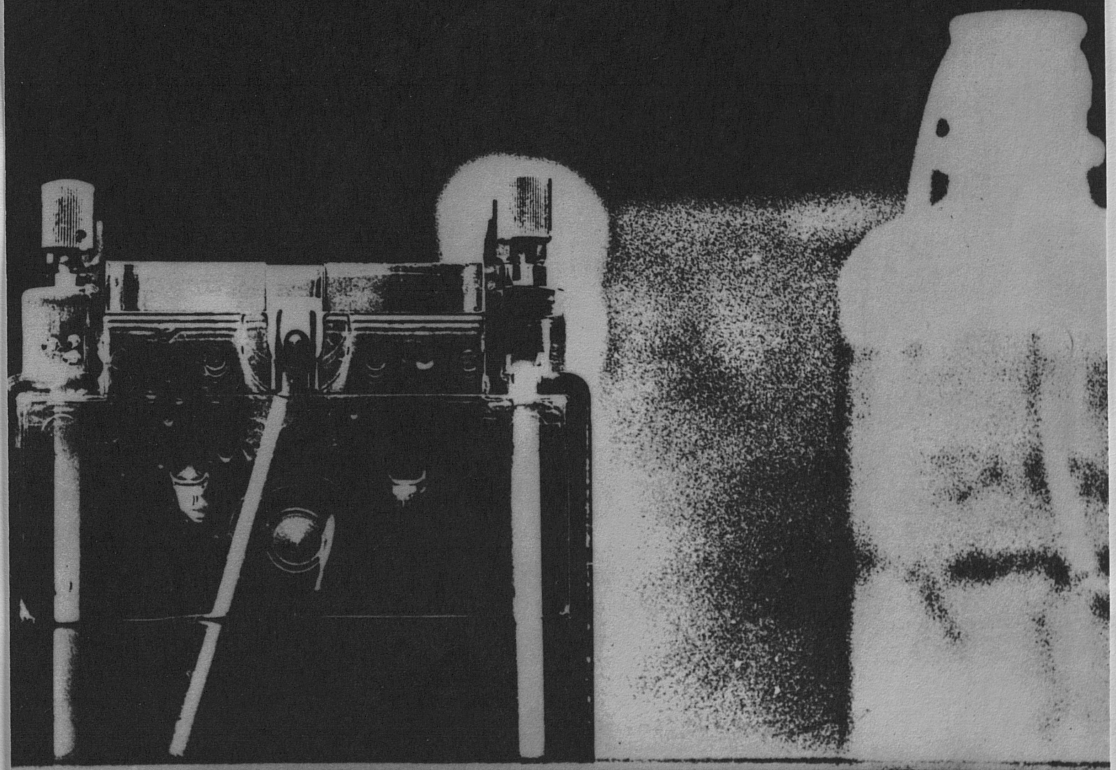
JULY

KENTUCKY ANIMAL SCIENCE RESEARCH REPORTS/1965



IVERSITY OF KENTUCKY AGRICULTURAL EXPERIMENT STATION PROGRESS REPORT 150

PROGRAM FOR 1965 ANNUAL LIVESTOCK FIELD DAY

LEXINGTON

July 14, 1965

Morning

Chairman -- C. Frank Buck

Coldstream Farm -- Conducted tours showing beef, sheep and swine research will start at regular intervals, beginning at 9 a.m. (EST). Last tour starts at 10 a.m.

Noon

Lunch

Courtesy of G. W. Gardner, Bluegrass Stockyards, Lexington

PRINCETON

July 16, 1965

Morning

Chairman -- Paul P. Appel

Livestock Farm West Kentucky Substation. Conducted tours showing beef and swine research will start at regular intervals beginning at 9 a.m. (CST). Last tour starts at 10 a.m.

Noon

Lunch

Courtesy of Farmers Elevators, Inc. and Field Packing Company, Owensboro

Afternoon

Chairman -- W. P. Garrigus

1:15 Address -- "Livestock and Meat Trends"

C. B. Cox, Vice President, Armour and Company

KENTUCKY

ANIMAL SCIENCE RESEARCH REPORTS

1965

PROGRESS REPORT 150

July 1965

UNIVERSITY OF KENTUCKY

AGRICULTURAL EXPERIMENT STATION

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BEEF CATTLE SECTION

SOURCE OF NITROGEN FOR SUPPLEMENTING GROUND EAR CORN RATIONS

N. W. Bradley, J. Ralph Overfield, C. O. Little and G. E. Mitchell, Jr.
University of Kentucky

Two previous experiments showed that a simple ration of ground ear corn, distillers dried grains with solubles (DDG/S), ground limestone, salt and vitamin A was excellent for fattening yearling steers in drylot. Replacing one-half of the DDG/S with urea resulted in a depressed rate of gain one year and had no effect the next year. Additions of trace minerals, alfalfa meal, molasses or a complex supplement containing B vitamins, lysine, and increased levels of calcium and phosphorus did not improve steer performance.

Because of the variable results with additions of urea, 120 steers were used in replicated lots of 10 steers each to test each of the following treatments:

1. Ground ear corn + DDG/S
2. Ground ear corn + DDG/S + urea
3. Ground ear corn + soybean meal (SBM)
4. Ground ear corn + SBM + urea
5. Ground ear corn + corn gluten meal (CGM)
6. Ground ear corn + CGM + urea

The urea in treatment 2 replaced one-half of the nitrogen in the DDG/S in treatment 1. Rations used in the other treatments were formulated to contain nitrogen equivalent to that in rations 1 and 2. Ration ingredients for all six rations are given in Table 1.

All lots of steers were fed their respective rations for a 133-day feeding period. Results of the feedlot trial are given in Table 2. Statistical analysis of the data revealed the following:

1. DDG/S gave a highly significant increase in rate of gain over corn gluten meal, corn gluten meal + urea and soybean meal + urea. DDG/S also increased average daily gain 0.19 lb. over soybean meal. This value approached significance at the 5 percent level.
2. DDG/S + Urea gave a highly significant increase in rate of gain over corn gluten meal and corn gluten meal + urea, also a significant increase in rate of gain over soybean meal + urea.
3. Soybean meal gave a highly significant increase in rate of gain over corn gluten meal, also a significant increase in rate of gain over corn gluten meal + urea and soybean meal + urea.

In this experiment DDG/S was the best of the supplements used, and corn gluten meal was the least desirable in respect to rate of gain and feed efficiency. Interestingly enough, replacing one-half of the protein in DDG/S or CGM did not significantly depress rate of gain. However, when urea replaced one-half of the protein in soybean meal, rate of gain was significantly depressed. These results confirm a previous conclusion that substituting urea and corn for a part of natural protein supplements sometimes, but not always, depresses performance. Obviously, this area of ruminant nutrition needs further research to define more clearly conditions under which depressed performance can be expected when urea is used in beef cattle rations.

Table 1. —Ration Ingredients (lb/ton)

Ingredients	1	2	3	4	5	6
Ground shelled corn	1,291	1,423	1,430	1,498	1,418	1,492
Ground corn cobs	323	356	358	375	355	373
DDG/S	359	179	---	---	---	---
SBOM	---	---	186	85	---	---
Urea	---	18	---	15	---	15.3
Corn gluten meal	---	---	---	---	201	93
Ground limestone	7.2	7.2	7.2	7.2	7.2	7.2
Salt	20	20	20	20	20	20
Vitamin A, I.U.	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000

Table 2. —Steer Performance

	DDG	DDG + Urea	SBM	SBM + Urea	Corn Gluten	Corn Gluten + Urea
Days on Expt.	133	133	133	133	133	133
No. steers	20	20	20	20	19	19
Initial Wt	741	743	742	742	744	737
Final Wt	1074	1062	1050	1021	1008	1011
Total gain	333	319	308	279	264	274
A.D.G.	2.51	2.40	2.32	2.10	1.98	2.06
Feed/Hd/day	22.2	21.6	21.5	20.5	19.6	19.7
Feed/cwt gain	887	899	930	977	1078	1047
Carcass Grade[a]	11.6	11.0	11.0	10.7	10.8	10.5

[a/] 10 = average good, 11 = high good, 12 = low choice.

SUPPLEMENTATION OF CORN-CORN SILAGE RATIONS FOR FEEDLOT CATTLE

J. T. Thompson, J. R. Overfield, N. W. Bradley and C. O. Little
University of Kentucky

The potential of high corn yields in certain areas of Kentucky and the demand for fed cattle in the state have increased the interest in practical feedlot rations for beef cattle. Reports from this station have included work with ground ear corn rations and various protein supplements. The results have verified that urea can be used efficiently for supplementing ear corn rations; however, only limited information is available on the effectiveness of urea supplements in silage rations. This experiment was conducted to obtain information on the feedlot performance of yearling steers fed different levels of corn silage and corn supplemented with soybean meal or urea.

Fifty yearling steers averaging 757 lb each were allotted to 5 groups of 10 and placed on the following rations:

Lots 1 and 2 - Ground shelled corn and supplement fed at 1.5% body weight, corn silage ad lib.
Lots 3 and 4 - Ground shelled corn and supplement fed at 1.0% body weight, corn silage ad lib.
Lot 5 - Ground shelled corn and supplement fed at 0.5% body weight, corn silage ad lib.

Lots 1 and 3 received a soybean meal supplement, and lots 2, 4 and 5 received a urea supplement. Composition of the supplements is given in Table 1. Before feeding, the supplements were mixed with the ground shelled corn portion of the ration, and this corn-supplement mixture was fed as a top dressing on the silage. All steers were implanted with 24 mg diethylstilbestrol at the beginning of the 125-day feeding period. At the end of the feeding period, the steers were slaughtered and various carcass measurements made.

The results of this experiment are summarized in Table 2. With both supplements, a reduction in the level of shelled corn in the ration from 1.5% to 1.0% of body weight and an increase in corn silage intake gave decreased rates of gain. These decreases were 0.19 lb per day with soybean meal supplement and 0.17 lb daily with urea supplement. Further reduction of corn intake to 0.5% of body weight with urea supplement decreased gain an additional 0.06 lb per day. These differences in rate of gain were accompanied by changes in dry feed intake. Feed required per 100 lb gain was not affected by corn-corn silage changes with the soybean meal supplement; however, with the urea supplement, less feed was required when corn was decreased and silage was increased. At each level of corn-corn silage feeding that a comparison could be made, the steers fed soybean meal gained at a faster rate and required less feed than the urea-fed steers.

The economy of these rations is shown by the feed cost figures. The feed costs per unit of gain for steers on the same silage levels were slightly larger with the urea supplement than with the soybean meal supplement in this experiment; however, this could change with changes in prices of soybean meal and urea. It should be pointed out that the rations which gave the fastest rate of gain were not necessarily the most economical. As the level of corn silage in the rations was increased the cost of gains was reduced. There were little differences in the various carcass measurements. Although only a small number of animals was involved in this experiment, the results suggest that urea can be efficiently utilized in corn silage rations and high quality beef can be produced economically with corn silage.

TYLOSIN FOR BEEF STEERS ON PASTURE

D. B. Herd, N. W. Bradley, D. E. McKechnie and G. E. Mitchell, Jr.
University of Kentucky

Results of two years' work at this station suggest that administration of the antibiotic tylosin in a sustained release bolus may improve gains of grazing steers. Preliminary investigations indicated that the effective life of the boluses being used was approximately 40 days; however, in the first year's work, treated steers gained

Table 1.—Composition of Soybean Meal and Urea Supplements Mixed with Ground Shelled Corn and Fed with Corn Silage.

	Soybean meal Supplement	Urea Supplement
Soybean meal (44%)	85.0	--
Urea (262 equiv.)	--	33.0
Ground shelled corn	--	34.0
Dicalcium phosphate	8.5	20.0
Limestone	6.0	12.0
Trace mineral premix[a]	0.5	1.0
Vitamin A[b]	+	+

a/ Composition of trace mineral premix in parts per thousand: manganese, 90; zinc, 80; iron, 30; copper, 5.5; iodine, 1.8; and cobalt, 1.0.

b/ Vitamin A was included to provide 20,000 I. U. per steer daily.

