	30

These data suggest that both lactating and dry cows can be wintered satisfactorily on ground ear corn supplemented with adequate vitamins and minerals. Even though both groups lost some weight it is believed that these small weight losses had no harmful effects on the cow or the fetus. It would also appear that the economics of wintering beef cows on grain might be justified in certain years when the cost of hay or other roughage is high.

PLASMA AMINO ACIDS AND ENERGY SOURCES IN SHEEP TREATED WITH INSULIN

J. L. Call, G. E. Mitchell, Jr.,
C. O. Little, R. E. Tucker and D. G. Ely

Insulin has been reported to influence the levels of glucose and fatty acids in the blood of both ruminant and monogastric animals. The hormone is essential for normal nitrogen metabolism in monogastric animals; however, the importance of insulin in the normal metabolism of protein in ruminant animals is poorly understood. This experiment was conducted in two parts to study the influence of insulin administrations on the circulatory nitrogen and energy sources of sheep.

In the first trial four mature wethers were placed in digestion crates and allowed a 7-day adjustment period. They were then prepared with temporary jugular catheters and an initial blood sample was taken. An insulin dosage of 0.20 unit per kg body weight was then injected. Forty-five minutes later another blood sample was taken. After insulin injection plasma sugars declined 46%, plasma acetate decreased 5.6%, plasma-free amino nitrogen declined 8.7% and total amino acids declined 26%. With the exception of glycine, each of the individual amino acids studied was lower following insulin injection.

The second trial was conducted in a manner similar to trial 1 except that 12 mature wethers received either 0.20 unit of insulin per kg of body weight or saline in a switch-back arrangement. Blood samples were taken prior to the injection of each treatment and 45 minutes after injection. Plasma samples were analyzed for reducing sugars, urea, acetate, plasma-free amino nitrogen and sixteen amino acids. Plasma glucose was significantly depressed by the insulin injection ($P < .001$), whereas urea, acetate and free-amino nitrogen were not affected. Of those amino acids analyzed, glutamic acid, isoleucine, leucine, tyrosine, lysine, histidine, proline and arginine were significantly depressed by insulin treatment ($P < .10$). The plasma levels of alanine, valine, methionine and phenylalanine were

lower following insulin treatment; however, the depressions were not statistically significant ($P < .10$). Aspartic acid, threonine, serine and glycine were not influenced by the insulin treatment.

The results of this study indicate a marked influence of insulin on plasma levels of several amino acids. It is noteworthy that insulin influenced the basic amino acids and, in general, the dietary essential amino acids most. This observation is in agreement with reports concerning the influence of insulin on the levels of plasma amino acids in monogastric animals.

PROLINE SUPPLEMENTATION OF HIGH ROUGHAGE - UREA RATIONS FOR SHEEP

Arnold Foster, C. O. Little and G. E. Mitchell, Jr.

Interest in cheaper rations for ruminants has directed much research toward the utilization of urea and other nonprotein nitrogen (NPN) sources. Several researchers have shown that total nitrogen in a ration can be supplied by urea. However, comparisons of all-urea-nitrogen rations with soybean protein rations have indicated reductions in animal performance of up to 50% with the NPN ration. Different approaches have been used in an effort to increase the utilization of urea in maintenance rations and to improve the use of higher levels in growing and finishing rations.

Table 1. — *In Vitro* Digestion and Microbial Protein Levels with Added Proline or Valeric Acid

Treatment	Cellulose Digestion %		Protein N (mg/100 ml)	
	Exp. 1	Exp. 2	Exp. 1	Exp. 2
Zero time	-	-	5	8
24-hr fermentation				
No added N	27	18	5	8
Urea	50	19	12	11
Urea + Proline	63	40	19	17
Urea + Valeric acid	68	53	18	15

Table 2. — Cellulose Digestion, Nitrogen Retention and Plasma Urea Nitrogen with Proline Supplementation for Wethers

	Cellulose, g/day		Nitrogen, g/day		Plasma Urea N
	Intake	Digested	Intake	Retained	mg/100 ml
13.2% Protein Level Treatment[a]					
Purified soy	237	90.2[c]	14.5	2.8[c]	17.3
Urea	237	76.3[d]	14.9	1.9[c]	27.4
Urea + 5.3 g proline per kg of ration	237	93.2[c]	15.1	1.1[d]	25.8
7.0% Protein Level Treatment[b]					
Urea	237	94.7	7.4	-0.3	12.48
Urea + 2.65 g proline/kg	237	93.0	7.4	0.0	11.07
Urea + 1.32 g proline/kg	237	95.3	7.4	+0.6	8.66

[a] Eight animals per treatment.
[b] Four animals per treatment.
[c, d] Values with different superscript are significantly different ($P < .01$).

Proline added to in vitro mixed cultures of rumen microorganisms has stimulated cellulose digestion. The experiments in this study were conducted to determine the relationship between cellulose digestion and incorporation of (NPN) into protein nitrogen (PN) by the rumen microorganisms and to study the rumen stimulatory effects of proline in vitro and in vivo.

The results indicate that certain factors which increased cellulose digestion in vitro also increased the synthesis of protein from urea by rumen microorganisms. Wethers responded to a high level of dietary proline by digesting increased levels of cellulose in a high-roughage ration supplemented with urea. Nitrogen balance in the wethers did not respond the same as did cellulose digestion. However, proline additions to urea-supplemented rations decreased plasma urea nitrogen levels and increased nitrogen retention of wethers fed marginal nitrogen levels.

NITROGEN COMPONENTS IN THE DIGESTIVE TRACT OF LAMBS FED CORN GLUTEN MEAL AND UREA

H. E. Amos, D. G. Ely, G. E. Mitchell, Jr. and C. O. Little

Limited data are available on the digestion and absorption of different protein sources in the gastro-intestinal tract of ruminants. Supplementary nitrogen sources of quite different chemical and physical properties were used in this study to estimate the utilization of urea in the rumen, dietary nitrogen escaping rumen degradation, and endogenous nitrogen secretion, as well as identifying the sites of protein hydrolysis and absorption in the ruminant animal.

Procedure

Fifteen Hampshire-sired crossbred wether lambs were fed five conventional fattening rations in which corn gluten meal (CGM), urea, or combinations of CGM and urea provided the supplementary nitrogen. In ration 1 CGM was the sole source of supplementary nitrogen, and in ration 5 urea provided all the supplementary nitrogen. In rations 2, 3 and 4 CGM provided 75, 50 and 25% of the supplementary nitrogen, with the remaining supplementary nitrogen provided by urea. At the end of 21-day feeding, all lambs were sacrificed, the gastro-intestinal tracts removed and sections ligated. Digesta samples were obtained from the rumen, omasum, abomasum, duodenum, jejunum, ileum, cecum and colon. Digesta samples were analyzed for total nitrogen, protein and nonprotein amino nitrogen.

Results and Discussion

The percentage of dietary nitrogen recovered in each section of the digestive tract is shown in Table 1. Except for ration 5, there was a marked trend for a lower percentage of nitrogen recovery in the rumen as the level of urea in the diet increased. Abomasal nitrogen recovery was highest with ration 2, the ration in which 75% and 25% of the supplementary nitrogen were provided by CGM and urea, respectively. The latter observation indicates considerable microbial utilization of the added urea and possibly small microbial degradation of the added CGM, resulting in a higher percentage of dietary nitrogen reaching the abomasum.

Table 1.— Percentage Recovery of Dietary Nitrogen in Each Digestive Tract Section

	Ration				
Section	1	2	3	4	5
Rumen	113	71	56	40	62
Omasum	110	102	62	33	64
Abomasum	78	131	64	40	45
Duodenum	298	481	366	272	174
Jejunum	283	173	188	141	172
Ileum	74	129	99	56	70
Cecum	21	31	21	25	26
Colon	30	37	42	28	27

There was also a trend for endogenous nitrogen secretion to increase as the percentage of dietary nitrogen reaching the small intestine increased (duodenal values, Table 1). Overall nitrogen digestibility was not influenced by source of supplementary nitrogen and resulted in a mean apparent nitrogen digestibility of 59% for all rations.

The distribution of dietary nitrogen into protein and nonprotein amino nitrogen is shown in Tables 2 and 3. There were no significant differences between treatments in the percentage of total nitrogen present as protein or nonprotein amino nitrogen in any section of the tract. The data indicate that the percentage of total nitrogen as protein decreased from the rumen to the jejunum and increased thereafter (Table 2) and was accompanied by an increased percentage of total nitrogen as nonprotein amino

Table 2. — Percentage Total Nitrogen Recovered as Protein in Each Digestive Tract Section

	Ration				
Section	1	2	3	4	5
Rumen	75	80	71	65	82
Omasum	89	87	84	71	82
Abomasum	52	67	70	63	55
Duodenum	46	59	56	58	59
Jejunum	28	28	24	24	15
Ileum	55	53	55	56	52
Cecum	59	59	56	62	62
Colon	73	79	76	78	70

nitrogen in these sections. These observations indicate that the lamb is capable of hydrolyzing protein reaching the abomasum and small intestine whether of dietary, endogenous or microbial origin (Table 2). The increases in nonprotein amino nitrogen in the abomasum, duodenum and jejunum indicate protein digestion, and the abrupt decrease in this component in the cecal digesta (Table 3) is indicative of amino acid absorption from the small intestine.

Table 3. — Percentage Recovery of Total Nitrogen as Amino Nitrogen in Each Digestive Tract Section

	Ration				
Section	1	2	3	4	5
Rumen	12	16	24	35	14
Omasum	9	9	10	20	11
Abomasum	52	29	22	28	47
Duodenum	49	47	38	48	47
Jejunum	91	81	91	73	86
Ileum	41	58	36	39	55
Cecum	26	30	22	22	28
Colon	23	12	13	13	22

LAMB PERFORMANCE ON CORN GLUTEN MEAL AND UREA SUPPLEMENTED RATIONS

H. E. Amos, D. G. Ely, C. O. Little and G. E. Mitchell, Jr.

Corn gluten meal which contains large quantities of zein protein, has been shown to be quite insoluble in the rumen and results in lowered quantities of lysine available for absorption. Urea, a nonprotein nitrogen source, is readily hydrolyzed in the rumen, releasing ammonia which may be used by the rumen microorganism for microbial protein synthesis. Microbial protein is considered to be a

relatively good source of lysine. Microbial protein and corn gluten meal by-passing the rumen would presumably be complimentary in amino acid content and result in improved lamb performance. The objective of this experiment was to measure lamb growth, feed intake and plasma amino acids in lambs receiving varying proportions of supplementary nitrogen from corn gluten meal and urea.

Procedure

Fifty Hampshire-sired crossbred wether lambs were assigned to 5 ration treatments of 10 lambs each. The rations were formulated to represent a conventional fattening ration for lambs with the supplemental nitrogen provided by either corn gluten meal (CGM) or urea. In ration 1, all supplemental nitrogen was provided by CGM. The CGM nitrogen decreased in increments of 25% in rations 1 through 5, respectively, with the remaining supplemental nitrogen provided by urea. Lamb weights, jugular blood and feed consumption were obtained after 56 days for calculation of the rate of gain, feed efficiency and plasma amino acid concentration.