Table 2.—Feed-lot Results and Carcass Data from Steers Fed Soybean Meal or Urea Supplements with Different Levels of Corn and Corn Silage (125-day Feeding Experiment)

Supplement	Soybean Meal		Urea		
Level of Corn as % Bd Wt	1.5%	1.0%	1.5%	1.0%	0.5%
Initial wt, lb	757	757	757	757	757
Final wt, lb	1056	1031	1041	1020	1012
Total gain, lb	299	274	284	263	255
ADG, lb	2.39	2.20	2.27	2.10	2.04
Ration intake, lb /hd /day					
Corn silage (wet)	23.9	32.5	24.6	32.3	37.7
Corn silage (air dry wt)	8.0	10.8	8.2	10.7	12.6
Shelled corn	12.0	7.3	12.8	8.1	3.7
Supplement[a]	1.55	1.63	0.77	0.84	0.76
Total air dry feed	21.5	19.7	21.7	19.6	17.0
Feed/cwt gain	901	900	958	938	833
Feed cost/cwt gain[b]	19.87	17.77	20.57	18.14	13.87
Dressing %	63.9	64.9	64.9	64.8	62.9
Carcass grade[c]	13.1	12.5	12.3	12.6	12.4
Rib eye, sq in.	11.65	12.83	11.88	12.95	11.93
Fat over rib eye, cm	1.63	1.61	1.90	1.49	1.57
Selling price/cwt	24.47	24.73	24.49	24.84	23.78

a/ Supplements were thoroughly mixed with the ground shelled corn before feeding.

b/ Feed costs calculated from the following: corn silage, $8.00 per ton; ground shelled corn, 52.00 per ton; soybean meal supplement, 86.80 per ton; and urea supplement, 97.20 per ton.

c/ Grade on scale of 12 = low choice, 13 = average choice.

d/ Price per cwt of live weight on grade-yield basis.

faster during the first two weeks after bolusing, but not from 14 to 42 days, suggesting a shorter-than-expected bolus life. The following year, bolusing at 14-day intervals was compared with 42-day intervals. Both treatments gave a substantial increase in gain over control animals, but the differences were not statistically significant. The 42-day bolus treatment was slightly more effective in increasing gains than the 14-day bolus treatment, suggesting that the boluses were effective for at least 42 days.

The following experiment was conducted to obtain additional information concerning the influence of tylosin boluses on the gains of grazing steers.

Fifty-one 550-pound yearling Angus steers were randomly allotted to a control group and a group receiving single tylosin boluses at the beginning of the experiment and at 42-day intervals thereafter.

The boluses weighed 64 $\pm$ 0.5 grams and contained 6 grams of tylosin activity as tylosin phosphate.

Each steer was implanted with 24 mg of stilbestrol. All steers grazed together on bluegrass-white clover pastures for 168 days beginning May 19, 1964. Weights were taken every 14 days. The steers were held off feed overnight before each period weight and off feed and water before initial and final weights were taken. Rumen samples were taken by stomach tube 1, 2, 4 and 6 weeks after the start of the experiment for determination of the tylosin activity present in ruminal fluid.

Performance of the steers is summarized in Table 1. The use of tylosin boluses gave a small but nonsignificant increase in average daily gain. Once again, it appeared that the bolus release rate was not uniform over the 42-day periods. It can be seen in Table 2 that the tylosin-treated steers consistently gained faster than did the control steers during the first 2 weeks after each bolus, but gained slower during the second and third 2-week periods. This large difference in gain during different periods after bolusing suggests that the tylosin was not being released at a uniform rate. This was further supported by a limited number of rumen assays which showed that the level of tylosin present in the ruminal fluid decreased progressively with time after bolusing and was essentially gone by the end of 4 weeks. This latter evidence was obtained during the first 42-day period only.

Under these conditions, where the tylosin was not uniformly released throughout the bolusing period, it was not possible to evaluate the growth-promoting properties of the antibiotic. Some other method of administration or an improved bolus with a more uniform release rate is needed before a fair analysis of the value of tylosin for grazing steers can be made.

Table 1.—Effect of Antibiotics on Grazing Steer Performance[a/]

	Control	Tylosin[b/]
Number of steers	25	26
Initial weight, lb	542	549
Final weight, lb	770	789
Total gain, lb	228	240
Total ADG, lb	1.36	1.43

a/ All steers were implanted with 24 mg of stilbestrol at the beginning of the experiment.

b/ Tylosin boluses (one bolus per steer) were administered at the beginning of the experiment and repeated at 42-day intervals.

Table 2.—Average Daily Gain of Steers at Different Times After Bolusing

	Time After Bolusing					
	0-14 days		14-28 days		28-42 days	
	C[a/]	T[b/]	C[a/]	T[b/]	C[a/]	T[b/]
First bolus, lb	3.37	3.95	2.74	2.39	.21	.14
Second bolus, lb	1.69	2.14	.79	.30	1.27	1.30
Third bolus, lb	1.67	2.01	4.06	3.65	.59	.51
Fourth bolus, lb	1.00	1.87	-.70	-.61	-.41	-.48
Average of the four boluses, lb	1.93	2.49	1.72	1.43	0.42	0.37

a/ Control.

b/ Tylosin at 42-day intervals.

MEASUREMENT AND SELECTION OF ECONOMICALLY IMPORTANT TRAITS IN BEEF CATTLE - 1964

N. W. Bradley, J. Ralph Overfield, J. D. Kemp and J. T. Thompson
University of Kentucky

The objectives of this long-range breeding project are to use rate of gain, efficiency of gain, conformation and carcass characteristics in an overall selection experiment and, also, to develop a method of estimating a bull's transmitting ability for carcass characteristics as well as rate of gain and conformation.

The herd of Hereford cattle being used in this project has increased steadily to a total of 349 head of varying ages. During the first three months of 1965, 93 calves were born. At present 176 cows and heifers are being bred to calve during January, February and March of 1966.

A postweaning performance test has been completed with 20 selected bulls from the 1963 calf crop. Three of these bulls were kept for progeny testing during the 1964-65 breeding season. The other 17 bulls were slaughtered to obtain carcass measurements. A summary of the performance data is given in Table 1, and a summary of the carcass measurements is given in Table 2. The data are summarized according to the sire of the bulls. Progeny test data for these two sires (SP 194 and HP RS 15) may be found in the 1963 Kentucky Animal Science Research Reports. Bulls sired by HP RS 15 gained 0.18 lb per head daily more than did the sons of SP 194. The progeny of HP RS 15 had an increase in fat thickness over the rib of 0.08 inch, an increase in dressing percent of 1.3, an increase in yield grade of 0.5 and an increase of almost 4% in the fat content of the rib.

Growth rate of calves sired by the first three herd sires selected for use in this project has been disappointing. Seven additional herd sires have been obtained. Preliminary growth data from calves sired by these bulls seems to be much improved. Complete results will be reported as they are collected and compiled.

Table 1.—Preweaning and Postweaning Performance of Bulls by Two Different Sires

Item	Sire	
	SP 194	HP RS 15
Preweaning		
Number	8	12
Age, days	221	234
Weaning Wt, lb	424	431
ADG, lb	1.56	1.59
Adj. ADG, lb	1.68	1.68
Type[a]	11.5	12.2
Index	106	110
Postweaning		
Number	8	12
Age in days	432	433
Final wt., lb	789	815
ADG, lb	2.15	2.33
Wt./Day of age, lb	1.83	1.88
Type[a]	12.0	12.4
Index[b]	115	119
Feed/cwt gain	816	813

[a] 11 = high good, 12 = low choice, 13 = average choice.

[b] (Wt /day of age x 40) + (Type x 5) - 18 = Postweaning index.

Table 2.—Carcass Data of Bulls by Two Different Sires

Item	Sire	
	SP 194	HP RS 15
Number	7	10
Wt at slaughter, lb	889	913
Cold carcass wt, lb	509	536
Dressing %	57.3	58.6
Hide wt, lb	75.6	77.5
Conformation[a]	12.1	13.2
Marbling score[b]	3.9	3.9
Ribeye area, sq in.	12.3	12.1
Fat thickness, in.	0.34	0.42
Kidney fat %	2	2
Quality[a]	10.0	10.1
Yield grade[c]	1.7	2.2
Carcass grade[a]	10.0	10.1
Color of fat[d]	2	2
Color of lean[e]	6.0	7.3
Wt. of rib, lb	22.0	22.8
% fat	26.7	30.6
% lean	57.9	54.5
% bone	15.4	15.9
W-B shear force, lb	16.1	16.5
Palatability[g]		
flavor	7.56	7.47
juiceness	7.45	7.33
tenderness	7.37	7.19
overall satisfaction	7.46	7.37

[a] 10 = average good, 11 = high good, 12 = low choice, 13 = average choice.
[b] 3 = traces, 4 = slight.
[c] The lower the yield grade the greater the estimated percent lean cuts.
[d] 2 = creamy white.
[e] The higher the number the darker the lean.
[f] 1" cores roasted at 325° to an internal temperature of 160° in an electric oven.
[g] Average of 3 scores. The higher the number the more desirable.

ANIMAL NUTRITION SECTION

CONCENTRATIONS OF PANTOTHENIC ACID, NIACIN, FOLIC ACID AND VITAMIN B_{12} IN RUMINAL FLUID OF STEERS FED DIFFERENT LEVELS AND FORMS OF HAY AND GRAIN

B. W. Hayes, G. E. Mitchell, Jr., C. O. Little and N. W. Bradley
University of Kentucky

It has been well established that changes in the level of concentrates in the ration and different types of feed processing produce major changes in the microbial activity in the rumen. Investigation concerning the possible effects of such changes on microbial B-vitamin synthesis, which occurs in the rumen, has been limited. Results reported last year in the Kentucky Animal Science Research Reports showed that ration effects on levels of thiamine and riboflavin in ruminal fluid from steers were significant ($P < .05$) but that levels of biotin were not significantly ($P > .05$) affected by the various rations studied. The present report is a continuation of that study to include pantothenic acid, niacin, folic acid and vitamin B_{12}.

Procedure

Samples of ruminal fluid from 48 yearling Angus steers, weighing approximately 397 kg (875 lb) were assayed microbiologically for the 4 B-vitamins. All steers were fed a ground ear corn and soybean meal ration for 14 days before 8 steers were assigned to each of the following treatments:

I. Flaked corn	IV. Ground corn and long hay
II. Ground corn	V. Flaked corn and ground hay
III. Flaked corn and long hay	VI. Ground corn and ground hay

Corn was self-fed and alfalfa hay was fed at the rate of 1.8 kg (4 lb) per head per day. In rations III and IV, corn and hay were fed separately, while in rations V and VI the corn and hay were combined in a complete mixture. Soybean meal, vitamins A and D, and minerals were mixed with the corn at appropriate levels to balance the rations according to NRC requirements. Rations were adjusted at frequent intervals to equalize intake of these components and to regulate ground hay intake. Ruminal samples were taken via stomach tube on the first and 56th days of the experiment.

Results and Discussion

Initial and average vitamin concentrations at 56 days (mcg/100 ml ruminal fluid) are presented in Table 1. The largest concentrations of all 4 B-vitamins were found in ruminal fluid of steers fed the all-concentrate rations (I and II). Pantothenic acid and niacin values for steers receiving ground corn (II) were significantly greater than those for steers receiving flaked corn (I), and these values were significantly greater than the values for steers receiving hay. Ruminal fluid from steers fed ground corn and either ground or long hay (IV and VI) contained significantly more niacin than ruminal fluid from steers fed flaked corn and ground hay (V).

Folic acid values for steers receiving the all-concentrate rations (I and II) were significantly greater than the values for steers receiving the other rations.

Vitamin B_{12} data show that steers maintained on flaked corn (I), ground corn (II) or ground corn and long hay (IV) had significantly more vitamin B_{12} in their ruminal fluid than steers fed ground hay and either flaked or ground corn (V and VI).

These data further demonstrate that ration changes can produce wide fluctuations in the levels of B-vitamins in ruminal fluid. Further research is needed to determine the practical implications of these findings.

Table 1.—B-vitamin Levels in Ruminal Fluid of Steers (mcg/100 ml ruminal fluid)

	Initial Concentration	Concentration after 56 Days on Respective Ration					
		I	II	III	IV	V	VI
Pantothenic acid	71	246^{b}	354^{a}	65	77	115	112
Niacin	146	649^{b}	850^{a}	$222^{c,d}$	375^{c}	141^{d}	324^{c}
Folic acid	7.6	18.6^{a}	18.0^{a}	8.0	8.3	9.1	14.4^{b}
Vitamin B_{12}	3.0	$6.4^{a,c}$	8.8^{a}	$4.6^{b,c,d}$	$5.6^{a,c}$	$2.2^{b,d}$	$2.1^{b,d}$

a, b, c, d Means in the same line, excluding initial concentration, that have different superscript letters are significantly different ($P < .05$).

B-VITAMIN SYNTHESIS IN VITRO: EFFECT OF SOURCE OF RUMEN MICROORGANISMS AND SUBSTRATE

B. W. Hayes, G. E. Mitchell, Jr., C. O. Little, G. D. Potter and C. R. Acord
University of Kentucky

Cellulose-digesting microorganisms are prevalent in the rumen when high roughage rations are fed to beef cattle and when the major component of the ration is grain there is an increase in ruminal amololytic activity. Thus, it seems possible that some of the differences in ruminal B-vitamin synthesis when animals are fed different rations may be due to the presence of different microbial populations in the rumen. The present in vitro study was designed to furnish information on this subject.

Procedure

Washed cell suspensions were prepared from ruminal fluid obtained from each of three steers that were fed daily rations shown in Table 1. Microbial cells from two volumes of ruminal fluid were suspended in one volume of a basal medium buffered with phosphate and bicarbonate. Series of flasks containing 150-ml aliquots of washed cell suspensions from each steer were incubated in 250-ml Erlenmeyer flasks with finely ground substrates given in Table 2. Amounts of substrate in each flask per 150 ml of the washed cell suspension were based on a ratio of the amounts of hay, corn and soybean meal in each steer's ration to an assumed ruminal ingesta volume of 75 liters. Each flask was fitted with a two-hole rubber stopper and glass tubing so that carbon dioxide could be bubbled through the mixture during incubation to provide anaerobiosis and agitation. Flasks were incubated in a constant temperature water bath at 39°C. After an 8-hour incubation period, contents in each flask were centrifuged at 20,000 X G. The resulting supernatant was assayed for individual B-vitamins by standard microbiological techniques.

Table 1.—Steer Rations (kg/steer/day)

	Alfalfa Hay	Ground Shelled Corn	Soybean Meal
Steer 1	6.80	--	--
Steer 2	1.36	6.63	0.68
Steer 3	--	6.63	0.68

Table 2.—Substrates for Washed Ruminal Microorganisms (g/150 ml)

Substrate	Alfalfa Hay	Shelled Corn	Soybean Meal
Control	--	--	--
Hay	13.5	--	--
Mixed	2.7	7.2	0.9
Concentrate	--	7.2	0.9

Results and Discussion

Results of this study are presented in Table 3. When microorganisms from the steer receiving the hay ration were used, apparent synthesis of riboflavin, niacin, folic acid, pantothenic acid and vitamin B_{12} was less as hay was removed from the substrate. Thiamine synthesis was greatest when the substrate was a mixture of hay, corn and soybean meal.

Microorganisms from the steer fed the mixed ration synthesized more riboflavin, niacin and pantothenic acid on the hay or mixed substrates than on the concentrate substrate. The mixed substrate favored the greatest synthesis of thiamine, folic acid and vitamin B_{12}, while the smallest amounts of these vitamins were synthesized when hay was the substrate.

Feeding the all-concentrate ration resulted in a rumen microbial population which synthesized less of all vitamins studied in the hay substrate than on either the concentrate or the mixed substrate. There was little difference between the concentrate and mixed substrates in promoting B-vitamin synthesis by these microorganisms.

Summary

With some exceptions, B-vitamin synthesis was greater when the *in vitro* substrates corresponded to rations of steers from which ruminal microorganisms were obtained. In general, larger amounts of B-vitamins were synthesized by microorganisms obtained from steers receiving the all-concentrate and mixed rations than by microorganisms from the steer receiving the hay ration.

Table 3.—Influence of Source of Ruminal Microorganisms and Substrate on In Vitro Synthesis of B-vitamins[a]

Substrate	Final pH	Mcg/100 Ml. Washed Cell Suspension					
		Ribo-flavin	Thia-mine	Niacin	Folic Acid	Pant. Acid	B_{12}
Microorganisms obtained from steer fed hay							
Control	6.65	52	1.9	30	2.3	0.9	0.5
Hay[b]	5.40	880	2.5	150	8.7	5.0	1.0
Mixed[c]	5.70	380	3.8	120	4.7	1.5	0.8
Concentrate[d]	6.10	200	2.5	80	3.5	1.0	0.6
Microorganisms obtained from steer fed mixed ration							
Control	6.70	80	1.2	70	2.3	1.0	1.0
Hay[b]	5.50	310	2.5	240	6.0	2.5	1.5
Mixed[c]	4.90	300	6.2	280	9.7	3.0	2.3
Concentrate[d]	5.25	180	3.8	150	7.0	1.1	1.8
Microorganisms obtained from steer fed all concentrate ration							
Control	6.70	140	2.5	150	16.3	2.0	1.4
Hay[b]	5.70	320	3.8	320	20.3	3.0	1.6
Mixed[c]	4.50	380	5.0	840	23.2	5.5	2.1
Concentrate[d]	5.30	360	6.2	840	23.0	5.5	2.5

[a]Aliquots of 150 milliliters of washed cell suspensions were adjusted to pH 6.9 and incubated with appropriate substrates in 250-milliliter Erlenmeyer flasks at 39°C for 8 hours.
[b]13.5 grams hay.
[c]Mixture of 2.7 grams hay, 7.2 grams corn and 0.9 gram soybean meal.
[d]Mixture of 7.2 grams corn and 0.9 gram soybean meal.

UTILIZATION OF GLUCOSE AND STARCH BY WETHERS WHEN GIVEN ORALLY OR INTO THE ABOMASUM

C. O. Little, G. E. Mitchell, Jr. and J. W. McAtee

Much of the carbohydrate material fed to ruminants is digested in the rumen and converted by microbial activity to short chain fatty acids. These acids form the major source of energy for tissue metabolism. This is in contrast to non-ruminants in which glucose plays a major role in energy metabolism. Because of the microbial conversion of carbohydrates into fatty acids in the rumen, it is generally believed that insignificant quantities of hexose sugars are actually absorbed from the ruminant digestive tract. Blood and tissue carbohydrates presumably are formed from other glucogenic compounds. However, little information is available as to the utilization of various carbohydrates posterior to the functional rumen and their influence on the metabolism of other nutrients. This experiment was designed to obtain such information in respect to glucose and starch.

Procedure

Six crossbred wethers, with an average weight of 40 kilograms, were used in this study. Three of the wethers were fitted with permanent abomasal fistulas prior to the beginning of this work. A basal ration of ground alfalfa hay was fed at the rate of 20 g per kg body weight (800 g daily). To the intact wethers, purified corn starch or glucose was given orally at 2 gm per kg body weight (80 g daily). An equal quantity of starch or glucose was given to the fistulated wethers in a warm water slurry directly into the abomasum through the fistula. Feces and urine were collected during a 7-day collection period following a 7-day preliminary period. Digestibility of dry matter, protein, cellulose and gross energy and nitrogen retention were determined. Blood samples were taken at the conclusion of each trial, 0, $\frac{1}{2}$, 1, 2, 4 and 6 hours after feeding, and blood sugar levels determined. The trials were arranged to obtain six observations for each method of administering starch and four observations for each method of administering glucose.

Results

The digestion and nitrogen retention results are summarized in Table 1. Digestibilities of ration dry matter and cellulose were not affected by the method of administering starch or glucose. Giving either starch or glucose orally resulted in an increase in crude protein digestion over the protein digestion when the carbohydrate was given into the abomasum. Although not significant, the differences in gross energy digestion suggest an increased digestibility when the carbohydrates were given orally. Calculations reveal that much of these differences in gross energy digestibility may be accounted for by the estimated energy values of differences in crude protein digested.

The nitrogen retention values are expressed as grams of nitrogen retained daily and, to adjust for differences in protein digestion, they are also reported as percentage of digested nitrogen retained. Wethers receiving oral glucose retained slightly more total nitrogen than those receiving glucose via the abomasum; however, the percentage of digested nitrogen retained was similar. When starch was given orally, the wethers retained more total nitrogen and more of the digested nitrogen.

Blood sugar levels were elevated when either starch or glucose was given into the abomasum; however, blood sugar following starch administration rose less rapidly and was not so high as blood sugar following glucose administration. Oral administration of glucose or starch had no appreciable effect on blood sugar levels.

Table 1.—Digestibility and Nitrogen Balance in Wethers Receiving Corn Starch or Glucose Orally or Into Abomasum

Carbohydrate	Corn Starch		Glucose	
Method of Administration	Oral	Abomasal	Oral	Abomasal
Digestibility (%)				
Dry Matter	69.9	68.0	69.3	67.0
Protein	69.3	60.8	68.9	61.3
Cellulose	71.0	71.4	66.3	65.8
Gross Energy	69.0	66.0	66.6	63.9
Nitrogen Retention				
G daily	3.61	1.86	2.58	2.30
% of digested	38.2	22.3	24.7	24.6

STARCH DIGESTION IN STEERS AS INFLUENCED BY DIETARY LEVEL

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Most of the digestion of starch in ruminants is generally assumed to take place in the rumen where starch is converted to volatile fatty acids (VFA) by micro-organisms. These VFA's are absorbed from the rumen to supply energy to the tissues. Post-ruminal digestion of starch in functioning ruminants has received little attention. This may be justified when rations containing low levels of starch are fed, but starch is the predominant energy source in many high-concentrate rations. Widespread use of high-concentrate rations has created a need to determine the effect of increasing increments of dietary starch on its post-ruminal digestion as well as its digestion in the rumen. The present study was designed to study the disappearance of starch during its passage through different sections of the ruminant gastro-intestinal tract.

Procedure

Eight yearling angus steers averaging 360 kg in weight were fitted with ruminal and either abomasal or posterior ileal fistulas. An abomasal and an intestinal fistulated steer were paired and pairs and diets shown in Table 1 arranged in a 4 x 4 factorial design. The steers were fed ground mixed diets varying in starch content from 19 to 63%, twice daily, for a 30-day preliminary and a 6-day collection period. The diets were equalized for protein, calcium, phosphorus and vitamin A. A gelatin capsule containing 5 grams of chromic oxide was given at each feeding, starting 8 days before and continuing during the 6-day collection period. Apparent digestion coefficients and quantity of starch passing from the rumen, small intestine and into the feces were determined from changes in chromic oxide to starch ratios.

Results

Starch recovery, digestion coefficients, and disappearance data are shown in Table 2. Steers on diets 1, 2, and 3 consumed 5448 g of feed daily, but, steers receiving diet 4 would consume only approximately 4086 g daily. The data indicate that a considerable amount of starch does escape fermentation in the rumen and that the amount is influenced by dietary level. Apparent ruminal digestion of starch showed no consistent trend but was least for diet 3. Apparent overall digestion of starch was not influenced by level of starch in the diet as all digestion coefficients were high (98-99%). However, variations in starch intake did influence the importance of post-ruminal digestion considerably. Most of the starch passing out of the rumen was apparently digested by the time it reached the cecum with the exception of diet 4 where a high proportion (44%) of the post-ruminal starch was digested in the large intestine.

Table 1.—Composition of Diets[a/]

Composition	Diets			
	1	2	3	4
Ingredient	%	%	%	%
Corn, ground yellow	20.0	40.0	60.0	80.0
Alfalfa hay, ground	76.0	53.1	30.8	7.5
Soybean meal, 50% C.P.	--	2.4	4.7	7.0
Animal fat	3.0	3.0	3.0	3.0
Dicalcium phosphate	0.5	0.5	--	1.0
Salt	0.5	0.5	0.5	0.5
Limestone	--	0.5	1.0	1.0
Chemical analysis				
Crude protein	12.5	11.8	11.9	11.4
Starch	19.0	36.0	50.7	63.5

[a/] 1000 IU Vitamin A added per pound of diet.

Table 2.—Effect of Varying Levels of Dietary Starch on Daily Starch Recovery and Digestion in Various Areas of the Digestive Tract

Item	Diet			
	1	2	3	4
Starch intake, gm	1002	1948	2438	2708
Starch recovered, gm				
Abomasum	357	542	1062	820
Posterior ileum	28	79	169	401
Feces	14	17	40	62
Starch digestion, %				
Oral to:				
Abomasum	63.5	72.4	55.8	69.0
Posterior ileum	97.2	96.0	93.4	85.3
Feces	98.7	99.0	98.4	97.7
Starch disappearance, gm				
Rumen	645	1406	1376	1868
Small intestine	329	463	893	419
Large intestine	14	62	129	339

NON-PROTEIN NITROGEN SOURCES FOR IN VITRO STARCH DIGESTION BY RUMEN MICROORGANISMS

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Increased emphasis on the use of grain in ruminant rations has called attention to a need for a more complete understanding of starch digestion by the microorganisms in the rumen. A method of studying starch digestion by rumen microorganisms cultured outside the rumen was reported in the 1964 Kentucky Animal Science Research Reports. This method has been used to compare a wide variety of non-protein nitrogen compounds. The results of these comparisons are summarized in this report.