Results and Discussion

Rate of gain and feed efficiency at the end of 56-days are presented in Table 1. The fastest rate

Table 1.— Feed Intake, Weight Gains and Plasma Amino Acid Levels of Lambs Fed Graded Levels of Corn Gluten Meal and Urea (56 Days)

	Supplemental Nitrogen				
	100% CGM	75% CGM 25% Urea	50% CGM 50% Urea	25% CGM 50% Urea	100% Urea
Feed intake, kg	71.8	69.5	70.2	73.1	65.2
Weight gain, kg	11.2	12.3	10.1	10.9	9.7
Plasma amino acids, um/100 ml					
Threonine	24.6	22.9	23.8	22.6	23.7
Valine	31.9	27.7	27.2	27.6	21.7
Methionine	5.5	3.7	2.7	4.9	3.8
Isoleucine	9.7	9.5	8.7	10/1	8.6
Leucine	33.9	28.4	24.1	32.4	13.4
Phenylalanine	12.0	11.4	10.0	19.0	9.5
Lysine	12.0	14.5	11.2	15.8	15.1
Histidine	11.2	14.5	11.2	15.8	11.7
Arginine	13.7	13.5	12.7	17.4	15.5
Total	154.5	146.1	131.6	165.6	123.0
Aspartic	4.0	3.8	4.8	5.2	3.6
Serine	19.7	14.2	12.4	16.0	16.6
Glutamic	15.1	18.4	17.5	16.3	15.6
Proline	22.5	17.1	8.7	11.4	11.4
Glycine	51.5	48.0	44.1	53.8	56.7
Alanine	30.5	39.5	27.6	33.7	28.7
Cystine	9.2	7.0	9.0	7.6	9.5
Tyrosine	14.8	10.5	10.2	13.8	9.3
Total	167.3	158.5	134.3	157.8	151.4

of gain was observed in lambs receiving the ration which supplied 75% and 25% of the supplemental nitrogen from CGM and urea, respectively. The all CGM ration also produced faster lamb gains than the rations in which urea supplied 50, 75 or 100% of the supplemental nitrogen. Both rate of gain and feed efficiency were lowered when urea supplied all the supplemental nitrogen.

Individual and total essential and non-essential amino acids present in the plasma of lambs receiving the CGM and urea rations are presented in Table 1. As CGM in the diet decreased and urea increased there was a trend for decreased leucine and increased lysine in the plasma. The all-urea ration produced the lowest concentration of essential and second lowest concentration of non-essential amino acids of any of the five rations fed.

The data suggest that small amounts of urea nitrogen may be beneficial to lamb performance when insoluble proteins such as CGM are included in lamb fattening rations. Performance of lambs fed the all-urea-supplemented ration was inferior to that of lambs fed rations supplemented with some preformed protein. These data also indicate that the source of dietary nitrogen may alter plasma amino acid concentrations in lambs, as indicated by increased lysine and decreased leucine as the level of urea in the diet increased.

RUMINAL HISTAMINE IN WETHERS FED DIFFERENT LEVELS OF PROTEIN

R. D. Long, G. E. Mitchell, Jr. and C. O. Little

In addition to systemic effects such as reduced blood pressure, histamine has the potential to arrest motility of the rumen causing subsequent digestive and metabolic disturbances. Histamine in the rumen may result from microbial decarboxylation of the amino acid histidine, tissue release of histamine or intake of histamine in feeds such as grasses, clovers and silages. These experiments were designed to determine whether the increased quantities of histidine in the rumens of animals fed increased levels of protein would result in increased concentrations of histamine in ruminal fluid.

Experimental Procedure

In the first experiment data on ruminal histamine were collected from four rumen-fistulated wethers fed 1 kg daily of corn-soybean meal rations containing 50% corn cobs. The proportions of corn and soybean meal were changed at 3-day intervals to increase crude protein in the ration from 8% to 20% in 2% increments. Histamine in samples of rumen fluid taken on the third day each ration was fed was determined fluorometrically.

In experiment 2 groups of four wethers each were fed either 10% or 20% protein for 2 weeks. Ruminal fluid was obtained through fistulas on alternate days during the experiment and analyzed for histamine content.

Results and Discussion

In the first experiment, the concentration of histamine in the ruminal fluid increased from an initial value of 0.498 mcg per ml on the 8% crude protein ration to a peak of 1.374 mcg per ml on the 12% ration, then declined gradually during the remainder of the experiment. This suggested that increased protein intake may have stimulated increased histamine levels initially and then have been offset by microbial adaptation later in the experiment. The design of the experiment did not permit separating these possible causes of the observed changes.

Results of the second experiment are summarized in Table 1. After starting at similar initial levels, concentrations of histamine in samples from wethers fed the 20% protein ration were greater than for those from wethers fed 10% protein at each sampling time. Peak concentrations for both rations were reached on the 7th day, when the difference between rations was highly significant ($P < .01$). Histamine concentrations for both groups then declined gradually for the remainder of the experiment.

The results indicate that adding protein to the diet increases the likelihood of observing high histamine concentrations in the rumen. They also suggest that adaptive mechanisms which tend to return elevated histamine levels to normal may be present.

Table 1. — Histamine in Ruminal Fluid from Wethers Fed 10% or 20% Crude Protein (mcg per ml)

Day	Ration Protein 10%	20%
0	0.414	0.446
1	0.437	0.637
3	0.529	0.696
5	0.779	1.020
7	0.808	1.249
9	0.690	1.182
11	0.673	1.024
13	0.607	0.883

SOURCE AND LEVEL OF NITROGEN FOR EARLY-WEANED LAMBS

J. B. Davis, D. G. Ely, W. P. Deweese and G. E. Mitchell, Jr.

It appears that lambs must have a functional rumen before they can be satisfactorily weaned to dry feed. If weaning at 4 to 8 wk is ever to be successful, lambs must consume maximum dry feed early in life to initiate early rumen development. The type of dry feed consumed prior to weaning has been shown to exert a greater influence on rumen development in lambs weaned at 4 wk of age than the quantity of feed consumed. This previous work was conducted using soybean meal as the supplemental nitrogen source. The present study was initiated to compare the utilization of different nitrogen sources, soybean meal, urea and no supplemental nitrogen, in creep diets fed to lambs from birth to weaning at 4 or 8 weeks of age.

Thirty-six Hampshire-sired crossbred lambs were assigned at 5 days of age to 3 treatment groups of 12 lambs each. Treatment groups were soybean meal supplemented, no soybean meal, and urea supplemented. The composition of the creep rations are shown in Table 1. The soybean meal and urea rations contained 19% crude protein, and urea constituted 2.9% of the entire mixture in the urea ration. The no-soybean meal ration contained 11% crude protein. One-half the lambs in each group were weaned at 33 days of age and were offered the same diets for an additional 28 days after weaning as they had received prior to weaning. The remaining six lambs in each group were weaned at 61 days of age. All rations were fed ad libitum. Feed consumption and lamb weights were taken weekly.

Table 1. — Composition of Rations (%)

Ingredient	SBM[a/]	No SBM[a/]	Urea
Ground shelled corn	32.6	54.6	51.7
Dehydrated alfalfa meal	20.0	20.0	20.0
Soybean meal (44% C.P.)	22.0	--	--
Urea (281)	--	--	2.9
Dried whey	15.0	15.0	15.0
Sucrose	2.5	2.5	2.5
Cane molasses	5.0	5.0	5.0
Dicalcium phosphate	1.0	1.0	1.0
Ground limestone	0.5	0.5	0.5
Trace mineralized salt	0.4	0.4	0.4
Vitamin premix	1.0	1.0	1.0

[a/] Soybean meal.

Pre-weaning growth of lambs from 5 to 33 days of age is shown in Table 2. Lambs fed the SBM creep gained faster than those in the other groups, probably as a result of greater daily creep feed intake. Daily feed intake was less with the urea creep than when the no-SBM ration was fed, although

the urea ration supported slightly greater gains. This indicates that the 11% protein creep diet (no SBM) did not provide enough protein to support maximum gain in lambs prior to 33 days of age.

Table 2. — Pre-weaning Performance of Lambs Fed Different Nitrogen Sources from 5 to 33 Days of Age

Treatment	SBM[a]	No SBM[a]	Urea
Initial wt, kg	6.7	6.3	6.6
Wt at 33 days, kg	14.2	11.5	12.7
Total gain, kg	7.5	5.2	6.1
Av daily gain, kg	0.27	0.19	0.22
Daily creep feed intake, g	104.20	42.90	27.90

[a] Soybean meal.

Table 3 shows performance of weaned and unweaned lambs fed the above discussed rations from 33 to 61 days of age. Weaned lambs fed SBM (19% crude protein) gained 0.16 kg per head daily, while lambs fed no SBM (11% crude protein) or urea (19% crude protein equivalent) only maintained weaning weight. Weaned SBM lambs had higher daily feed intakes than weaned lambs in the other groups but still required only 3.9 kg feed to produce each kg of gain. Unweaned SBM lambs also gained faster than unweaned lambs in the other groups. Unweaned lambs in the no-SBM and urea groups gained only slightly faster than weaned lambs fed SBM. Differences in feed intake between weaned and unweaned lambs offered the no-SBM and urea diets were not significant. This indicates that the high level of urea itself did not severely reduce intake but that SBM was stimulatory to dry feed consumption.

Table 3. — Performance of Weaned and Unweaned Lambs Fed Different Nitrogen Sources from 33 to 61 Days of Age

Ration Treatment	SBM[a]		No SBM[a]		Urea	
	W[b]	UW[c]	W[b]	UW[c]	W[b]	UW[c]
Initial wt, 33 days, kg	14.2	14.3	11.7	11.2	12.0	13.4
Final wt, 61 days, kg	18.8	22.1	12.1	16.8	12.0	19.5
Total gain, 28 days, kg	4.6	7.8	0.4	5.6	0.0	6.1
Average daily gain, kg	0.16	0.28	0.01	0.20	0.00	0.22
Daily feed intake, kg	0.63	0.38	0.40	0.31	0.33	0.29
Feed/gain	3.9	1.4	40.0	1.6	Neg.	1.3

[a] Soybean meal.
[b] Weaned at 33 days of age.
[c] Unweaned.

When an 11% protein ration was offered to lambs prior to weaning at 33 or 61 days of age or after weaning at 33 days, daily consumption of dry feed appeared to be inadequate to support optimum lamb growth. When urea was substituted for SBM, so that urea constituted 3% by weight of the entire ration mixture, dry feed consumption decreased as did lamb gains. In this study, SBM appeared to stimulate consumption and made available more protein to the animal, resulting in faster lamb growth than when the other nitrogen sources were fed.

LEVELS OF UREA IN CREEP FEEDS FOR LAMBS

D. G. Ely, W. P. Deweese and H. E. Amos

Previous results indicate that lamb performance is not adversely affected when creep rations containing 1% urea are fed to lambs from birth to weaning at approximately 56 days of age. However, higher concentrations of urea in the diet may reduce lamb performance. This study was initiated to compare pre-weaning lamb performance up to 56 days of age when lambs are offered creep feeds containing different amounts of urea.