Procedure

Nineteen different nitrogen compounds were studied as sources of nitrogen for in vitro starch digestion by rumen microorganisms. The sources included urea, ammonium, amino, guanidino and amide forms from the following compounds: urea, ammonium chloride, ammonium phosphate, ammonium sulfate, ammonium acetate, aspartic acid, glutamic acid, serine, valine, methionine, lysine, arginine, amino guanidine, guanidine acetate, acetamide, propionamide, butyramide, malonamide and succinamide.

These compounds were added to provide 3, 6 and 9 mg nitrogen per 20 ml of nutrient medium containing minerals, buffers, and approximately 100 mg purified corn starch. Treatments were replicated 4 times in each of two trials with 8-hour incubation periods.

Results and Discussion

In all experiments, the addition of urea resulted in a highly significant increase in starch digestion. Adding the 3-mg level of urea nitrogen resulted in a major stimulation of starch digestion, adding the 6-mg level resulted in moderate additional response; however, adding the 9-mg level produced results similar to the 6-mg level. This demonstrates that the system used does require nitrogen for effective starch digestion, that urea is an excellent source of nitrogen for this purpose, and that reasonable quantities of urea were added.

Ammonium acetate, ammonium chloride, ammonium phosphate and ammonium sulfate additions each resulted in responses similar to the responses to urea at all three levels of nitrogen studied.

None of the amino acids studied was as effective as urea in stimulating starch digestion. Aspartic acid additions resulted in significantly greater starch digestion than additions of any of the other amino acids studied, but aspartic acid was significantly inferior to urea. Additions of arginine, methionine and serine produced some response but were less effective than additions of valine, glutamic acid and lysine which proved to be poor sources of nitrogen.

None of the amides and neither of the guanidine derivatives studied consistently stimulated starch digestion more effectively than did the control containing no added nitrogen.

These results show that microorganisms from the rumen can use non-protein nitrogen to meet their nitrogen requirements for starch digestion. However, some nitrogen sources meet this requirement much more effectively than others. These differences may be related to rate of ammonia release from the different compounds. Results of preliminary studies of ammonia levels in the incubation mixtures after 4 or 8 hours of fermentation support this hypothesis, with high-ammonia levels being associated with stimulation of starch digestion.

CONVERSION OF ZEIN TO MICROBIAL PROTEIN IN LAMBS FED TWO CELLULOSE: STARCH RATIOS

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Much of the protein digested in the abomasum and lower parts of the digestive tract of ruminants is contributed by the microorganisms which have developed in the rumen. This permits ruminants to flourish under circumstances where their main protein supply is unbalanced as to amino acid composition and allows them to be less dependent on the amino acid composition of the diet than monogastric animals. Carbohydrates in the diet and their fermentation by the rumen microorganisms may have a decisive influence on the extent of conversion of dietary protein to microbial protein. This study was initiated to determine the effect of two cellulose: starch ratios on the conversion of zein to bacterial protein.

Procedure

Six crossbred wether lambs weighing approximately 90 lb and fitted with permanent abomasal fistulas were used to estimate the influence of cellulose: starch ratios on ruminal conversion of zein to microbial protein. Rations containing ratios of 70:30 and 40:60 purified cellulose to starch and 12.9% purified zein as the only nitrogen source were fed at the rate of 200 g twice daily. Three-week preliminary periods were followed by 6-day collections of feces and urine. During the collection periods, samples of abomasal fluid were taken at each 2-hour interval after both the a. m. and p. m. feedings. All lambs received each ration in a reversal arrangement during the experiment to provide six observations per treatment. Proteins in abomasal fluid were differentiated on the basis of solubility in ethanol.

Results

Apparent digestibility and calculated true digestibility of ration protein were 40.5 and 58.9 with the 70:30 ration and 38.6 and 56.5 with the 40:60 ration. Average nitrogen retentions with both rations were negative, being -3.7% of intake for the 70:30 ration and -1.3% of intake for the 40:60 ration. Ratio of cellulose to starch had little influence on conversion of zein. Of the total nitrogen in abomasal contents, 40.8% and 42.5% for the 70:30 and 40:60 rations, respectively, were identified as zein.

INFLUENCE OF DIETARY NITRATE ON PRE-INTESTINAL DESTRUCTION OF VITAMIN A BY STEERS

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Pre-intestinal destruction of vitamin A has been demonstrated in several experiments at this and other stations. The nature of the destruction taking place has not been determined, but vitamin A is frequently destroyed by oxidation. Thus the addition of an oxidizing agent such as nitrate to the ration might be expected to enhance vitamin A destruction. Limited in vitro data obtained at other stations indicate that nitrate additions increase vitamin A destruction in ruminal fluid. Possible chronic nitrate toxicity has been reported to have detrimental effects on vitamin A status in some experiments but no effect in others. The experiments reported here were designed to determine whether the addition of potassium nitrate to the ration would influence apparent pre-intestinal destruction of vitamin A.

Procedure

Two steers with ruminal and abomasal fistulas were fed oat straw and a simple mineral mixture free choice. In addition, each steer received one lb of protein supplement twice daily. Supplement A consisted entirely of soybean oil meal with 44% crude protein. Supplement B contained a mixture of 354 g of soybean oil meal, 55 g of ground shelled corn and 45 g of potassium nitrate. Feeding 2 lb per day of supplement B provided a daily intake of 90 g of potassium nitrate (approximately 1% of the ration). Individual steers were fed either supplement A or supplement B for a 2-week preliminary period plus 3 weeks during which four estimations of vitamin A destruction were conducted. Supplements fed to the two steers were then reversed, and the trial was repeated. Pre-intestinal destruction of vitamin A was estimated by administering one million IU of vitamin A acetate dispersed in 20 ml of 20% Tween 80 and 20 g of chromic oxide through the ruminal fistula. Twenty-four hours after dosing, abomasal contents were withdrawn through a permanent abomasal fistula and analyzed in triplicate for chromic oxide and vitamin A. The change in the ratio of chromic oxide to vitamin A from the ratio administered was used to estimate the percentage of administered vitamin A reaching the abomasum. This procedure was repeated at one-week intervals.

Results and Discussion

Calculated recoveries of vitamin A from the abomasal fluid 24 hours after it was placed in the rumen are presented in Table 1. These data confirm previous observations of extensive ruminal destruction of vitamin A. However, it is significant that apparent destruction of the vitamin A acetate administered in Tween was less extensive than has been previously observed in studies with gelatin-coated vitamin A supplements. In comparing results obtained with supplements A and B there is no indication that adding potassium nitrate to supplement B increased vitamin A destruction. Apparently the reducing conditions found in the rumen combined with probable metabolism of the potassium nitrate by rumen microorganisms prevented any increase in destructive activity which might have resulted from adding potassium nitrate to the ration.

Table 1.—Vitamin A Recovery from Abomasal Fluid (%)[a/]

Steer No.	Supplement A	Supplement B (KNO_3)	Average
1	43.1%	62.2%	
	32.4	46.2	
	44.6	55.8	
	69.1	32.2	48.2%
3	41.8	45.1	
	35.2	39.5	
	42.1	66.4	
	35.5	55.7	45.7
Average	43.0	50.4	

[a/] Calculated from the ratio of vitamin A to chromic oxide in abomasal fluid compared to the ratio administered 24 hours earlier.

CAROTENOID BALANCE OF VITAMIN A DEPLETED SHEEP

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Various reports have indicated that sheep are capable of showing a negative carotene balance under certain conditions. It is also known that sheep may not show characteristic vitamin A deficiency symptoms even when on a prolonged low-carotene intake. It has been difficult to explain the occurrence of a negative carotene balance or the ability of sheep to subsist on low-carotene intakes that would be disastrous for other animals. Some microorganisms, Phycomyces blakesleeansis, Staphylococcus aureus, Corynebacterium and others, exhibit the ability in vitro to synthesize carotenoids from substrates as soy protein, acetate, or leucine. Labeled acetate and leucine have been shown to be utilized by microorganisms to synthesize radioactive carotenoids. From this information it would seem plausible that intestinal microorganisms of sheep might have a role in partially supplying them with vitamin A precursors.

Procedure

A carotene balance study was undertaken, using six wethers that had been on a low-carotene ration of wheat straw and 0.25 lb of soybean meal daily for 30 months. The wethers did not show acute symptoms of vitamin A deficiency. Serum levels and liver stores are shown in Table 1. While serum levels of vitamin A were not severely depressed, liver stores (1.12-1.84 mcg/g) were depleted. A mixed ration of corn cobs, milo and soybean meal plus mineral mix was chosen to give a very low carotene intake; thus, small quantities of carotenoids that might be synthesized by intestinal microflora could easily be in excess of intake.

Table 1.—Serum levels and Liver Stores of Vitamin A in Depleted Three-year-old Wethers

Sheep No.	Serum Levels Before Trial mcg/100 ml	Serum Levels After 30 Days on Low-carotenoid Ration mcg/100 ml	Liver Stores mcg/g
1	27.8	17.7	--
2	22.2	15.6	1.12
3	27.8	27.8	1.73
4	30.2	15.6	1.32
5	19.5	17.7	1.85
6	32.3	19.5	1.84
Average	26.6	19.0	1.57
Std. error =	1.9	1.8	.142

After a 10-day preliminary period the wethers were placed in metabolism crates for 7 days of fecal collections. Samples were analyzed for carotene by an adapted A.O.A.C. method using a solvent mixture of 70% hexane and 30% acetone. The solvent was decanted at 24-hour intervals for 3 days to insure complete extraction. Considerable fat-soluble yellow material was present in the crude extract, but after saponification in 10% aqueous KOH and chromatographing on an activated alumina column, relatively little pigment was present. This chromatographed pigment was read at 436 m_u on a spectrophometer and optical density compared with a beta carotene standard.

Results and Discussion

Results of the balance trial (Table 2) show a negative carotene balance ranging from 1.65 to 3 times the total carotene intake strongly suggesting microbial synthesis. Spectroscopic evaluation of the chromatographed pigment did not indicate that the sample was pure beta carotene. The absorption curve followed a standard beta carotene curve rather well between wavelengths 436 m_u and 600 m_u but below wavelengths 436 m_u the chromatographed sample was much more absorbant than standard beta carotene. A biological assay is being conducted with rats to determine the vitamin A activity of the pigments. The question of the pigments' utilization by sheep has not been answered. Serum levels of vitamin A taken 30 days after the sheep had been on the very low carotene intake dropped from an average of 26.6 mcg/100 ml to 18.9 mcg/100 ml suggesting sensitivity to reduced intake.

Table 2.—Daily Carotenoid Balance of Depleted Wethers on a Low Carotenoid Ration[a/]

Sheep No.	Total Carotenoid Intake - mcg.	Total Carotenoid in Feces (mcg)	Balance mcg
1	202	598	-396
2	202	393	-191
3	202	674	-472
4	202	436	-234
5	202	356	-154
6	202	334	-132
Average	202	465	-263
Std. error		56.6	

[a/] Ration consisted of 57% corn cobs, 37% milo and 6% soybean meal. The mixture contained 0.248 mcg carotenoid/g DM. and was fed at a rate of 817.2 g DM/day.

VOLATILE FATTY ACID CONCENTRATIONS IN RUMINAL FLUID OF STEERS FED NEOMYCIN AND BACITRACIN

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Antibiotics have generally been most effective as feed additives for feedlot steers when high-roughage rations are fed. These rations usually result in the production of high levels of acetic acid and relatively low levels of propionic acid. Since propionic acid is used more efficiently for fattening than acetic acid, it is considered desirable to reduce the acetic acid to propionic acid ratio (C_2:C_3) in the rumen. Little attention has been given to the influence of antibiotic feeding on the production of these and other volatile fatty acids in the rumen. This experiment was designed to provide preliminary information about the possible influence of high levels of oral neomycin and bacitracin on volatile fatty acid concentrations in the rumen.

Procedure

Four mature steers with rumen fistulas were used in two simple reversal trials. Each steer was fed 3.63 kg (8 lb) of alfalfa hay and 0.45 kg (1 lb) of ground shelled corn twice daily throughout both trials. In the first trial two steers assigned at random received 500 mg of neomycin sulfate mixed with the corn daily for 22 days, while the other two steers served as controls. The antibiotic treatment was then discontinued for one week before reversing the treated and control steers for the next 22 days. Samples of ruminal fluid were taken on two consecutive days before neomycin sulfate feeding was started and on days 1, 2, 7, 8, 14, 15, 21 and 22 after treatment began. These samples were analyzed for acetic, propionic, butyric, valeric and isovaleric acids by gas chromatography. The second trial was conducted in a similar manner with 500 mg per head per day of bacitracin methylene disalicylate replacing neomycin sulfate as the antibiotic.

Results and Discussion

Results of the neomycin sulfate feeding trial are summarized in Table 1. Since no consistent time trend was observed, all post-treatment observations are pooled for this presentation. It is apparent from these data that feeding neomycin sulfate at the rate of 500 mg per head per day did not exert a major influence on the acetate: propionate ratio, the total concentration of volatile fatty acids, or the molar concentration of any of the acids studied.

Results of the bacitracin methylene disalicylate feeding trial are summarized in Table 2. This treatment produced little change in molar concentration of individual volatile fatty acids or in the acetate: propionate ratio. Average total volatile fatty acid concentration in the ruminal fluid of steers receiving bacitracin was 15% lower ($P < .05$) than the average concentration in the ruminal fluid of control steers.

Table 1.—Volatile Fatty Acid Content of Ruminal Fluid From Steers Fed Neomycin Sulfate[a/]

	Pre-treatment	Control	Neomycin
Total concentration (micromoles/ml)	72.1	76.8	80.6
Molar %			
Acetate	74.4	76.1	75.5
Propionate	17.0	16.9	17.4
Butyrate	5.2	4.6	4.5
N-valerate	0.8	0.5	0.6
Iso-valerate	2.6	1.9	2.0
C_2/C_3 ratio	4.4	4.5	4.3

[a/] 500 mg per steer per day.

Table 2.—Volatile Fatty Acid Content of Ruminal Fluid From Steers Fed Bacitracin Methylene Disalicylate[a/]

	Pre-treatment	Control	Bacitracin
Total concentration (umoles/ml)	90.4	92.8	79.3*
Molar %			
Acetate	73.3	72.9	72.8
Propionate	16.9	16.4	16.7
Butyrate	7.4	7.9	7.4
N-valerate	0.5	0.7	0.8
Iso-valerate	2.0	2.1	2.3
C_2/C_3 ratio	4.3	4.4	4.4

[a/] 500 mg per steer per day.
* $P < .05$

AMINO ACID COMPOSITION AND BIOLOGICAL VALUE OF RUMINAL FLUID PROTEINS FROM STEERS FED ROUGHAGE OR CONCENTRATE RATIONS

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Ruminants convert a portion of their dietary protein to microbial protein which is, in turn, digested in the abomasum and other parts of the lower digestive tract. Through this mechanism, ruminants are capable of utilizing proteins in their rations which are improperly balanced as to amino acid composition. Consequently, the amino acid balance of proteins reaching the abomasum is of greater concern to ruminants than is the amino acid balance of dietary proteins. Fermentation of different levels of concentrates in the rumen may affect the amino acid makeup of microbial proteins. This experiment was undertaken to determine the amino acid composition and biological value of ruminal fluid proteins from concentrate-fed and hay-fed steers.

Procedure

Ruminal ingesta were collected via rumen fistulas from roughage-fed steers receiving 4.5 kg alfalfa hay and from concentrate-fed steers receiving 5.45 kg corn, 1.82 kg alfalfa hay, and 0.45 kg soybean meal daily. The ingesta were strained through four layers of cheesecloth, and the fluid was centrifuged at 2,000 X G to remove feed particles. The supernatant was again centrifuged at 16,000 X G to sediment the microbial cells. The sedimented cells were resuspended in distilled water, centrifuged again at 16,000 X G and dried at 50°C. The dired preparations were included as nitrogen sources for weanling rats, and biological values were compared with purified casein by the Thomas-Mitchell method. The dried preparations were hydrolyzed in 6 N HCl for 24 hours, the acid evaporated, the dried material redissolved in distilled water and analyzed by ion exchange chromatography for amino acid composition.

Results

The results of this experiment are summarized in Table 1. Amino acid analyses of acid hydrolysates of the ruminal preparations were within the range of previously reported values with the exception of proline which was slightly higher in both preparations. The preparation from concentrate-fed steers were higher in glutamic acid, proline, glycine, phenylalanine and arginine, and lower in alanine and valine. Threonine, leucine, and histidine concentrations were similar in both preparations. Biological values for the rats fed dried ruminal fluid from hay-fed steers, dried ruminal fluid from concentrate-fed steers, and casein were 58, 70, and 73, respectively.

Table 1.—Amino Acid Composition of Acid Hydrolysates of Dried Ruminal Fluid Preparations from Steers Fed Roughage or Concentrate Rations

	% of Total Amino Acid Nitrogen	
	Roughage	Concentrate
Aspartic acid	9.80	9.66
Threonine	4.93	4.88
Serine	4.28	4.08
Glutamic acid	9.83	10.23
Proline	4.04	4.15
Glycine	7.37	8.55
Alanine	10.31	9.27
Valine	6.21	5.48
Cystine	.46	.35
Methionine	1.28	1.21
Isoleucine	5.71	5.47
Leucine	6.03	6.01
Tyrosine	3.36	3.09
Phenylalanine	3.19	3.40
Lysine	11.23	11.15
Histidine	3.04	3.04
Arginine	10.78	11.50

DISTRIBUTION OF RADIOACTIVITY IN LAMBS RECEIVING C^{14}-LABELED CAROTENE

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The vitamin A activity in natural feedstuffs fed to sheep is furnished as carotenoid precursors. These precursors are converted to vitamin A after they are consumed. Most of this conversion normally takes place in the wall of the small intestine. Carotenoids injected directly into the blood would not pass through the intestinal wall and might be converted to vitamin A to a different extent than those coming from the gastro-intestinal tract. Vitamin A depletion has also been reported to have a detrimental effect on conversion of carotenoids to vitamin A. Labeling carotene with carbon 14 facilitates study of the metabolism of physiological doses. In the present study C^{14}-labeled carotene was given to normal and depleted lambs by intravenous or intraruminal injection.

Procedure

Two lambs fed a low-carotene ration for $5\frac{1}{2}$ months prior to the experiment (total liver vitamin A 5-11 mg) and two lambs fed 7,500 I.U. of vitamin A daily for 40 days were compared. One lamb from each group received either intravenous or

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intraruminal injections of C^{14}-labeled carotene. Each injection contained 332 mcg of carotene in 1 ml of 20% aqueous Tween "80" and 4.2954 microcuries of radioactivity. At the end of 8-hour (intravenous) or 24-hour (intraruminal) incubation periods, the lambs were sacrificed, and the radioactivity of the urine and the non-saponifiable fat-soluble portion of various tissue samples, fecal material, and contents of the digestive tract was determined by liquid scintillation counting.

Results

Distribution of the recovered radioactivity is summarized in Table 1. Most of the radioactivity injected into the rumen was accounted for; however, only a small amount of the radioactivity injected into the blood was recovered. Evidently, considerable activity was present in forms not extracted by fat solvents or in tissues not sampled, or had been eliminated as $C^{14}O_2$. Less radioactivity was recovered from vitamin A depleted than from normal lambs regardless of site of administration. This suggests faster and more complete metabolism of the carotene by the depleted lambs.

Table 1.—Radioactivity Recovered from Tissues and Excreta of Sheep Receiving C^{14}-labeled Carotene, (10^{-4}uc)[a/]

Tissues and Excreta	Lamb No. and Vitamin A Status			
	1 Intraruminal-depleted	4 Intraruminal-normal	2 Intravenous-depleted	3 Intravenous-normal
Feces	7824.4600	3049.6246	None	None
Contents of digestive tract	32609.1577	38790.4603	1.3554	None
Blood[b/]	37.0664	46.7208	145.9902	899.0388
Liver	61.2205	28.9082	27.9850	1073.5536
Urine	274.0505	396.9051	630.8765	423.3500
Kidneys	3.1977	1.2562	2.6754	56.1574
Eyes	.2754	.1660	.2256	1.4121
Adrenals	.4191	.0785	6.1160	.0452
Kidney fat	None	None	None	None
Muscle tissue	None	None	None	None
Total	40809.8473	42314.1197	815.2241	2453.5571
% of administered dose	95.01	98.51	1.90	5.71
% of absorbed dose[c]	14.92	42.55		

[a/] Each lamb was administered 4.2954 mc C^{14} activity.

[b/] Calculated from activity in blood at time of slaughter and estimated blood volume based on lamb weight.

[c/] Based on C^{14} activity apparently absorbed and activity recovered in blood, liver, urine, kidneys, eyes and adrenals.

SHEEP SECTION

THREE LEVELS OF PROTEIN FOR EARLY-WEANED LAMBS SIRED BY EITHER HAMPSHIRE OR SOUTHDOWN RAMS

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A feeding trial with 72 twin lambs was conducted to compare the response of early-weaned lambs self-fed in drylot on three levels of protein. The lambs were out of 2-year old Montana ewes. Thirty-six were sired by Hampshire rams and 36 by Southdown rams. The lambs were creep-fed, weaned at 56 days of age, and then randomly allotted on the basis of their 28-day weights to rations containing either 12.5, 15.6 or 19.9% crude protein. Twelve lambs were allotted to each of six separate lots divided according to protein level and breed of sire. Rations used are shown in Table 1. Water was available in automatic waterers. Southdown sired lambs were marketed at 85 to 90 lb liveweight and Hampshire sired lambs at 90 to 95 lb liveweight.

Table 1.—Rations

	Protein Level		
	12.5%	15.6%	19.9%
Ground alfalfa hay	30	30	30
Cracked corn	58	47	35
Soybean meal pellets	9	20	32
Salt	1	1	1
Steamed bonemeal	1	1	1
Aureomycin Crumbles	1	1	1

Results are summarized in Table 2. There were no significant differences in average daily gain among the different protein levels. Average daily gains for combined sire groups fed the high-, medium- and low-protein rations were 0.60, 0.62 and 0.60 lb, respectively. Feed required per pound of gain decreased slightly as protein level decreased. Hampshire-sired lambs gained significantly faster ($P < 0.01$) than Southdown-sired lambs (0.66 pound compared with 0.55 lb). Feed required per lb gain averaged 5.03 lb for Hampshires as compared with 5.54 for Southdowns. Levels up to 18 to 20% crude protein for early-weaned lambs have given best results in work reported by other stations. In this trial 12.5% was equivalent to the higher levels used in promoting gain and slightly more efficient in feed conversion. It should be noted that soybean meal pellets were used in this trial. Heating during the pelleting process may have reduced protein solubility, thereby resulting in lower rumen losses and increased retention.

Table 2.—Results of Trial

	Hampshire-sired Lambs			Southdown-sired Lambs		
Protein Level	12.5%	15.6%	19.9%	12.5%	15.6%	19.9%
Number of lambs	12	12	12	12	12	12
Av initial weight, lb	40.7	36.8	38.1	37.8	36.3	37.2
Av final weight, lb	91.8	91.9	92.0	89.1	86.1	85.7
Av daily gain, lb	0.63	0.67	0.67	0.56	0.56	0.53
Feed/lb gain, lb	5.15	5.06	4.94	5.58	5.54	5.49

GENETICS SECTION

EFFECTIVENESS OF DIFFERENT ORAL PROGESTROGENS IN SYNCHRONIZING ESTRUS AND OVULATION IN EWES

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Methods of synchronizing the estrous cycles of farm animals, so that they can be bred in groups at one time, are being investigated. The development of a simple, effective method for synchronizing estrus and ovulation would probably lead to the extensive use of artificial insemination in sheep, swine and beef cattle. The development of orally-effective progestational compounds has been shown to be effective in inhibiting estrus and ovulation.

Sixty ewes were divided into 5 groups of 12 each. Groups 1, 2 and 3 were fed 1.0, 1.5 and 2.0 mg of 6-chloro-Δ^6-17-acetoxyprogesterone (CAP) per ewe per day, respectively. Group 4 was fed 75 mg. of 6-methyl-17-acetoxyprogesterone (MAP) per ewe per day. All ewes remained on treatment for 15 days. Group 5 served as controls. Results are shown in the following table.