One hundred twenty-two crossbred lambs were assigned at 27 days of age to 4 pre-weaning creep rations. Ration treatments were soybean meal supplemented and urea supplemented at 1, 2, or 3% of the entire rations. All rations were fed ad libitum and contained 19% crude protein. A fifth group received no creep feed (milk) and served as controls. All lambs were weaned at 56 days of age, at which time lamb weights and feed consumption were recorded and feed efficiencies calculated.

Table 1. — Composition of Creep Rations (%)

Ration	SBM[a/]	1% Urea	2% Urea	3% Urea
Ingredient:				
Ground shelled corn	32.6	39.3	45.5	51.7
Dehydrated alfalfa meal	20.0	20.0	20.0	20.0
Soybean meal (44% C.P.)	22.0	14.3	7.2	--
Urea (281)	--	1.0	2.0	2.9
Dried whey	15.0	15.0	15.0	15.0
Sucrose	2.5	2.5	2.5	2.5
Cane molasses	5.0	5.0	5.0	5.0
Dicalcium phosphate	1.0	1.0	1.0	1.0
Trace mineralized salt	0.4	0.4	0.4	0.4
Ground limestone	0.5	0.5	0.5	0.5
Vitamin premix	1.0	1.0	1.0	1.0

[a/] Soybean meal.

Performance of lambs in the different treatment groups is summarized in Table 2. Lambs receiving no creep (milk) gained slowest, while those receiving the soybean meal creep gained fastest. As the level of urea in the creep increased, daily gains and feed intakes decreased. The creep ration containing 3% urea appeared unpalatable and, thus, reduced daily gains when compared with the 1 and 2% urea levels or soybean meal. These results indicate that the 1% urea creep was utilized as efficiently as the soybean meal creep, as measured by the amount of feed required to produce each increment of lamb gain.

Table 2. — Pre-weaning Performance of Lambs Fed Different Levels of Urea

Treatment	Milk	SBM[a/]	1% Urea	2% Urea	3% Urea
Number of lambs	22	25	24	25	26
Initial wt, kg	13.5	13.8	10.4	11.2	9.0
Weaning wt, kg	16.1	18.9	18.0	17.6	16.7
Average daily gain, kg	0.14	0.27	0.25	0.21	0.20
Daily creep feed intake, kg	--	0.36	0.30	0.27	0.21
Feed/gain	--	1.33	1.20	1.29	1.05

[a/] Soybean meal.

PHYSICAL FORMS OF CORN IN SHEEP RATIONS FOR YOUNG LAMBS

W. P. Deweese, D. G. Ely and G. L. M. Chappell

Two growth trials were conducted to study the pre-weaning performance of lambs when different physical forms of corn were fed as the only creep feed. In the first trial, four groups of suckling lambs were placed on four treatments: I - control, no creep; II - shelled yellow corn; III - cracked yellow corn; IV - ground yellow corn. Results are shown in Table 1.

Table 1.— Performance of Lambs Fed Different Forms of Corn in Creep Rations - Trial I

Treatment	No Creep	Shelled Corn	Cracked Corn	Ground Corn
No. of lambs	10	19	20	20
Av initial wt, kg	4.4	7.15	7.10	7.32
Av weaning wt, kg	13.7	13.8	14.81	14.24
ADG, kg	0.16	0.19	0.22	0.20
Feed intake/day, kg	--	0.08	0.15	0.12
Feed/gain	--	0.42	0.68	0.60

In the second trial, five groups of suckling lambs were placed on five treatments: I - control, no creep; II - shelled yellow corn; III - cracked yellow corn; IV - ground yellow corn; V - simple creep mixture, 89% cracked yellow corn, 10% soybean meal and 1% Aureomycin Crumbles. Results are shown in Table 2. Lambs were weaned at about 56 days on each trial.

Table 2.— Performance of Lambs Fed Different Forms of Corn in Creep Rations - Trial II

Treatment	No Creep	Shelled Corn	Cracked Corn	Ground Corn	Simple Creep
No. of lambs	21	29	20	22	25
Initial wt, kg	13.5	11.3	11.1	10.9	11.7
Weaning wt, kg	16.1	16.5	17.8	16.6	18.3
Average daily gain, kg	0.14	0.19	0.23	0.20	0.27
Feed intake/day, kg	--	0.17	0.23	0.09	0.25
Feed/gain	--	0.89	1.00	0.45	0.93

The lambs receiving no creep gained considerably slower than any of the creep-fed groups. Of the three corn creep groups, the cracked corn group gained most rapidly in both trials. This was evidently a result of greater daily consumption of the cracked corn. These lambs were also the least efficient converters of feed to gain of the corn-fed groups.

The simple creep lambs gained faster than any of the other groups in Trial II. This suggests that supplemental protein (SBM) will increase lamb gains when included in a basal corn creep ration. However, feed efficiency was not significantly improved above that observed when only whole, cracked, or ground corn was fed.

EFFECTS OF WEANING AGE ON LAMB PERFORMANCE

D. G. Ely, J. B. Davis, W. P. Deweese and J. F. Nishimuta

Intensive sheep production systems appear to necessitate early weaning of lambs. Lambs have been successfully weaned at 56 days of age. Weaning at 28 days of age appears to adversely affect post weaning performance. This study was initiated to compare pre- and post-weaning performance of lambs weaned at 7-day intervals between 36 and 64 days of age.

Thirty-one Hampshire-sired crossbred lambs were assigned to the same creep ration when 8 days of age. Composition of the creep ration is shown in Table 1. All lambs were housed together until 36 days of age. Six lambs remained with their dams until 64 days of age. All weaned lambs received the same ration following weaning until 64 days of age. The ration was fed ad libitum to all groups.

Average daily gains, feed consumption and feed efficiencies are presented in Table 2. Pre-weaning gain increased as days of age at weaning increased from 36 to 50 days. Feed required per gain also increased as age at weaning increased. Lambs weaned at 43 days gained faster and more efficiently following weaning than those weaned at 36, 50, or 57 days of age. However, lambs weaned at 57 days

Table 1. — Composition of Ration

Ingredient	%
Ground shelled corn	32.6
Dehydrated alfalfa meal	20.0
Soybean meal (44% C.P.)	22.0
Dried whey	15.0
Sucrose	2.5
Cane molasses	5.0
Dicalcium phosphate	1.0
Ground limestone	0.5
Trace mineralized salt	0.4
Vitamin premix	1.0

were more efficient gainers for the entire experimental period than those weaned earlier, or at 64 days of age. This finding occurred even with a loss of weight during the 7-day post-weaning phase from 57 to 64 days for these lambs.

Table 2. — Performance of Lambs Weaned at Different Ages

Measurement Period	Average Daily Gain[a/]	Daily Feed Consumption[a/]	Feed/Gain[a/]
8 to 36 days of age[b]	0.23	0.02	0.09
36-day weaned:[c]			
8 to 36 days	0.21	0.02	0.09
36 to 64 days	0.03	0.61	20.33
8 to 64 days	0.11	0.31	2.82
43-day weaned:[c]			
8 to 43 days	0.24	0.03	0.13
43 to 64 days	0.18	0.50	2.78
8 to 64 days	0.21	0.20	0.95
50-day weaned:[c]			
8 to 50 days	0.27	0.05	0.19
50 to 64 days	0.14	0.60	4.29
8 to 64 days	0.24	0.19	0.79
57-day weaned:[c]			
8 to 57 days	0.25	0.09	0.36
57 to 64 days	- 0.03	0.48	Neg.
8 to 64 days	0.19	0.14	0.74
64-day weaned:[c]			
8 to 64 days	0.29	0.25	0.86

[a/] All values in kilograms unless otherwise specified.
[b/] Average for 31 lambs.
[c/] Days of age at weaning.

These results indicate that lambs fed the ration used in this study and weaned at 57 days of age gain more efficiently to 64 days than those weaned earlier or at 64 days of age. Overall gains favored weaning at 64 days, but increased gains were not directly proportional to increased feed consumption.

INFLUENCE OF ASPERGILLUS ORYZAE FERMENTATION EXTRACT ON CELLULOSE DIGESTION BY SHEEP

John Niver, R. E. Tucker and G. E. Mitchell, Jr.

Some molds of the genus Aspergillus have been shown to produce enzymes with cellulolytic activity. Since ruminants rely on enzymes produced by microorganisms to break down the cellulose they ingest, it is possible a supplemental enzyme preparation will aid cellulose digestion. Earlier work has indicated that a fermentation extract of Aspergillus oryzae may improve fiber digestion by sheep fed a ration containing ground grass hay and ground shelled corn.

For this experiment eight wethers were randomly assigned to two groups. Each group received 1,000 g of a pelleted basal ration containing 50% ground shelled corn, 46% orchard grass hay, 3% soybean meal and 1% steamed bone meal. During period 1, group 1 served as treatment animals and received 900 mg of enzyme-carrier per head per day mixed with the basal ration. A 14-day preliminary period was followed by a 7-day total fecal collection. The rations were then reversed and a second 14-day preliminary was followed by 7 days of total fecal collection. Fiber was determined as acid detergent fiber by the Van Soest method. Cellulose digestability coefficients are shown in Table 1. These data suggest that the Aspergillus extract may increase cellulose digestion during adjustment to the ration.

Table 1.— Percent Cellulose Digestability in Wethers with an Extract of Aspergillus oryzae Added to the Ration

	Lamb 1	2	3	4
Period I				
With Extract	44.3	34.4[a]	45.6	46.8
Period II				
No Extract	46.1	44.9	44.4	50.2
	Lamb 5	**6**	**7**	**8**
Period I				
No Extract	33.2	33.5	33.6	33.4
Period II				
With Extract	40.8	34.1	41.1	40.5

[a/] Wether consumed less than 900 g per day during period 1.

STEROID SYNTHESIS BY THE ADRENALS OF VITAMIN A-DEFICIENT WETHERS

K. E. Webb, Jr., G. E. Mitchell, Jr. and C. O. Little

Investigations into the composition of urine from vitamin A-deficient ewes have implicated the adrenals as one of the primary sites of injury in vitamin A deficiency. Adrenal steroid synthesis in two vitamin A-deficient and two control wethers was evaluated. The adrenals were removed from the sheep and immediately homogenized in a buffered medium. Steroid conversion from ^{14}C-labeled progesterone with and without the addition of 1.16 μM of vitamin A alcohol was estimated after incubation of the homogenate for 2 hours at 39°C under an atmosphere of 75% oxygen and 5% carbon dioxide. Benzene: chloroform (6:1) extracts were chromatographed with toluene-propylene glycol to separate eight different steroids. The steroids were identified by radioscanning and quantitated by liquid scintillation counting.

As shown in Table 1, corticosterone synthesis was observed to be reduced by vitamin A deficiency but could be brought close to the control levels by additions of vitamin A to the homogenate. These data suggest that vitamin A is required for normal steroid synthesis.