Table 1.—Effect of CAP and MAP on Estrus and Ovulation in Ewes

Treatment	No. of Ewes	Daily Dose, mg	Duration of Treatment, days	Percent of Ewes in Estrus within 8 days after End of Treatment	Percent of Ova Fertilized
CAP	12	1.0	15	33.0	100.0
CAP	12	1.5	15	41.7	33.0
CAP	12	2.0	15	50.0	0.0
MAP	12	75.0	15	83.7	40.8
Control	12	----	--	50.0	87.5

None of the treated ewes came into estrus during the treatment period. Only 43 percent of the ewes receiving CAP came into estrus within 8 days after end of treatment, whereas 84 percent of the ewes receiving MAP came into estrus. This difference was significant ($P < .05$). Dosage levels for CAP did not have a significant effect on the percentage of ewes coming into estrus after treatment, nor on the interval from end of treatment to estrus. CAP was about 50 times as effective orally as MAP in suppressing heat and ovulation in ewes, but the percentage of ewes with synchronized estrus was low. Ewes not in estrus after treatment were slaughtered. Ovulation rate did not differ from that of control ewes. Many of the ewes receiving CAP had ovulated following treatment without exhibiting estrus. Ovulation appears to have been synchronized, but the estrous period was not. Ewes that came into estrus in each group were bred, and one-half of each group were slaughtered for fertility data. Fertility was lower in the treated groups. Lambing rate was also lower for treated ewes.

EFFECT OF SHORT-TIME EXPOSURE TO CONTINUOUS LIGHT ON OVULATION RATE AND FERTILITY OF EWES

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The most important known climatic factors influencing reproductive efficiency are light and temperature. It is well-established that elevated environmental temperatures are detrimental to fertility in sheep. The influence of light on modification of estrual activity in ewes has been extensively studied. However, the effects of light on ovulation rate and fertility have not been studied under well-controlled conditions.

Eighty dark-faced western crossbred yearling ewes were randomly divided into three groups after the estrual cycles had been established by daily teasing with aproned rams. At time of estrus one group of 30 ewes was placed in an open pen in a barn with artificial lighting. A second group of 30 ewes was placed in the lighted pen on the eighth day after estrus. Fluorescent light with an intensity at 18 inches from the floor of 35-40 foot-candles directly beneath the light and 10 foot-candles in the corners of the pens was provided. Lights were turned on by automatic timer at 4 p.m. and off at 8 a.m. During the day the ewes were allowed outside with limited pasture available. Twenty control ewes were assigned to the study at the same time as the treated ewes and were kept under similar conditions except that no artificial light was used. The ewes were checked for estrus and were artificially inseminated at the first estrous period after they were placed in continuous light. Results in ewes slaughtered three days after breeding are shown in Table 1.

Table 1.—Effects of Exposure to Light on Ovulation Rate and Fertility in Ewes

Item	Control Ewes	Ewes Exposed to Continuous Light	
		For 8 Days	For One (17 days) Cycle
No. of ewes	20	30	30
Ovulation rate	1.7	1.9	2.0
Fertilized ova, %	85.3	83.3	91.7
Average length of estrous cycle, days	16.3	16.6	16.3
Average duration of estrus[a]	2.0	2.2	2.0

[a]Number of days in heat.

The percentage of ova fertilized in control ewes, in ewes exposed to continuous light for the last half of the estrous cycle, and in ewes exposed to continuous light for a full estrous cycle, were 85.3, 83.3, and 91.7, respectively. Ovulation rates were 1.7, 1.9 and 2.0, respectively. Seventeen percent of the ewes exposed to light had triple ovulations, whereas none occurred in the control ewes. Exposure to continuous light for short periods did not interfere with the estrous cycle, the duration of estrus, or fertility.

The increase in ovulation rate approached significance and suggests that light may exert a "flushing" effect in cycling ewes. Theoretically, an increase in ovulation rate could result from stimulation of the pituitary gland to secrete additional follicle-stimulating hormone.

SELECTIVE BREEDING FOR EARLIER LAMBING IN A PUREBRED FLOCK OF SOUTHDOWN SHEEP

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Results of selecting for earlier date of lambing and for higher reproductive efficiency are being studied in a flock of Southdown sheep. The flock is closed to outside breeding, and ewes failing to lamb each year are culled. Late lambing ewes are also culled as replacement yearling ewes become available. Since 1961 approximately one-third of the breeding flock has been made up of yearling ewes. The flock is divided into three breeding groups, and yearling sires are used each year. These are the earliest-born lambs from each breeding group. Inbreeding is kept to a minimum by avoiding parent-offspring and half-sib matings. To date there has been no indication of the appearance of recognized undesirable recessive traits.

A 5-year summary of lambing performance, birth weight and 120-day weight of lambs is shown in Table 1. The percentage of ewes lambing has increased over that of the first few years of the study, when less than 80% of the ewes lambed. Lambing rate has varied from 1.38 to 1.50, and an average of 73.9% of the lambs have survived to weaning time (July 1). Most of the lamb losses have occurred at birth.

Table 1.—Five-year Summary of Lambing Performance of Ewes and Birth Weight and 120-day Weight of Lambs

	Year				
Characteristic	1960	1961	1962	1963	1964
Ewes lambing, %	85.7	93.3	96.8	90.0	95.2
Lambing rate	1.43	1.50	1.38	1.43	1.48
Lambs alive at weaning (July 1), %	72.7	75.0	72.6	72.2	77.0
Average birth wt, lb					
Males	6.65	6.52	6.29	6.92	6.94
Females	6.49	6.02	6.01	6.12	6.14
Both	6.55	6.27	6.12	6.46	6.49
Average 120-day wt, lb					
Males	53.0	55.2	56.8	57.8	57.9
Females	48.3	49.4	50.9	55.1	49.6
Both	50.0	52.2	53.9	56.5	54.1

The average date of lambing for 1964 was March 2. This is the earliest average lambing date since the study began in 1956. Average lambing dates for 1963, 1962, 1961 and 1960 were March 7, 11, 6 and 25, respectively. Average lambing date for 22 yearling ewes in the flock was March 6. Average birth weight of the lambs was lower in 1962, but there is no indication that lamb weights have changed over the years as a result of selecting for earlier lambing. Average weight at 120 days of age has increased slightly. This may be due to improved management.

Fertility level of the flock has increased, and in 1964 95 percent of the ewes lambed. During the last four years 90 percent or more of the ewes have lambed. Average birth weight of lambs was 6.49 lb. Average birth weight of lambs in the flock has ranged from 6.12 to 6.55 lb. Males averaged 0.5 lb heavier than females, and singles averaged 0.76 lb heavier than twin lambs. Lambing rate was 1.43, and 77 percent of the lambs were alive at weaning time (July 1). Average 120-day weight was 54.1 lb, and males averaged 5.5 lb heavier than females. Average 120-day weight has ranged from 50.0 to 56.5 lb.

SEMEN TRAITS OF YEARLING SOUTHDOWN RAMS DURING JULY

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Semen quality of the mutton breeds of sheep has been shown to decline during the summer months. Part of a study in selecting for earlier lambing in Southdown sheep has been concerned with the evaluation of the quality of semen produced by yearling rams during the summer. Differences found in laboratory tests of semen may be a useful means of predicting the fertility level of rams during the breeding season. Such differences may prove to be useful in selecting rams with potentially higher fertility early in the breeding season.

Each year laboratory tests of semen collected by means of an electro-ejaculator from five early-born yearling rams by each sire are made during three consecutive weeks in July. Approximately 1 ml of semen is taken at each collection and the percentage of motile cells, a percentage of abnormal cells and sperm cell concentration are determined.

Results of the semen tests by sire groups for the 5-year period 1960-64 are shown in Table 1.

The data show year-to-year variation in motility, sperm cell concentration and percentage of abnormal cells; however, no marked changes or trends are apparent for any of the semen characteristics. To date there has been little relation between semen traits determined during July and the subsequent breeding performance of the rams. The average date of first estrus has been late September, and seasonal changes in semen quality may occur between time of testing and time of breeding.

Table 1.—Five-year Summary of Semen Characteristics of Rams

Year	Sire Group	Vol. per Collection ml	Motile Cells %	Sperm Cell Concentration, Billion/ml	Abnormal Cells, %
1960	1	0.78	64	1.60	20.0
	2	0.95	65	2.03	25.1
	3	0.97	60	1.04	15.1
	Average	0.90	63	1.59	20.1
1961	1	0.89	58	1.37	28.7
	2	0.82	45	1.19	45.3
	3	0.93	55	1.50	38.1
	Average	0.88	52	1.35	37.3
1962	1	0.91	59	1.63	21.5
	2	1.02	59	1.50	25.8
	3	0.98	62	1.85	21.2
	Average	0.97	60	1.66	22.8
1963	1	0.93	51	1.68	13.3
	2	0.92	59	1.73	13.2
	3	0.93	63	1.70	21.6
	Average	0.93	58	1.70	16.0
1964	1	1.02	51	1.22	36.9
	2	0.95	41	1.14	33.5
	3	0.97	53	1.82	19.8
	Average	0.98	48	1.39	30.1

MAINTENANCE OF INDUCED CORPORA LUTEA IN ANESTROUS EWES BY HYSTERECTOMY

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Estrus and ovulation can be induced in anestrous ewes following treatment with progesterone and pregnant mare serum (PMS), but cyclic activity seldom results. The life of corpora lutea induced under these conditions may be shorter than normal. Since hysterectomy in the estrous ewe results in a condition similar to that during the anestrous season, e.g., absence of overt signs of estrus and ovulation, it is of interest to determine the effects of hysterectomy in the anestrous ewe relative to the effect on corpora lutea and the expression of estrous behavior when ovulation is induced.

Ten anestrous ewes were hysterectomized on June 2 and 3. A similar group of 10 ewes served as controls. Anestrus was verified by failure of the ewes to stand for teaser rams and by the absence of large follicles and luteal tissue in the ovaries at the time of laparotomy. On June 22 and 25 all ewes were given a subcutaneous injection of 30 mg of progesterone, and on June 30 each ewe was injected with 750 I.U. of PMS. The ewes were checked daily with teaser rams.

Two days after the PMS injection 6 of the 10 control ewes came into estrus, whereas none of the hysterectomized ewes showed estrus. Thirteen days after the PMS injection one-half of the control and one-half of the hysterectomized ewes were slaughtered. The presence of corpora lutea in the ovaries of all of the ewes indicated that they had ovulated, and there was no significant difference between the two groups of ewes in ovarian weight and weight of luteal tissue. Twenty-four days after the PMS injection the remaining ewes were killed. Results are summarized in the following table.

Table 1.—Results of Hysterectomy in Anestrous Ewes

Treatment	No. of Ewes	Percent of Ewes Showing Estrus	Average Number of Corpora Lutea	Average Weight of Luteal Tissue, g	Average Diameter of Luteal Cells, microns
Control	10	60	--	--	--
13-day[a]	5	--	2.4	0.58	23.4
24-day[b]	5	--	regressed	--	--
Hysterectomized	10	0.0	--	--	--
13-day	5	--	2.2	0.69	24.1
24-day	5	--	1.8	0.71	23.2

[a] Slaughtered 13 days after PMS injection.
[b] Slaughtered 24 days after PMS injection.

The ovaries in the control ewes contained no luteal tissue and were significantly lighter in weight than ovaries from the hysterectomized ewes at day 24. The corpora lutea in the hysterectomized ewes were as large as those examined on day 13 and were still apparently active. Histologically the corpora at 24 days after the PMS injection in the hysterectomized ewes were similar in appearance to the corpora in both groups of ewes when examined at 13 days. The effect of hysterectomy in the anestrous ewe is similar to that in the cycling ewe, in that the induced corpora lutea were maintained longer than normal. There is no obvious explanation for failure of hysterectomized ewes to show estrus.

MEATS SECTION

RELATIONSHIP OF RETAIL YIELD AND EDIBLE PORTION TO MEATINESS CHARACTERISTICS OF KENTUCKY SPRING LAMBS

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Sheep numbers in Kentucky have declined tremendously over the years, yet sheep production today is a profitable business for many Kentucky farmers. Some of the decline in sheep and lamb numbers has indirectly resulted from changes in consumer preferences. More and more consumers are preferring leaner, more muscular, lamb cuts that have less waste fat and bone and are fast and easy to prepare. Retailers, likewise, are demanding carcasses with less trimmable fat in an attempt to realize more profit and satisfy their customers. This shift in consumer demand has had a dramatic impact on sheep and lamb production. The light weight, thick, blocky and many times over-finished lamb of the past has given way to a heavier more muscular, thinner finished lamb of the present.

The degree of fatness has been shown in pork and beef studies to be responsible for most of the variation in yield of retail cuts. More recently, similar studies have been conducted on lamb carcasses, of which, however, only limited results are available. Therefore, the objective of this experiment was to determine the relationship of several meatiness characteristics with retail yield and edible portion from lamb carcasses of similar grade and weight.