Table 1.— Steroid Synthesis from Labeled Progesterone by Adrenal Homogenates

	Percent of Progesterone Converted			
	Control Wethers		A-deficient Wethers	
	Cortisol	Corticosterone	Cortisol	Corticosterone
No vitamin A added	15.7	24.1	20.3	14.5
1.16 μM vitamin A added to homogenate	13.1	29.9	14.4	25.3

EXCRETION OF VITAMIN A ACID BY SHEEP

I. D. Hume, J. A. Boling and G. E. Mitchell, Jr.

Earlier experiments at Kentucky indicated that secretion into the bile was a major excretory pathway of vitamin A in ruminants. A mean of 17.6% of the radioactivity from injected ^{14}C-B carotene and 21.4% of that from ^{3}H-vitamin A acetate was excreted in the bile in 24 hr. B-carotene is the precursor of vitamin A, and vitamin A acetate is a storage form of the vitamin. On the other hand, vitamin A acid is a possible end-product of vitamin A metabolism and is not stored in the body to any extent. It should, therefore, be excreted more rapidly than other forms of the vitamin. To test this hypothesis two adult ewes fed chopped alfalfa hay ad libitum were fitted with catheters in the common bile duct and in the urinary bladder. Each ewe was injected via the jugular vein with 5 uCi vitamin A acid-14-^{14}C on two occasions 1 week apart. Total bile and urine collections were made at timed intervals for 24 hr. Non-radioactive bile collected previously was infused into the duodenum at the same rate as the active bile flowed from the common bile duct catheter, in order to maintain continuity of bile flow.

In 24 hr after injection 56.7% of the radioactivity was recovered in the bile and 39.6% in the urine. Total recovery (bile + urine) was 96.5%. Approximately 98% of the radioactivity recovered in the bile in 24 hr was excreted in the first 12 hr of collection. This rate of excretion of vitamin A acid is markedly higher than that of the other forms of vitamin A studied. It is consistent with the proposed role of vitamin A acid as an end-product of vitamin A metabolism.

EFFECT OF MOLYBDENUM AND SULFATE ON COPPER STATUS OF LAMBS

R. D. Kline, V. W. Hays, G. L. Cromwell
and D. G. Ely

Sixteen crossbred lambs averaging 25.5 kg were allotted at random from weight outcome groups within sex to four replicates of four treatments in a randomized block design. Dietary treatments were factorially arranged to provide (1) control containing approximately 10 ppm copper, (2) control + 15 ppm copper as copper sulfate, (3) control + 11 ppm molybdenum as ammonium molybdate and 2,200 ppm sulfate as sodium and potassium sulfate and (4) control + 15 ppm copper + 11 ppm molybdenum + 2,200 ppm sulfate.

Two lambs fed the control + 15 ppm copper diet died of copper toxicity after 79 and 84 days of the 88-day experiment. The performance of these two lambs, average daily gains, feed per unit of gain, hemoglobin (g/100 ml blood) and hematocrit levels (%) was normal through 56 days of the experiment.

Excluding the two lambs that died, the average daily gain was higher for those receiving 15 ppm copper as compared with those receiving the control, control + molybdenum and sulfate or control + copper, molybdenum and sulfate (185 vs 171, 171 and 177 g/day). Likewise, those lambs receiving copper utilized their feed more efficiently than did those receiving the control, control + molybdenum and sulfate or control + copper, molybdenum and sulfate diets (5.78 vs 6.16, 6.27 and 6.07).

Hemoglobin (g/100 ml blood) and hematocrit (%) were not influenced by dietary treatment. The mean values for the four diet treatments were: 15.2, 37; 15.3, 36; 17.4, 42; 15.7, 38, respectively.

Plasma copper was lower for the lambs receiving copper + molybdenum + sulfate as compared with those fed the other diets (1.08 vs 2.22, 1.27 and 1.12 mcg/ml).

Lambs fed copper + molybdenum + sulfate had lower loin copper as compared with those fed molybdenum + sulfate, copper or control diets (3.38 vs 3.70, 3.94 and 3.45 ppm). Liver copper levels were reduced by adding molybdenum + sulfate or copper + molybdenum + sulfate as compared with control or copper diets (354, 605 vs 769, 1572 ppm). Molybdenum and sulfate were effective in reducing copper toxicity.

LEVEL AND MODE OF FEEDING EFFECTS ON ANIMAL PERFORMANCE AND CERTAIN BLOOD AND RUMEN METABOLITES

Carl E. Miller and Don R. Jacobson

Efficient animal production depends on the ingestion of sufficient nutrients to meet requirements for maintenance and production. The most efficient convertors of feed into animal products are in general the animals with the highest level of feed intake. If feed intake can be increased through an improved understanding of the mechanisms involved in appetite regulation, one may increase animal efficiency. The objective of the present experiment was to study responses to variation in consumption which might be related to voluntary feed intake.

Experimental Procedure

Nine steers of dairy breeding were blocked for body weights, then randomly divided into three groups. The groups were offered a complete ration of 2 parts chopped alfalfa-orchardgrass hay and 1 part ground corn for 2 hr twice daily. All groups were fed ad libitum during a 57½-day preliminary period. Group I was fed ad libitum during the 90-day treatment period. Groups II and III were fed 85 and 115%, respectively, of the average intake per 100 kg of body weight per day of group I in the previous week. The Group III steers were allowed to consume voluntarily as much as their allotted ration at each feeding as they desired. The remaining feed was placed into the rumen via the rumen fistula if possible. Rumen fill was determined for the steers in group III just prior to the afternoon feeding in the preliminary and treatment periods. Rumen pH and VFA's in ruminal fluid and jugular blood and plasma amino acids were determined for all steers at 3 hr post-feeding. Dry matter digestibility, nitrogen balance and water consumption were also determined.

Results and Discussion

Group I was found to have a significantly higher average daily feed intake than groups II and III. Groups II and III had intakes of 81 and 78%, respectively, of the intake of group I. The intra-ruminally fed steers went off feed, and the rumens became so compacted that only a much reduced intake was achieved. The steers of group III increased significantly ($P < 0.05$) the percent rumen digesta dry matter (10.3 to 13.1%), and the dry matter as a percent of body weight significantly ($P < 0.01$) increased from 12.9% in the preliminary period to 15.9% in the treatment period. The groups exhibited no significant differences in dry matter digestability, nitrogen balance, average daily gain, feed efficiency, plasma amino acids, rumen pH, water consumption, and plasma and rumen volatile fatty acids. Correlations between rumen acetate level prior to the pm feeding and the subsequent voluntary pm feed intake were non-significant. Reticulo-rumen fill appeared to be the primary factor, making it impracticable to maintain a higher level of feed intake in the intraruminally fed steers.

PORTAL BLOOD FLOW IN A HOLSTEIN CALF EMPLOYING THE DOPPLER SHIFT TECHNIQUE

Charles J. Sniffen, I. D. Hume and D. R. Jacobson

Absorption of nutrients from the GI tract has been estimated by several different techniques. Methods such as rate of VFA disappearance from the rumen, balance trials and labeled substrates are indirect and subject to considerable variation. One method which has gained popularity in recent years is to measure the concentration of metabolites in the carotid blood (blood going to the GI tract) and the concentration of nutrients in the portal blood (blood draining the GI tract). By difference (portal - carotid) we can obtain a direct measurement of absorption of various nutrients. If the volume of blood flowing through the portal vein could be measured, the amount of a nutrient absorbed could then be calculated.

Blood flow measurements by methods such as dye dilution, isotope dilution and electromagnetic are not suitable for continuous determinations, but they have been used for short term measurement of blood flow.

By the Doppler shift technique we have been able to measure blood velocity over long periods of time in animals in a relatively unrestrained state. The velocity measurements can then be expressed on a volume basis, either by measuring the ID of the portal vein at the cuff or by pumping blood through the portal vein at different known rates after sacrificing the animal.

An 8-week-old Holstein bull calf was fed milk at 8% of body weight daily in two feedings at 12-hr intervals. Blood flow measurements were taken continuously for two 24-hr periods. In previous work relative blood velocity was measured by taking velocity readings every 5 min for 48 hr. In the present work the signal was sampled every 0.01 second and integrated, giving a more precise measurement of the area under the relative blood velocity curve. This integrated signal was recorded as a series of 5-volt second peaks or triangles. Instead of reading tracings a recycle counter with a continuous digital clock has been developed. This counter accumulates total blood velocity for any interval desired. Blood velocity counts were noted at 0.5 hr before feeding and at 0.5, 1.5, 2.5, 4.5, 7.5, and 11.5 hr after feeding. During the second 24 hr, portal and carotid blood samples were also taken at the intervals just mentioned. Following absorption measurements on milk the calf was fed excellent quality chopped alfalfa hay and calf starter at 20 and 80% of NRC digestible energy requirements, respectively, for 2 weeks. Blood flow was then measured as before, except that blood velocity measurements and blood samples were taken at 0.5 hr before feeding and at 1.5, 3.5, 5.5, 7.5, 9.5 and 11.5 hr after feeding.

Following this second absorption study the calf was sacrificed and the liver, with the portal vein and blood flow transducer intact, was recovered from the animal. At the same time blood was collected from the calf and heparinized. A piece of silastic tubing was sutured into the portal vein and any other branches were ligated. A small incision was made in the liver at a point just before the main vessel in the liver branches. This relieves some of the pressure and alleviates the problem of the liver becoming engorged with blood. The liver was then put into a 10-liter container filled with blood. A small beaker was put into the container and the end of the outlet tube was put into this. This set up was then connected with a roller heart pump. The heparinized blood was then pumped through this system at a wide range of velocities to convert to the actual blood volumes.

The results from the foregoing calibration were found to be highly repetitive and linear over the velocity range measured. The prediction equation was $Yx = 526x - 747$ ($r=.99$) where x = counts per time interval and Yx = ml of blood per time intervals.

It can be seen in Table 1 that the blood flow in calves on the milk diet showed a more noticeable diurnal pattern than that of those on dry feed, but total variation was greater on dry feed. Mean blood flow was also higher on dry feed than on milk, but correction for body weight removed much of this difference.

Between-trial variation was small, and the values of 47.2 and 43.4 ml/min/kg for milk and dry feed, respectively, compare closely with those found in other laboratories with different techniques. The method appears suitable for use with portal and carotid sampling to estimate nutrient absorption.

Table 1. — Blood Flow in a Calf Fed Milk then Hay and Concentrate[a/]

Milk		Hay and Concentrate	
Time After Feeding, Hr	Blood Flow liters/hr	Time After Feeding, Hr	Blood Flow liters/hr
0	189	0.5	228
1.0	197	2.5	239
2.0	193	4.5	234
3.5	197	6.5	244
6.0	190	8.5	226
9.5	198	10.5	235
0	2.2[b/]	0.5	225
1.0	-	2.5	229
2.0	195	4.5	248
3.5	203	6.5	236
6.0	0.96	8.5	219
9.5	206	10.5	231
mean	196.9		232.8
CV	2.67		3.54
0	203	0.5	224
1.0	208	2.5	240
2.0	198	4.5	238
3.5	0.96	6.5	227
6.0	0.97	8.5	227
9.5	213	10.5	210
0	192	0.5	228
1.0	201	2.5	226
2.0	199	4.5	242
3.5	202	6.5	224
6.0	193	8.5	211
9.5	200	10.5	214
mean	200.2		225.9
CV	2.97		4.69
ml/min/kg	47.2		43.4
ml/min/kg[3/4/]	136.8		133.1

[a/] Milk fed at 8% of body weight daily and hay and concentrate fed at 20 and 80% of NRC DE requirements.
[b/] Two-hour mean

PRODUCTION OF GANGRENE IN THE EXTREMITIES OF BOVINE ANIMALS FROM INJECTION OF FESCUE EXTRACT

R. H. Hatton and Don R. Jacobson

Intraperitoneal catheters were placed in three holstein steers for injection of an ethanol extract of toxic tall fescue hay to determine if gangrenous symptoms of fescue foot can be produced from intraperitoneal administration. Initial dose level for all three steers was 0.2 lb hay equivalent/100 lb body weight. Heart and respiration rate and skin temperature and rectal temperature measurement data were obtained on the preliminary day and on the first two days of treatment. The steers were closely observed for gangrenous lesions throughout the extended administration period.

Lesions were observed on the tip of the tail of one of the three treatment steers. A necrotic condition of the tail began to appear as early as the 6th day of extract administration. By the 17th treatment day necrosis was more noticeable, and on the 27th day gangrene was easily distinguishable in photographs.

No lesions were ever observed in the hoof area of the affected steer. Subsequent increase of the dose level to 0.4% hay equivalent failed to result in an increase in severity of toxicity. Post mortem examination of the affected animal revealed no gross internal abnormalities from administration of extract.

EFFECT OF DIETARY GELATIN ON HOOF DEVELOPMENT IN HORSES

Judy Goodspeed, J. P. Baker, R. E. Pulse
H. J. Casada and J. N. Walker

Clinical reports of improvement in hoof quality from the feeding of gelatin has stimulated interest in a controlled investigation of the effect of dietary gelatin on hoof development and composition.

Twenty weanling Thoroughbred colts were divided into 2 groups with 10 serving as controls, while the remainder received the gelatin treatment. All horses were fed a growing ration of mixed grain and clover-timothy hay, with the treated group receiving 114 g of gelatin per head per day in addition to the growing ration.

The trial was conducted over a 9-month period with hoof samples collected at monthly intervals. Specific gravity determinations were made on the samples by a mercury displacement technique. This determination was made on sections of the hoof wall from which the white line had been removed. Samples of hoof also were tested for tensile strength (standard A.S.T.M. procedure). These samples were prepared by sanding both sides of a lateral section and then making a concave groove on both sides at the mid-point of the sample to insure breaking at this point.

Table 1 illustrates the means of the hoof samples within each month by treatment. The hoof samples from the group receiving gelatin were consistently found to have lower specific gravities than the samples from the untreated group. The overall mean differences between the groups was statistically significant ($P < .01$). Because of a slight change in method of sample preparation, only the samples beginning with the fourth collection period are reported. This did not affect the date since, because of the pattern of hoof growth, samples taken earlier in the study should not have been influenced by the dietary treatments.

A comparison of means of hoof samples within months is presented in Table 2. The overall means for the tensile strength for the samples from the treated and untreated groups were not found to be statistically significant. The strength data were highly variable with significant differences in month of collection, horses within treatment and in treatment x month interaction.

Table 1.— Specific Gravity

	Feb	Mar	April	May	June	July	Overall mean
Control group	1.06	1.05	1.08	1.10	1.07	1.12	1.08
Treated group	1.02	1.00	1.03	1.03	1.02	1.05	1.02

Amino acid concentration of the hoof samples and of the hair samples, also collected at monthly intervals, did not appear to be related to treatment.

Table 2.— Tensile Strength, kg/sq mm

	Dec	Jan	Feb	Mar	April	May	June	July	Overall mean
Control group	1.752	1.772	1.395	1.773	1.717	1.965	1.842	1.861	1.76
Treated group	1.905	1.896	1.468	1.597	1.975	1.852	1.875	1.780	1.79

HORSE BLOOD GLUCOSE LEVELS AS AFFECTED BY DIFFERENT RATIONS

B. H. Crawford, Jr., J. P. Baker and Sandi Lieb

High-carbohydrate rations result in the production of glucose owing to enzymatic digestion in the small intestine of the horse. Although blood glucose values have been presented, little information is available on the effect of ration on these values.

Two 3 x 3 Latin square experiments were conducted to study dietary effects on blood glucose levels. The 3 multiple-fistulated horses used in the 6 trials were maintained individually in box stalls and fed twice daily at 12-hr intervals. The rations were calculated to meet maintenance requirements for energy (NRC) in experiment 1 and increased by 10 percent in experiment 2. The three rations consisted of: 1) oats; 2) oats and hay; and 3) hay. All rations contained 5 percent molasses.

Jugular blood samples were taken prior to feeding and at 2-hr intervals after feeding for a total of seven samples per horse per trial. Average serum glucose levels are illustrated in Table 1. Mean glucose values for the low and high levels were 67.2 and 29.9, respectively. The mean blood glucose levels by treatment and collection are shown in Table 2.

Table 1.— Mean Serum Glucose Values[a/]

Treatment		Oats	Oats-Hay	Hay
Exp. 1	(Low energy)	71.7	67.8	62.1
Exp. 2	(High energy)	85.8	76.5	77.5
Pooled mean glucose		78.8	72.1	69.9

[a/] Mg per 100 ml.

Blood glucose values were highest for the oat ration, lowest for the hay ration, and intermediate for the oat and hay ration. Higher glucose peaks were observed with the oats ration and were more variable than peaks for the other rations. Results of experiment 1 showed a significant difference in blood glucose levels between horses, periods and rations. These differences did not exist in experiment 2 in which the energy level had been increased by 10%.

Table 2.— Mean Glucose Values[a/]

	Time						
Treatment	7 am[b/]	9 am	11 am	1 pm	3 pm	5 pm	7 pm[b/]
Oats	63.7	88.5	93.3	67.0	68.3	80.5	90.0
Oats and hay	60.3	69.3	76.8	77.3	69.5	71.2	79.8
Hay	58.7	58.3	77.5	74.2	68.3	73.2	78.5

[a/] Mg per 100 ml.
[b/] Feeding time.

A difference was noted in the pooled serum glucose levels as energy in the ration was increased by 10%. The significant differences noted in serum glucose and the decreased variability observed at the higher energy level suggest that the NRC recommendation may be low.

ENERGY ABSORPTION AND UTILIZATION IN THE EQUINE

Sandi Lieb, J. P. Baker and B. H. Crawford, Jr.

Horses and ruminants often subsist on similar types of feedstuffs, but because of anatomical differences, the processes of digestion and absorption differ considerably in the two species. In the horse the ingesta are subjected to fermentation in the cecum and colon after passing through the stomach

and small intestine where the more soluble dietary components have been subjected to enzymatic digestive and absorptive processes.

Enzymatic digestion of carbohydrates results largely in the production of glucose, while microbial fermentation yields volatile fatty acids (VFAs), primarily acetic, propionic and butyric. Although the absorption of both glucose and VFAs has been demonstrated in the horse, little is known about their metabolism, and the relative importance of the different sources of energy for this species has not been determined.

The purpose of this study was to investigate hepatic utilization of energy sources in the equine through the measurement of portal-carotid differences following infusions of the substances into the cecum.

Three cecal-fistulated ponies with indwelling catheters located in the portal vein and carotid artery were used for sampling the blood before and after passing the liver. The ponies were maintained individually in box stalls with oats fed twice daily and timothy hay ad libitum. The treatments consisted of 250 ml of solutions (Table 1) infused into the ceca of the ponies. Blood samples were drawn from the catheters 5 min pre-infusion and 5, 10, 15, 30, 60, 90, 120 and 180 min post-infusion resulting in a total of 126 samples per treatment over seven trials.

Table 1. — Composition of Solutions Infused into the Cecum (amounts per 250 ml)

Treatment	Solution
Control	Water only
Glucose	6 gm glucose + water
VFA	20.9 gm Na Acetate 6.8 gm Na Propionate + water[a] 3.7 ml butyric acid

[a]/ VFA solution adjusted to basic pH with NaOH.

The plasma levels of glucose and of VFAs observed are shown in Table 2. Results from these limited data indicate that the equine liver does utilize acetate, propionate and butyrate as well as glucose. The means for the portal and carotid plasma samples differed significantly for all three VFAs - acetate $P < .05$, and propionate and butyrate $P < .01$. It may be noted that the comparatively low level of infused glucose had no influence upon plasma glucose levels, but it did appear to influence plasma VFA levels. The treatment solutions appeared to exert the greatest influence on portal levels at the 30-min post-infusion collection.

Table 2. — Least Square Means of Plasma Glucose and Volatile Fatty Acids by Treatment and by Collection Site

	Glucose	Acetate	Propionate	Butyrate
	(mg/100 ml)		(umole/ml)	
Treatments:				
Control	97.9	3.23	0.189	0.063
Glucose infusion	101.5	3.41	0.172	0.070
VFA infusion	102.3	3.90	0.281	0.096
Site:				
Carotid	98.3	3.25	0.092	0.045
Portal	102.8	3.78	0.336	1.108

EFFECT OF DIETARY CALCIUM AND PHOSPHORUS LEVEL ON PERFORMANCE AND SKELETAL DEVELOPMENT OF GROWING-FINISHING SWINE

C.W. Scherer, V. W. Hays, J. R. Overfield and G. L. Cromwell

A factorial experiment involving 160 SPF* Yorkshire pigs was conducted to evaluate the effects of dietary levels of calcium and phosphorus in corn-soybean meal diets on the performance and skeletal development of pigs from 16.7 to 97.0 kg body weight. Calcium levels of 0.50, 0.65, 0.80 or 0.95% and phosphorus levels of 0.50 or 0.65% were fed until the pigs reached a mean weight of 45.5 kg, after which calcium levels were reduced to 0.35, 0.50, 0.65 or 0.80% and phosphorus levels to 0.40 or 0.50%. Dicalcium phosphate and calcium carbonate (ground limestone) were used to adjust the calcium and phosphorus levels. The barrows (9 per treatment) were slaughtered for carcass and skeletal evaluation.

No significant ($P < .05$) differences in gain, feed/gain or carcass measurements were detected among pigs fed the various combinations of calcium and phosphorus. No interactions of calcium and phosphorus on any of the response criteria were detected. Level of phosphorus did not significantly ($P < .05$) affect metacarpal breaking strength, metacarpal ash or turbinate ash. Breaking strength increased linearly ($P < .01$) and turbinate and metacarpal ash increased quadratically ($P < .05$) as calcium level increased.