Procedure

Right sides of 106 choice and prime Kentucky spring lambs were broken down into wholesale cuts and closely trimmed to one-eighth inch of external fat suitable for retail channels. These cuts were weighed and expressed as a percent of the chilled right side weight. Each closely trimmed cut was then boned and any large deposits of fat removed. This latter cut was termed "edible portion," and it too was expressed as a percent of the chilled right side weight. The leg and rib from each right side were further broken down into separable fat, lean and bone.

Results and Discussion

Table 1 shows the means and standard deviations for the closely trimmed cuts and the edible portion of the major cuts and their combinations. The main difference between means for a given cut is the weight of bone and fat that was removed from the cut to make the edible portion. Bone, in most cases, is fairly constant whereas fat is the most variable. The shoulder and leg, respectively, had the greatest percentage difference in means when expressed as a percent of the right side weight. The rib and loin were next in magnitude but somewhat less than either the shoulder or leg.

Table 1.—Means, Standard Deviations and Mean Differences for Closely Trimmed and Edible Portion of Selected Lamb Cuts

Selected Cuts	Percent Closely Trimmed Lamb Cuts Mean	S.D.	Percent Edible Portion Mean	S.D.	Mean Differences (%)
Leg	27.23	1.43	23.22	1.29	4.01
Loin	8.31	0.86	6.49	0.76	1.82
Rib	7.31	0.54	5.23	0.47	2.00
Shoulder	21.48	1.45	16.04	1.31	5.45
Leg + loin	35.54	1.83	29.71	1.63	5.83
Leg + loin + rib	42.85	1.86	34.94	1.69	7.91
Leg + loin + rib + shoulder	64.08	3.86	50.91	2.50	13.17

N = 106

Results presented in Table 2 show the correlation coefficients between percent retail yield and edible portion of the right side with meatiness characteristics of lamb carcasses. It may be observed from this table that individually none of these variables is extremely highly correlated with retail yield. The percent separable fat in the rib appeared to have the highest relationship (-.64), followed closely by the percent separable fat in the leg (-.58) and percent separable lean of the rib (0.58). The fat thickness at the 12th rib was less highly correlated (-.51), whereas the rib eye area was very poorly correlated (0.14) with retail yield.

Table 2.—Simple Correlation Coefficients of Percent Retail Yield and Edible Portion of Right Side with Meatiness Characteristics of Lamb Carcasses

Meatiness Characteristics	Percent Retail Yield of Right Side	Percent Edible Portion of Right Side
Right side weight	0.27	-.26
Rib eye area	0.14	0.18
Fat thickness (12th rib)	-.51	-.50
Percent kidney and kidney fat	-.59	-.46
Percent separable lean in leg	0.56	0.67
Percent separable fat in leg	-.58	-.63
Percent separable lean in rib	0.58	0.56
Percent separable fat in rib	-.64	-.56

N = 106
$(P < .05) = 0.19$
$(P < .01) = 0.25$

The separable lean and fat of the leg appeared to have the highest relationship, 0.67 and -.63 respectively, with edible portion of the right side. Separable components of the rib were also highly correlated ($P < 0.01$) with edible portion. Rib eye area again

was poorly correlated with edible portion, whereas fat thickness and percent kidney fat accounted for 25 and 21%, respectively, of the variation in percent edible portion of the right side.

Table 3 shows the relationship of individual and combined cuts with percent retail yield of the right side. The leg was the most highly correlated (0.71) single cut followed by the shoulder (0.57) and loin (0.48). A combination of the leg and loin gave the highest correlation (0.79) with percent yield.

Table 3.—Simple Correlations of Percent Retail Yield of Right Side with Individual and Combined Lamb Cuts

Closely Trimmed Lamb Cuts	Percent Retail Yield of Right Side
Leg	0.71
Loin	0.48
Rib	0.07
Shoulder	0.57
Leg + loin	0.78
Leg + loin + rib	0.79
Leg + loin + rib + shoulder	0.61

N = 106
($P < .05$) = 0.19
($P < .01$) = 0.25

THE EFFECTS OF MUSCLE QUALITY ON QUICK-AGED, DRY-CURED HAMS

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Thirty-two skinned hams, averaging 15.2 lb, were selected on the basis of muscle quality. Half were selected for high quality and half for low quality. The high quality hams were characterized by a moderate amount of marbling, firmness, uniform color, and closeness of structure. The low quality ones were characterized by a lack of marbling, pale or two-toned muscles, a loose or open structure as indicated by seam separation, and a soft, watery appearance. All 32 hams were dry-cured two days per lb (average weight), allowed to hang 30 days at 35 - 40 F. for salt (NaCl) equalization, smoked at 100 F, and aged 12 weeks at weekly intermittent temperatures of 65 and 95 F with a relative himidity of approximately 60%. Weight losses were recorded at regular intervals during processing and aging. After the aging period the hams were cut and evaluated for color, firmness, and aroma. Samples were then taken for palatability, shear, and chemical tests.

Weight loss, as shown in Table 1, increased throughout processing and aging, with the greatest amounts occurring during the salt equalization period and the first 2

weeks aging. Weight losses were less ($P < 0.01$) at the end of the aging period for the hams with high quality muscle. Since an attempt was made to select hams which possessed similar amounts of external fat, the increased shrinkage of the low quality hams was apparently due to their low water-binding capacity and high initial moisture content.

Table 1.—Mean Weight Losses for all Periods, %

Group	Cure	Salt Equal	After Smoke	Weeks Aging 2	4	6	8	10	12
High Qual	2.66	9.39	11.21	16.86	18.40	20.14	21.66	22.66	24.94
Low Qual	4.62	11.04	12.88	19.30	21.36	23.44	25.22	26.52	29.80

Palatability tests (Table 2) showed that high quality hams had higher scores for saltiness and tenderness ($P < 0.01$). There were no significant differences between the two groups in respect to flavor and overall satisfaction, although the mean scores for high quality hams were greater for both characteristics.

Table 2.—Mean Taste Panel Scores[a]

Group	Flavor	Saltiness	Tenderness	Overall Satisfaction
High Qual	7.10	7.54	7.44	7.17
Low Qual	6.71	7.06	6.58	6.70

[a]Higher scores are more desirable.

Although the taste panel gave higher tenderness scores to the high quality hams, there were no significant differences in tenderness as measured by the Warner-Bratzler shear device (Table 3).

Table 3.—Mean Shear Values

Group	S.M.	S.T.	B.F.
High Qual	19.75	15.42	20.20
Low Qual	20.32	14.92	19.16

Chemical analyses of the lean (Table 4) showed that high quality hams contained less salt (NaCl) and crude protein (nitrogen X 6.25) ($P < 0.01$) and more ether extract ($P < 0.01$).

Table 4.—Mean Chemical Analyses for Lean Samples

Group	NaCl, %	Moisture, %	Ether Extract, %	Crude Protein, %
High Qual	4.69	55.06	10.66	26.06
Low Qual	5.78	55.36	6.40	28.39

Chemical analyses of the fat samples (Table 5) revealed that the low quality hams had higher free fatty acid (FFA) and thiobarbituric acid (TBA) values ($P < 0.01$) for their external fat with no significant difference for the seam fat.

Table 5.—Mean Chemical Analyses for Fat Samples

	External Fat			Seam Fat	
Group	FFA	I. No.	TBA	FFA	I. No.
High Qual	6.56	60.02	0.21	3.19	58.51
Low Qual	8.93	61.61	0.33	4.14	59.74

The results of this study indicate that there could be an advantage in using hams of high quality muscle for aged ham production.

THE EFFECTS OF PANCREATIC LIPASE AND PAPAIN ON QUICK-AGED, DRY-CURED HAMS

John A. Jacobs, James D. Kemp and William G. Moody
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Sixty-four skinned hams, weighing 12.4 to 17.9 lb, were divided equally into four groups: LT, LC, PT, and PC. The LT and PT groups were injected with pancreatic lipase and papain respectively. The aqueous enzyme solutions were injected at a rate of 5% (fresh weight) to give a final enzyme concentration of approximately 4 parts per million. The LC and PC hams, mates of the enzyme-treated hams, were dry-cured and used as controls. All hams were dry-cured 2 days per lb (average weight), allowed to hang an additional 30 days at 35°-40°F for salt equalization, smoked, and aged for 12 weeks at weekly intermittent temperatures of 65° and 95°F with a relative humidity of approximately 60%. At the end of the aging period, all hams were cut and evaluated for firmness, color and aroma. Samples were removed for palatability, shear, and chemical tests.

When the papain-treated (PT) hams were cut it was discovered that they contained numerous soft and mushy spots. This was undoubtedly due to an unequal distribution of the papain. Apparently the papain would penetrate no farther than the points of injection.

The mean weight losses for all groups during all periods are presented in Table 1. At the end of the aging period, the average weight loss for the combined enzyme groups was 26.85% as compared with 27.37% for their control mates. However, this difference was not significant.

Table 1.—Mean Weight Losses for all Periods, %

Group	Cured	Salt Equal	Smoked	Weeks Aging 2	4	6	8	10	12
LT	3.26	9.10	11.14	18.48	20.83	22.98	24.62	25.89	27.58
LC	3.74	10.38	12.19	18.24	22.22	22.17	23.84	24.98	28.58
PT	2.89	8.95	10.82	17.53	19.66	21.63	23.19	24.31	26.12
PC	3.54	10.06	11.92	17.92	19.54	21.42	23.04	24.20	26.15

Taste panel tests (Table 2) revealed that the control hams received higher scores for flavor ($P < 0.01$), saltiness ($P < 0.01$), tenderness ($P < 0.05$), and overall satisfaction ($P < 0.01$) than the enzyme-treated hams. Although the papain-treated hams were actually more tender than the control hams, they received lower scores because of soft, mushy spots which were considered an objectionable form of tenderness. The lipase-treated hams received higher ($P < 0.01$) scores for flavor and overall satisfaction than the papain-treated hams.

Table 2.—Mean Taste Panel Scores[a]

Group	Flavor	Saltiness	Tenderness	Overall Satisfaction
LT	6.71	6.81	6.54	6.56
LC	6.94	7.28	7.09	6.94
PT	5.26	6.64	6.87	5.27
PC	6.87	7.32	6.92	6.92

[a] The possible scores ranged from 1:00 (dislike extremely) to 9:00 (like extremely); a score of 5 was "neither like or dislike," a score of 6 was "like slightly," and a score of 7 was "like moderately."

Warner-Bratzler shear force values (Table 3) show higher (less tender) values ($P < 0.01$) for the lipase treated hams for all three muscles than for the papain treated hams. The papain-treated hams were more tender ($P < 0.01$) than their controls, except for the semitendinosus muscles which were apparently not reached by the enzyme solution.

Table 3.—Mean Shear Force Values

Group	Semi-membranosus	Semi-tendinosus	Biceps Femoris
LT	22.63	18.98	24.02
LC	19.52	15.81	20.14
PT	16.37	15.17	15.12
PC	20.05	14.52	19.30

Chemical analyses of the lean (Table 4) revealed that the enzyme treated hams contained more ($P < 0.01$) salt (NaCl) than the control hams. In addition, the lipase hams contained less ($P < 0.05$) moisture and more ($P < 0.05$) crude protein (nitrogen X 6.25).

Table 4.—Mean Chemical Values for Lean

Group	% NaCl	% Moisture	Ether % Extract	Crude % Protein
LT	6.22	52.51	8.74	27.54
LC	5.28	55.16	8.40	27.22
PT	5.86	55.18	8.77	26.38
PC	5.19	55.25	8.66	27.23

Chemical analyses of the fat (Table 5) show that the lipase caused an increased amount ($P < 0.01$) of free fatty acid production in the seam fat. Although the papain also had an effect on free fatty acid production this was not significant. The difference in iodine values between the LT and LC and PT groups was probably due to chance and apparently existed when the hams were fresh.

Table 5.—Mean Chemical Values for External and Seam Fat

	External Fat			Seam Fat	
Group	FFA	I. No.	TBA	FFA	I. No.
LT	7.89	63.32	0.26	8.18	61.10
LC	7.94	63.29	0.24	3.88	61.48
PT	8.04	56.16	0.32	5.14	57.79
PC	7.54	58.34	0.31	3.45	56.77

Overall, the control hams were far superior to the enzyme-treated hams. Apparently, the chief problem in using enzymes is in obtaining an equal distribution throughout the hams. Until this problem is solved, future work is likely to be in vain.