Main effects for gains (g/day), feed/gain, metacarpal ash (%), turbinate ash (%) and metacarpal breaking strength (kg), respectively, were: (0.50% phosphorus), 758, 3.16, 54.4, 37.6, 146; (0.65% phosphorus), 754, 3.12, 54.8, 38.4, 146; (0.50% calcium), 754, 3.12, 53.6, 35.4, 133; (0.65% calcium), 740, 3.16, 55.0, 38.7, 141; (0.80% calcium), 749, 3.12, 55.3, 38.9, 157; and (0.95% calcium), 776, 3.16, 54.4, 39.0, 153.

No visual symptoms of turbinate atrophy or distortion were observed in any of the pigs.

COPPER STORES OF PIGS AS RELATED TO DIETARY ADDITIONS OF COPPER, MOLYBDATE, SULFATE AND SULFIDE

R. D. Kline, V. W. Hays and G. L. Cromwell

A 2 x 4 factorial experiment involving 96 pigs averaging 22.2 kg was conducted to study the effects of four added levels of copper (0, 150, 200, 250 ppm) as copper sulfate with or without molybdenum (50 ppm) as ammonium molybdate and sulfate (5,000 ppm) as sodium and potassium sulfate.

Molybdenum and sulfate did not affect average daily gains (726 vs 726 g) or feed per unit gain (3.45 vs 3.50). Average daily gain of pigs fed 0, 150, 200 and 250 ppm copper were 699, 749, 698 and 758 g. Feed per unit gain with increasing copper was 3.38, 3.46, 3.66 and 3.40. Dietary copper had no significant effect on hemoglobin level (g/100 ml), with average values being 16.2, 15.9, 16.5 and 15.8. Likewise, added copper did not significantly decrease hematocrit levels (47, 44, 45 and 44%). Molybdenum and sulfate addition did not affect hemoglobin or hematocrit values (15.9 vs 16.3 and 44 vs 45). Plasma copper was not consistently influenced by increasing dietary copper (2.57, 2.48, 2.53 and 2.64 ppm) or by adding molybdenum and sulfate (2.51 vs 2.61 ppm). Liver copper levels increased with each level of added copper (18, 27, 73 and 150 ppm). Adding molybdenum and sulfate did not reduce liver copper (65 vs 69 ppm).

A second 2 x 3 factorial experiment involved 48 pigs averaging 40.5 kg were fed diets with 0, 250 and 500 ppm copper as copper sulfate with and without 50 ppm molybdenum as ammonium molybdate and 1000 ppm sulfide as sodium sulfide. Average daily gains were improved by feeding 250 ppm copper as compared with feeding 0 or 500 ppm copper (762 vs 700 and 739 g). Also, feeding 250 ppm copper improved feed per unit gain over those fed 0 or 500 ppm copper (3.38 vs 3.60, 3.53). Added molybdenum and sulfide reduced average daily gains (752 vs 715 g) and increased feed per unit gain (3.44 vs 3.56). Plasma copper levels were decreased by increasing dietary copper (2.92, 2.42 and 2.29 ppm). Likewise loin copper levels were only slightly lower as dietary copper increased (2.39, 2.38 and 2.18 ppm). Added molybdenum and sulfide did not reduce loin copper levels (2.19 vs 2.45 ppm).

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*Specific pathogen-free.

Liver copper levels increased with increasing dietary copper (19, 36, 532 ppm). Additions of molybdenum and sulfide were effective in reducing copper stored in the liver (369 vs 23 ppm).

EFFECTS OF COPPER, ZINC AND IRON INTERRELATIONSHIPS IN PIGS

R. D. Kline, V. W. Hays and G. L. Cromwell

Eighty crossbred pigs averaging 17.2 kg were allotted at random from weight outcome groups within sex to two replicates of a factorial arrangement of three added copper levels (0, 250, 500 ppm) as copper sulfate and three zinc levels (100, 200, 300 ppm) as zinc sulfate. A 10th treatment included 500 ppm copper, 300 ppm zinc and 300 ppm iron as ferrous sulfate.

Average daily gain was depressed by feeding 500 ppm copper as compared with 0 or 250 ppm copper (697 vs 739 and 779 g). Feed per unit gain was not influenced to any degree by increasing copper (3.26, 3.19 and 3.16). Average daily gain was higher in pigs fed 100 or 200 ppm zinc as compared with those fed 300 ppm zinc (741 and 753 vs 722 g). Less feed was required per unit of gain by pigs fed 300 ppm zinc as compared with those fed 100 or 200 ppm (3.21 and 3.31 vs 3.08).

Hemoglobin (g/100 ml of blood) and hematocrit (%) values were depressed by feeding 500 ppm copper as compared with 0 or 250 ppm copper (11.4, 36 vs 14.6, 43 and 14.6, 43). Increasing the level of dietary zinc had very little effect on hemoglobin or hematocrit values (13.5, 41; 13.5, 40; 13.6, 43). Contrary to what one would expect, plasma copper levels were lower in pigs fed 500 ppm as compared with the plasma levels of pigs fed 0 or 250 ppm copper (2.50 vs 2.51 and 2.70 ppm). Loin copper levels were also slightly lower in pigs fed 500 ppm copper as compared with 0 or 250 ppm (1.75 vs 1.84 and 1.76 ppm). Increased dietary levels of zinc did not significantly affect loin copper (1.76, 1.63 and 1.97 ppm) or plasma copper (2.45, 2.58 and 2.68 ppm).

Liver copper levels increased with increasing dietary copper (16, 80 and 1,143 ppm), whereas increased dietary zinc levels influenced liver copper only slightly (508, 323 and 408 ppm). Liver and loin copper levels, hemoglobin levels and hematocrit levels of pigs fed 300 ppm each of iron and zinc were 1,381 and 2.01 ppm, 11.8 and 36, respectively. These date indicate that zinc and iron levels above that recommended for practical diets were not effective in reducing copper stores of pigs.

COMPARISON OF VARIOUS FEED ADDITIVE COMBINATIONS FOR GROWING-FINISHING SWINE

M. D. Whiteker

An experiment involving 80 Hampshire and Yorkshire pigs was conducted to compare the effects of various combinations of feed additives on growth rate and feed conversion of growing-finishing swine.

The following treatment groups were used:

Treatment 1 - Control

Treatment 2 - ASP-250 to 70 lb; 36 g/ton of Terramycin + 0.01% arsanilic acid to 110 lb; 25 g/ton Terramycin + 0.007% arsanilic acid to market weight.

Treatment 3 - 40 g/ton of Tylan to 70 lb; 20 g/ton of Tylan to 110 lb; 10 g/ton of Tylan to market weight.

Treatment 4 - ASP-250 to 70 lb; 40 g/ton of Tylan to 110 lb; 20 g/ton of Tylan to market weight.

The pigs were randomly allotted to treatment from groups based on weight within sex and breed. Each treatment was imposed on five replicate pens of four pigs each. The average initial weight of the pigs was 35.5 lb and the average final weight was 193 lb. A 16% protein corn-soybean meal diet fortified with vitamins and minerals was fed to a mean pig weight of approximately 110 lb, after which 13% protein was fed until the termination of the experiment.

The results of the experiment are summarized in Table 1. Pigs fed the additive combinations gained at a similar rate and required a similar amount of feed per unit gain as those fed the control diet.

Table 1.— Comparison of Various Feed Additive Combinations for Growing-Finishing Pigs

	Treatments			
	1	2	3	4
Av daily gain, lb	1.44	1.44	1.45	1.42
Feed/gain	3.03	3.11	3.07	3.02

COMPARISON OF TWO VARIETIES OF OPAQUE-2 CORN AND NORMAL CORN FOR GROWING PIGS

C. R. Marroquin, G. L. Cromwell and V. W. Hays

Two 28-day experiments involving 72 growing pigs were conducted to compare the nutritional value of two varieties of opaque-2 corn and normal corn in diets supplemented with 0, 10 and 20% dehulled soybean meal. Each diet was offered ad libitum to four individually fed pigs averaging 18.1 and 8.8 kg in experiments 1 and 2, respectively.

Pigs fed opaque-2 corn gained significantly ($P < .05$) faster (582 vs 474, 311 vs 262 g/day) and required significantly ($P < .01$) less feed per unit of gain (3.69 vs 4.66, 3.83 vs 5.16) than those fed normal corn in experiments 1 and 2, respectively, summed over all levels of soybean meal. Although rate and efficiency of gain was not significantly ($P < .05$) affected by the variety of opaque-2 corn fed, one variety supported slightly faster gains (593 vs 571, 334 vs 288 g/day) in trials 1 and 2, respectively, and lower feed/gain responses in trial 1 (3.48 vs 3.89).

Increasing the level of soybean meal significantly ($P < .01$) increased the rate of gain (345, 597, 695; 149, 325, 409 g/day) and reduced feed/gain (5.73, 3.43, 2.86; 6.72, 3.48, 2.62) in trials 1 and 2, respectively. Feed/gain response to soybean meal level was quadratic ($P < .05$) in both trials, whereas gain response was quadratic ($P < .01$) in trial 1 and linear ($P < .01$) in trial 2. The corn x soybean meal (protein) level interaction was significant ($P < .05$) for gain and feed/gain responses in trial 1 and for feed/gain response in trial 2.

These data further demonstrate the superior nutritional value of opaque-2 corn and suggest that differences in nutritional value exist between varieties of opaque-2 corn.

COMPARISON OF OPAQUE-2 AND NORMAL CORN FOR FINISHING SWINE

G. L. Cromwell, T. W. Cathey and V. W. Hays

Thirty-nine Yorkshire and crossbred pigs averaging 46.5 kg and 100.2 days of age were used to compare normal and opaque-2 corn fed free-choice with a fortified soybean meal supplement. A normal corn-soybean meal complete-mixed diet was used as a third treatment. Each diet was offered to three replicate pens of four or five pigs each for an average of 64.7 days.

Pigs fed corn and supplement free-choice gained slower (702 vs 710 g/day) but required significantly ($P < .05$) less feed per unit of gain (3.52 vs 3.85) than those fed the complete-mixed diet. Pigs fed opaque-2 corn and supplement free-choice gained slower (690 vs 713 g/day) but more efficiently (3.38 vs 3.65, $P < .10$) and consumed less supplement (231 vs 365 g/day, $P < .10$) than those fed a similar diet of normal corn.

In a second experiment, 75 Yorkshire and crossbred gilts averaging 61.1 kg were used to evaluate opaque-2 corn supplemented with 0, 4, 8 or 12% soybean meal. Normal corn supplemented with 12% soybean meal was included as a fifth treatment. Each diet was offered to five pens of three gilts for a period of 42 days.

Gains increased quadratically ($P < .05$) and feed/gain responses decreased linearly ($P < .01$) with increasing levels of soybean meal in the opaque-2 diets. Gains (g/day) and feed/gains of pigs fed opaque-2 corn plus 0, 4, 8 and 12% soybean meal and normal corn plus 12% soybean meal were, respectively: 679, 4.62; 769, 4.08; 796, 3.97; 778, 3.83; 814, 4.10.

EFFECT OF PROTEIN LEVEL ON PERFORMANCE OF FINISHING GILTS

G. L. Cromwell, T. W. Keeth, C. H. Nichols and V. W. Hays

An experiment involving 75 Yorkshire and Yorkshire x Hampshire gilts initially averaging 125.3 lb body weight and 113 days of age was conducted to study the effect of protein level during the finishing stage on rate and efficiency of gain. Corn and soybean meal diets containing 16, 14 or 12% protein were offered ad libitum to six replicate pens of four or five gilts per pen. The gilts were confined to concrete floored pens with open-front housing. The experiment was terminated for each replicate of gilts when they averaged 210 lb on weekly weighings.

The results of the experiment are presented in Table 1. Gilts fed 14 and 16% protein gained slightly faster than those fed 12% protein; however the differences were not significant ($P < .05$). Gilts fed 12% protein required more feed per unit of gain than those fed the higher protein levels. The feed/gain response to protein level was quadratic ($P < .05$).

Table 1.— Effect of Protein Level on Performance of Finishing Gilts

	Protein, %		
	16	14	12
No. gilts	25	25	25
Av initial wt, lb	125.3	125.3	125.2
Av final wt, lb	216.9	218.1	208.3
Av daily gain, lb	1.42	1.44	1.31
Feed/gain[a/]	4.32	4.12	4.65

a/ Significant ($P < .05$) quadratic effect of protein level.

The relatively poor gains and feed/gain responses in this experiment were partially attributed to an outbreak of diarrhea (transmissible gastroenteritis) which occurred during the trial.

These data indicate that a 12% protein level will not support maximum rate and efficiency of gain of gilts from 125 lb to market weight.

EFFECTS OF PROTEIN AND FAT LEVEL ON PERFORMANCE OF GROWING PIGS

J. E. Drews, T. R. Lambuth, V. W. Hays, G. L. Cromwell and W. G. Moody

Two experiments involving 84 crossbred pigs were used to study the effects of protein level and fat addition on pig performance. In the first experiment 32 individually-fed pigs averaging 9.1 kg body weight and 24 days of age were fed diets containing 10 or 20% protein and 0 or 10% added fat to a final weight of 34 kg. Protein level was adjusted by the addition of equal amounts of starch and cerelose to the 20% protein corn-soybean meal diet so that the ratio of amino acids from corn and soybean meal remained the same. Fat replaced equal quantities of starch and cerelose.

Average daily gain (g), average daily feed (g), feed/gain, calculated metabolizable energy (Kcal)/kg gain, and protein efficiency ratio (g/gain/protein eaten) for pigs fed diets containing protein and fat levels of 10-0, 10-10, 20-0 and 20-10% of the diet were 445, 1,143, 2.58, 8,325, 3.90; 405, 980, 2.44, 8,919, 4.11; 512, 1,097, 2.16, 6,732, 2.60 and 520, 953, 1.80, 6,301, 2.80. Pigs fed 20% protein diets gained significantly ($P < .01$) faster, ate significantly ($P < .01$) less feed per day, and required

significantly ($P < .01$) less total feed, metabolizable energy and more protein per unit of gain as compared with pigs fed 10% protein diets. Feed/gain was significantly ($P < .01$) lower for pigs fed diets containing 10% added fat.

In a second experiment, 52 pigs averaging 19.7 kg body weight and 66 days of age were fed diets containing 12 or 20% protein and 0 or 10% added fat. Protein levels were adjusted by varying the level of corn and soybean meal, and fat replaced an equal amount of cerelose. Each of the four diets were offered ad libitum to four pens of three or four pigs per pen. Pigs were removed from the experiment as they individually reached 93 kg at weekly weighings.

Average daily gain (g) and feed/gain for pigs fed diets containing protein and fat levels of 12-0, 12-10, 20-0 and 20-10 were, respectively, 794, 3.39; 758, 3.29; 854, 3.17 and 872, 2.87. Pigs fed diets containing 20% protein gained significantly ($P < .01$) faster and required less feed per unit of gain. Pigs fed 10% added fat required significantly ($P < .01$) less feed per unit of gain than pigs fed no added fat. The interaction between protein and fat approached significance ($P < .05$) for both average daily gain and feed/gain as the addition of fat to the diet resulted in greater improvement of pig performance at the 20% protein level than at the 10% protein level.

REPRODUCTIVE AND PROGENY PERFORMANCE OF PROTEIN RESTRICTED GILTS

M. J. DeGeeter, V. W. Hays, D. D. Kratzer and G. L. Cromwell

Twenty-one and 18 gilts were fed either 2% (low) or 17% (high) protein, respectively, to study the effect on reproduction and progeny performance. The diets were formulated to contain similar levels of metabolizable energy, vitamins and minerals with corn and corn-soybean meal as the protein sources in the low and high diets, respectively. The diets were fed at a level of 1.82 kg/day from 15 days post-breeding to farrowing.

Gilts fed 17% protein gained significantly ($P < .05$) more during gestation (24.1 vs 5.4 kg) and farrowed slightly more total pigs (9.1 vs 8.7) and live pigs (7.6 vs 6.3) than those fed 2% protein; however average pig birth weights were similar for both treatments (1.27 kg).

At parturition half of each group was switched to a 5 or 17% protein level resulting in four gilt treatments high-high, high-low, low-high and low-low. Gilt weight losses during lactation were 11.8, 38.6, 43.6 and 12.3 kg for the four treatments, respectively. Within 48 hours after birth, pigs from each litter within both gestation treatments were randomly distributed across the four gilt treatments resulting in eight nursing pig treatments high-high-high, high-low-high, low-high-high, high-low-low, low-high-high, low-high-low, low-low-high and low-low-low.

Four wk after parturition, 160 pigs (20 per treatment) were assigned to pens with four pigs per pen and fed a corn-soybean meal diet (16% protein) for 124 days. The average daily gain (g) prior to weaning was 260, 256, 232, 152, 262, 272, 235 and 204 for the eight pig treatments. Average daily gain (g) and feed/gain after weaning at four weeks of age were 690, 695, 663, 663, 667, 654, 654 and 654; 2.79, 2.88, 2.75, 2.96, 2.80, 2.66, 2.79 and 2.87.

Hematocrit, hemoglobin and total plasma protein and albumin levels did not differ at mean pig weights of 9.1, 45.5 or 90.9 kg.

Six pigs, weighing an average of 23.5 kg, from each of the four treatments (high-high-high, high low-high, low-high-low, and low-low-low) were placed in individual metabolism cages for a 6-day nitrogen balance study. Nitrogen retained per day and percent retained of apparent absorbed nitrogen were 14.76, 14.56, 16.00 and 15.72 g; and 62.2, 61.7, 65.5 and 65.9%, respectively, for the four treatments.

LEARNING ABILITY OF OFFSPRING FROM PROTEIN-RESTRICTED GILTS

D. L. Hammell, D. D. Kratzer, V. W. Hays, M. J. DeGeeter
and G. L. Cromwell

Forty-two crossbred gilts were randomly allotted to a 2% (low) or a 17% (high) protein diet. Gestation diets were started 15 days after breeding with each gilt fed individually in feeding stalls. The gilts were allowed 1.82 kg of feed daily. During lactation, gilts were continued on low- and high-protein diets (ad libitum), with the low diet increased from 2 to 5% protein. Within 48 hr after farrowing, pigs from a low and high gilts were transferred or cross-fostered. The resulting pig treatments were: high-high (pigs farrowed by a gilt fed high protein and not transferred), high-low (pigs farrowed by a gilt fed high protein and transferred to one fed low protein), low-high (pigs farrowed by a gilt fed low protein and transferred to a gilt fed high protein) and low-low (pigs farrowed by a gilt fed low protein and not transferred).

All pigs were weaned at 2 wk of age and fed a 23% protein diet. At 3 wk of age 77 high-high, 55 high-low, 37 low-high and 43 low-low pigs were tested for learning ability by a procedure in which pigs learned to avoid electrical shock by responding to a warning buzzer. Each animal was tested three consecutive days with 5 trials the first two days and 10 trials the third day. The average number of correct responses out of 10 trials on the third day were 3.95 (high-high), 3.84 (high-low), 4.51 (low-high) and 3.74 (low-low).

At 7 wk of age, 27 (high-high), 18 (high-low), 22 (low-high) and 16 (low-low) pigs were tested in a 3-choice-point water maze used as a second measure of learning ability. The maze was an 8 x 30 ft water tank with partitions in it. Each animal was tested 3 successive days with 3 trials daily. On day 1 the pigs were sent through the maze and left or right choices were permitted; however the animals were not allowed to go back through any choice points. On the second day the pigs were introduced to an escape pattern of three right-side choices. The number of errors (wrong choices) and the amount of time (min) taken by the pigs to swim the length of the tank on this pattern were used as scores of maze learning ability. The mean number of errors and amount of swimming time on the third day were: 7.52, 3.55 (high-high); 6.89, 3.33 (high-low); 7.54, 4.13 (low-high); and 6.81, 4.26 (low-low); respectively.

EFFECT OF FEEDING COMPLEX VS. SIMPLIFIED DIETS TO SOWS DURING GESTATION AND LACTATION ON REPRODUCTIVE PERFORMANCE

G. L. Cromwell, J. R. Overfield and V. W. Hays

Data were collected from 72 SPF Yorkshire gilts and sows in three trials to determine the effects of feeding complex or simplified diets during gestation and lactation on reproductive performance. The simplified diet was a fortified corn-soybean meal ration, whereas the complex diet contained 5% alfalfa meal and 5% meat and bone meal. Both diets were formulated to contain approximately 15% protein, 0.9% calcium and 0.7% phosphorus. Adequate levels of trace minerals and vitamins were added to both diets. Neomycin sulfate and terramycin (100 g of each per ton) were added during the lactation period.

The diets were fed at a level of 4 (summer) or 5 (winter) lb/day during the gestation period and ad libitum during the 5-week lactation period. Sows and gilts were kept in pastures during gestation but were confined to farrowing stalls during the lactation period.

The results of the study are summarized in Table 1. Sows fed the simplified gestation diet farrowed slightly more pigs, however litter size in both groups was quite variable and the difference was not significant. A higher percentage of dead pigs were farrowed in trial 3 as compared with those in trials 1 and 2 (21 vs 7 and 6%). This difference may have resulted from an outbreak of transmissible gastroenteritis which occurred during the farrowing period of trial 3.

The number of pigs surviving to 3 or 5 weeks of age tended to be slightly higher for sows fed simplified diets; however pigs nursed by sows fed the complex diet were slightly heavier at 3 and 5 weeks of age. Type of diet did not appear to influence the level of intake during lactation.

Table 1. — Effect of Feeding Complex vs Simplified Diets to Sows During Gestation and Lactation on Reproductive Performance

Item	Trial 1 Sow Lactation Diet[a]		Trial 2 Sow Gestation and Lactation Diet		Trial 3 Sow Gestation Diet[b]		Gestation Treatment Average[c]		Lactation Treatment Average[d]	
	Complex	Simple	Complex	Simple	Complex	Simple	Complex	Simple	Complex	Simple
No. sows	11	12	13	14	12	10	25	24	24	26
Av No. pigs farrowed	10.55	11.92	9.54	10.43	9.58	10.00	9.56	10.25	10.00	11.12
Av No. pigs farrowed alive	9.91	11.00	8.69	10.07	7.83	7.60	8.28	9.04	9.25	10.50
Av birth wt, lb	3.16	2.71	3.23	2.96	3.04	2.99	3.14	2.97	3.20	2.84
No pigs at 3 weeks	9.73	9.82	8.08	9.43					8.83	9.61
Av pig wt, 3 weeks, lb	13.19	12.11	13.42	13.16					13.31	12.68
No. pigs at 5 weeks	9.73	9.82	8.08	9.43					8.83	9.61
Av pig wt, 5 weeks, lb	22.82	20.36	22.40	22.58					22.59	21.56
Av pig creep consumption, 5 weeks, lb	4.00	2.70	2.92	3.34					3.42	3.04
Sow av. daily feed consumption, 5 week lactation, lb	14.95	14.42	14.53	15.14					14.72	14.81

[a] All sows fed a complex gestation diet
[b] Owing to an outbreak of transmissible gastroenteritis, only the farrowing data are presented.
[c] Average of Trials 2 and 3.
[d] Average of Trials 1 and 2.

These data suggest that a fortified corn-soybean meal diet for sows during gestation on pasture and during lactation in confinement is adequate for good reproductive performance and that the addition of alfalfa meal and meat and bone meal does not improve reproductive performance.

COMPLEX VS. SIMPLIFIED STARTER DIETS FOR BABY PIGS

G. L. Cromwell, V. W. Hays and J. R. Overfield

Forty-nine litters of SPF Yorkshire pigs were used to determine the effects of offering a complex or simplified starter diet as a creep feed on consumption and gains to 5 wk of age.

Composition of the two diets is presented in Table 1. The simplified starter was a corn-soybean meal diet fortified with vitamins, minerals and antibiotics. In addition, the complex diet contained 15% milk products, (dried skimmilk and dried whey) and 5% sucrose. Both diets were formulated to contain approximately 19% protein, 0.70% calcium and 0.65% phosphorus. The diets were fed in meal form, and soybean oil was added to both diets to reduce dustiness. All pigs were nursed by sows confined to farrowing stalls, and the diets were placed in the pen when the litters were approximately 1 to 2 wk of age. Pigs were weighed and starter consumption was determined when pigs were 3, 4 and 5 wk of age.

Average consumption by all litters was very low prior to 4 wk of age with most (68%) of the 5-week feed consumption being consumed during the fifth week. Pigs offered the complex starter diet consumed more feed during each weekly period and the total 5-wk consumption was significantly ($P < .05$) greater than that of pigs fed the simplified diet. This difference was reflected in the slightly heavier 5-week weights of the pigs fed the complex diets. Pig survival to 5 wk was not influenced by type of starter offered.

Table 1. — Composition of Starter Diets

Ingredient	Type of Diet	
	Complex	Simple
	%	%
Corn, ground	52.80	67.30
Dehulled soybean meal	22.50	27.50
Dried skim milk	7.50	-
Dried Whey	7.50	-
Sucrose	5.00	-
Soybean oil	2.00	2.00
Dicalcium phosphate	1.25	1.50
Calcium carbonate	0.50	0.75
Salt, iodized	0.50	0.50
Vitamin mix[a/]	0.10	0.10
Trace mineral mix[b/]	0.10	0.10
Aureo-SP-250	0.25	0.25
Total	100.00	100.00

a/ Contributed the following per lb of diet: vitamin A, 2000 I.U.; vitamin D, 400 IU; riboflavin, 4.0 mg; pantothenic acid, 10.0 mg; niacin, 20.0 mg; vitamin B_{12}, 10.0 mcg.

b/ Contributed the following (ppm): Co, 0.5; Cu, 5.5; Fe, 50; I, 0.75; Mn, 27.5; and Zn, 100.

Table 2. — Complex vs. Simplified Starter Diets for Baby Pigs

Item	Type of Starter Diet		Average
	Complex	Simple	
No. litters	25	24	49
Av no. pigs farrowed	10.56	10.46	10.51
Av no. pigs farrowed alive	9.96	9.79	9.88
Av birth wt, lb	3.00	3.04	3.02
Av no. pigs at 5 wk	9.20	9.25	9.22
Av litter wt at 5 wk, lb	204.8	201.9	203.4
Av pig wt at 5 wk, lb	22.46	21.93	22.20
Av starter consumption/pig, lb			
wk 1-3	0.26	0.21	0.24
wk 4	0.89	0.70	0.80
wk 5	2.52	1.87	2.20
Total	3.67	2.78	3.24
Av daily lactation diet consumption, lb	14.44	15.13	14.78

EFFECT OF ASCORBIC ACID, FAT AND CHOLESTEROL ON PERFORMANCE AND PLASMA CHOLESTEROL LEVELS OF SWINE

G. L. Cromwell, R. D. Kline and V. W. Hays

Two experiments were conducted to determine the effects of dietary ascorbic acid on performance and plasma cholesterol levels of growing pigs. In experiment 1, ascorbic acid was added at levels of 0, 500, 1000 or 2000 mg/kg to four diets containing 10% fat (HEF, animal and vegetable mixture) and 0.5% cholesterol. A 14% protein diet without fat or cholesterol was used as a control. Each diet was fed for 56 days to six pigs averaging 30.4 kg.

Pigs fed diets containing fat and cholesterol gained at a similar rate (656 vs 662 g/day) but required less feed per unit gain (2.91 vs 3.29) and had higher plasma cholesterol levels (1.79 vs 1.34 mg/ml, $P < .05$) than those fed the control diet. Of pigs fed fat and cholesterol, ascorbic acid tended to improve gains (678 vs 592 g/day) and feed/gain (2.86 vs 3.03) but only the 500 mg/kg level of ascorbic acid reduced plasma cholesterol levels (1.45 vs 1.83 mg/ml) with the 1000 and 2000 levels not being effective (1.81 and 2.08 mg/ml).

In experiment 2, six treatments were factorially arranged to compare three fat sources (no fat, 10% HEF and 10% lard) with and without ascorbic acid (500 mg/kg). Cholesterol was added at a level of 0.5% to the diets containing fat. Each diet was fed for 41 days to two pens of five pigs initially averaging 23.3 kg. Gain and feed/gain responses were significantly ($P < .05$) less for pigs fed HEF or lard than for those fed no added fat (704 and 694 vs 779 g/day; 2.67 and 2.63 vs 3.01 feed/gain). Gain and feed/gain responses were not significantly ($P < .05$) affected by ascorbic acid addition (732 vs 719 g/day; 2.74 vs 2.79 feed/gain). Plasma cholesterol levels were significantly ($P < .01$) higher in pigs fed HEF + cholesterol than in those fed diets without fat + cholesterol (1.75 and 1.61 vs 1.27 mg/ml). Ascorbic acid addition had no effect on plasma cholesterol levels (1.55 vs 1.54 mg/ml).

Single additions of 10% HEF, 10% lard or 0.5% cholesterol influenced plasma cholesterol less (1.32, 1.34 and 1.19 vs 1.23) than did a combination of HEF or lard and cholesterol (1.83 and 1.55).

EVALUATION OF SOME PREDICTORS OF SWINE RESPONSE TO TEMPERATURE AND HUMIDITY

D. P. Nelson*, B. J. Barfield*, G. L. Cromwell and V. W. Hays

The trend to confinement housing of swine has required the installation of environmental modification systems in livestock production facilities. During the winter the usual practice is to use ventilation fans and supplemental heat if required. During the summer various means are available for environmental modification, such as ventilation, evaporative cooling, and air conditioning. To choose between these methods requires that the benefits of various levels of environmental modification be estimated and compared with the costs of providing the modification.

A prediction relationship for the change in rate of gain and feed conversion efficiency as a function of temperature and humidity is needed in order to construct an economic model. An experiment was conducted during the summer of 1969 to evaluate three methods of predicting this response. The prediction methods used were obtained from a review of the literature. These relationships had been obtained from experiments with swine exposed to constant temperature and humidity conditions. The test was conducted to determine the applicability of these relationships to swine exposed to naturally varying conditions.

Four treatments, consisting of (1) air conditioning, (2) wetted pad evaporative cooling, (3) natural ventilation, and (4) heated natural ventilation, were used. There were five replications with four pigs per replicate for each treatment. The test was conducted over an 8-wk period. The average temperature and humidity, and the rate of gain and feed efficiency were determined each wk. The average temperature and humidity for each wk was used to predict the response of the pigs in that treatment, and these values were compared to the observed rate of gain and feed efficiency. The initial average weight of the pigs was 100 lb, and the final average weight was 193 lb.

The results indicated a large variability in performance among the individual pigs and between the replications. There was little overall difference in the performance of the pigs between treatments. Two of the predictors tested did a good job of predicting the response, while the other one greatly overpredicted the decline in performance. On the basis of this experiment, little benefit appeared to result from additional modification beyond a simple ventilation system.

The best prediction results were obtained with a temperature index [0.25 x wet bulb temperature, (F) + 0.75 x dry bulb temperature (F) proposed by Roller and Goldman (Trans. ASEA 12:2:164, 1969)] used in conjunction with the change in rate of gain and change in feed efficiency curves presented by Hazen and Mangold (Agr. Eng. 41:9:585, 1960).

EFFECTS OF IODINATED CASEIN AND TAPOZOLE ON VITAMIN A TURNOVER IN RATS

C. L. Fields, G. E. Mitchell, Jr., C. O. Little and J. A. Boling

Previous work at this station** indicated that oral administration of iodinated casein or Tapozole influenced the rate of vitamin A turnover in steers. Since growth rate also influences vitamin A turnover, this experiment was conducted to determine the influence of these compounds on vitamin A when growth rate is held constant. Rats were used as experimental animals because of the ease of controlling growth rate between treatment groups.

Procedure

Liver stores of tritium-labeled vitamin A were established in 48 male albino rats by oral administration of tritium-labeled vitamin A acetate in 3 g of commercial laboratory chow. Thirty-five days after administration of tritium-labeled vitamin A, individuals were allotted to three groups and fed the basal diet, the basal diet plus 10 mg of Tapozole per kg, or the basal diet plus 260 mg of

*Department of Agricultural Engineering.
**Ky. Agr. Exp. Sta. Prog. Rept. (1968).

iodinated casein per kg. Each rat was weighed daily and feed intake was measured and adjusted to facilitate maintenance of equal daily gains within and between treatment groups. Four animals from each treatment group were sacrificed at 2-wk intervals and their livers removed and analyzed for vitamin A and tritium activity. Biological half-time estimates were then obtained from the regression of liver specific activity (DPM/mcg vit A) on time.

Results and Discussion

The biological half-life estimates for control, iodinated casein and Tapozole groups were 97, 62 and 76 days, respectively. Both treatments appeared to increase the turnover rate of vitamin A, with iodinated casein causing a greater increase in rate of turnover than Tapozole when body weight gains of treatment groups were equalized.

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