PARTIAL PUMPING OF HAMS

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Sixty unskinned hams were divided into three equal groups. The first group was dry-cured with 10% of a mixture containing salt, sugar and saltpeter, and rubbed on the surface of the hams in 3 applications at 5-day intervals. The second group was partially pumped with 4% of a 75° pickle. Then, enough dry cure was applied to the outside to make the total amount equivalent to the 10% dry-cured group. The third group was similarly treated except that the hams were partially pumped at 6% of their fresh weight. All hams were cured for 30 days at approximately 38°F. After an additional 30 days were allowed for salt equalization and, then after soaking for 10-15 minutes in lukewarm water, the hams were smoked at a smokehouse temperature of 100°F followed by a 6-month aging period at approximately 65°F. The hams were weighed to the nearest 0.01 lb while fresh, after pumping, after curing, after salt

equalization, after smoking, and at monthly intervals throughout the 6-month aging period. The percentage changes in weight for the three respective groups appear in Table 1.

Table 1.—Percent Weight Changes

Group	Cured	Salt Equal	Smoked	1 mo.	2 mo.	3 mo.	4 mo.	5 mo.	6 mo.
Dry-cured	2.75	7.55	9.32	16.47	19.44	21.84	23.26	24.82	25.98
Pumped-4%	+1.12*	3.92	5.72	13.22	16.62	19.22	20.72	22.50	23.75
Pumped-6%	+3.45	2.25	4.21	11.75	15.56	18.12	19.78	21.63	23.02
Mean (pumped)	+2.28	3.08	4.96	12.48	16.09	18.67	20.25	22.06	23.38

* Plus figures (+) indicate increase in weight over fresh weight.

Overall shrinkage increased throughout the processing and aging periods with the greatest rate of shrinkage occurring between smoking and the first month of aging. The pumped hams had an average increase of 2.28% over fresh weights after the curing process. Pumped hams shrank an average of 23.38%, and dry-cured hams shrank an average of 25.98% after 6 months' aging. Palatability scores for flavor, saltiness, tenderness and overall satisfaction were determined by a six-member taste panel using a 9 point hedonic scale, with 9 being "like extremely" and 1 being "dislike extremely."

Table 2.—Palatability Scores*

Group	Flavor	Saltiness	Tenderness	Overall Satisfaction
Dry-cured	6.96	7.06	6.20	6.66
Pumped-4%	6.48	6.58	6.26	6.18
Pumped-6%	6.12	6.06	5.85	5.64

* 8 - like very much; 7 - like moderately; 6 - like slightly; 5 - neither like nor dislike.

As can be seen from Table 2, dry-cured hams were generally ranked higher than the partial-pumped hams, and as the level of pumping increased, consumer acceptance decreased. In general, the hams were fairly all accepted, although one chief criticism was the lack of tenderness in all groups, which is probably due to the lower-than-normal (65°F) aging temperature.

Differences in salt and moisture content existed and are evident in Table 3.

Table 3.—Salt and Moisture Content

Group	Salt, %	Moisture, %
Dry-cured	6.05	53.34
Pumped-4%	7.19	53.88
Pumped-6%	7.66	54.08

Pumped hams were higher in salt content than dry-cured hams, and as the pumping percentage increased, so did the salt and moisture, although the difference in moisture was very light.

Although weight losses can be reduced by partial pumping, its use is not recommended in the production of aged country hams. Preliminary evidence of palatability studies suggests that partial-pumped hams are too salty and are not so desirable in other palatability traits as dry-cured hams.

THE EFFECTS OF TEXTURE AND COLOR OF MUSCLE ON BEEF RIB DESIRABILITY

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Much of the recent beef carcass research and interest has centered around cutability studies and decreased demand for older overfinished cattle. In addition to these studies, however, wide variations in beef carcass acceptability have been observed even among cattle of the same quality and cutability grade but vastly different in both texture and color of the rib eye muscle. With this observation in mind, a study was conducted to determine the effects of coarse and fine textured marbling and muscle on the chemical, physical and organoleptic properties of beef ribs. In addition to the extreme variation in texture of the two groups, the coarse-textured ribs were usually dark or "off color" whereas the fine-textured ribs were light or cherry red.

Procedure

Two groups of 17 ribs each were carefully selected from 120 similar weight and age Angus cattle which had been fed and managed alike. Texture differences were subjectively determined, but only ribs showing obvious variations were selected. The rib eye muscle color was determined by subjective evaluation and the use of the Munsell color paddles. Both groups came from choice grade carcasses, ranging in marbling degree from small plus to moderate plus and in maturity from typical A to B minus. In addition to these characteristics, other carcass traits (Table 1) such as conformation, rib eye area, fat thickness, kidney knob, yield score, and fat color were all very similar for the two groups.

It was the intent of this experiment to have these variables alike or nearly so in order to eliminate as much of the interaction and/or indirect effect as possible.

Table 1.—Carcass Characteristics of Fine- and Coarse-textured Beef Ribs

Carcass Traits	Group I Fine Texture		Group II Coarse Texture	
	Mean	Range	Mean	Range
Hot carcass wt (lb)	694.7	571 to 744	714.1	635 to 775
Conformation	Ch^{o}	Good + to P^{o}	Ch^{o}	Ch- to Ch+
Marbling	Modest +	Small + to Moderate +		Small + to Moderate +
Rib eye area (in.^{2})	11.98	10.71 to 14.18	13.20	11.05 to 17.54
Fat thick (in.)	0.70	0.40 to 1.10	0.66	46 to 1.00
Kidney knob (%)	3.29	2 to 4	3.23	2.0 to 4.5
Maturity	A+	A^{o} to B-	A+	A^{o} to B-
Yield score[a]	3.5	2.2 to 4.3	3.1	1.9 to 4.7
Carcass Grade	Ch^{o}	Ch- to CH+	Ch^{o}	Ch- to Ch+
Fat color	Creamy white	Creamy white	Creamy white	Creamy white

[a] Derived from USDA Beef Carcass Yield Grade Finder.

All of the ribs, separated from the carcasses according to the procedure recommended in the 1953 Reciprocal Meat Conference Proceedings, were held for 5 days in a 36 to 40^{o}F cooler. Then they were cut into appropriate sampling sections and frozen at 0^{o}F to await subsequent physical, chemical and organoleptic tests. The wholesale ribs were divided into three sections for convenience of storage and analysis. The 6-7-8th rib roast from each rib was used for organoleptic, shear, and cooking purposes. These roasts were cooked at a constant 300^{o}F oven temperature and removed for taste and shear tests whenever the internal temperature reached 155^{o}F. Two cores, 2 inch in diameter, were removed from the center of the rib eye muscle of each roast and were sheared three times for tenderness on the Warner-Bratzler shear device. In addition to the shear tests, a six-member taste panel evaluated another portion of the rib eye muscle for tenderness, juiciness, flavor and overall satisfaction. Weight losses were also determined for each roast by weighing and after cooking. The 9-10-11th rib portion was physically separated into fat, lean and bone. The remaining 12th rib portion was boned and the rib eye muscle ground three times with an electric meat grinder through a one-eighth inch plate. This ground meat was frozen and later analyzed for moisture and ether extract.

Results and Discussion

The means and standard deviations of the organoleptic, shear and cooking data for the two groups are shown in Table 2.

From these results it may be noted that a definite trend resulted in favor of the fine-textured ribs (Group I). In general, these differences were small and non-significant according to analysis by the students "t" test. However, the differences in tenderness, as measured by the Warner-Bratzler shear device, and the percentage cooking loss approached significance at the 0.05 level. The fine textured group appeared to be more tender and had a lower percent of cooking losses. There also appeared to be more variation around the means of the coarse-textured group (Group II) as denoted by the larger standard deviations. Although the results in Table 2 were not statistically significant, further investigations in this area seem justified since a definite trend was noted in these data.

Table 2.—Organoleptic, Shear and Cooking Data on Fine and Coarse Textured Beef Rib Roasts

6-7-8th Rib	Group I Fine Texture Means	S.D.	Group II Coarse Texture Means	S.D.
Flavor	7.7[a]	0.4	7.6	0.2
Tenderness	8.0[b]	0.4	7.7	1.8
Juiciness	7.8	0.5	7.5	0.6
Overall satisfaction	7.8	0.4	7.6	0.4
Warner-Bratzler Shear[c]	11.4	1.7	13.3	3.3
Cooking loss (%)	27.5	2.2	28.3	2.5

[a] A mean score of 7.0 denotes "like moderately" by the taste panel.
[b] A mean score of 8.0 denotes "like very much" by the taste panel.
[c] Increasing shear values indicate less tender meat.

The physical and chemical composition of the two groups are shown in Table 3.

Table 3.—Physical and Chemical Composition of Fine and Coarse Textured Beef Ribs

Phy. Separation 9-10-11th Rib	Group I Fine Texture Mean	S.D.	Group II Coarse Texture Mean	S.D.
Fat (%)	40.6	2.4	40.3	4.2
Bone (%)	13.2	1.0	13.0	0.9
Lean (%)	46.1	2.3	47.0	4.2
Rib eye (%)	20.7	1.6	21.0	2.6
Chem. Analysis 12th Rib				
Lean color	2.2[a]	1.2	5.1[bc]	2.0
Moisture (%)	69.5	1.6	69.5	2.1
Ether extract (%)	8.0	2.2	8.2	2.3

[a] Color score of 2.0 indicates light to cherry red.
[b] Color score of 5.0 indicates dark to brownish red.
[c] ($P < 0.01$)

There was very little difference in the percentage of fat, bone, lean and rib eye of the two groups. Again, as was noted in Table 2, consistently larger standard deviations in Group II indicate a greater variation around the mean. The closeness of the percentage of separable components of the two groups was expected since both groups were of the same grade and were similar in fat thickness and rib eye area. The color of the lean on the cut surface of the 12th rib was considerably ($P < 0.01$) lighter and more desirable for the fine-textured group than for the coarse group. The percentage of moisture and ether extract were not different for the two groups but, again, these data were expected and further substantiate the results showing the same percentage of separable components for the two groups.

QUALITY COMPARISONS AND CHEMICAL COMPOSITION OF THE LOIN EYE FROM THREE DIFFERENT WEIGHT GROUPS OF HAMPSHIRE BARROW AND GILT LITTERMATES

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Presently we are striving to produce a meat-type hog with the minimum amount of fat which still retains an optimum level of quality. It has been established that as a pig increases in weight, it will deposit a greater amount of fat in relation to lean meat. An approach to this problem has been to market hogs at lighter weights. However, besides the quantity of lean meat, quality is extremely important because it is this factor which greatly influences consumers acceptance.

This study was conducted as part of the one reported last year on the physical composition of pork cuts and relative cutout percentages of pork carcasses. The loins from 10 litters of Hampshire barrows and 10 litters of Hampshire gilts (3 pigs from each litter were used; 1 littermate was slaughtered at 160 $\pm$ 5 pounds, another at 190 $\pm$ 5 pounds, and the last at 220 $\pm$ 5 pounds) were cut between the 10th and 11th rib, and then the cut surface was subjectively evaluated with respect to color, firmness, marbling, and texture, using a modified version of the Wisconsin pork quality standards. Results of the quality evaluation are shown in Table 1. There was no significant difference in color and marbling scores among the three weight groups or between the two sexes. A highly significant difference was found in respect to firmness between the barrows and gilts which is logical because barrows are comparatively fatter and thus should be firmer. Also, a highly significant difference was found in texture among the three weight groups with the 160-pound hogs having the finest texture. Based on quality as a whole, no major differences were found among the three weight groups or between the two sexes, which supports earlier work done at this station.

The chemical composition (Table 2) of a lean loin eye sample from each animal showed no significant differences among the three weight groups or between the two sexes with respect to ether extract (fat), protein, and ash. However a highly significant difference was found in the moisture content of the loin eye muscle among the three weight groups. This indicates that as a hog increases in weight, the lean tissue decreases in moisture and the moisture which is lost is probably replaced by fat, although the results indicate that barrows should be marketed at lighter weights than gilts because barrows will tend to deposit more intermuscular fat at a faster rate, resulting in pork cuts with more seam fat. These wasty pork cuts are <u>not</u> what the consumer desires at the present time. There were no major apparent differences in quality among the three weight groups or between the two sexes studied in this experiment.

Table 1.—Quality Scores

	Live Weight Groups (lb)								
	160			190			220		
	Barrows	Gilts	Total	Barrows	Gilts	Total	Barrows	Gilts	Total
Quality Factor:									
1. Color[a]	2.8	2.7	2.75	2.6	2.9	2.75	2.9	2.5	2.70
2. Firmness[b]	2.8**	2.5**	2.65	2.9**	2.6**	2.75	3.0**	2.6**	2.80
3. Marbling[c]	2.1	1.8	1.95	2.40	2.3	2.35	2.4	2.1	2.25
4. Texture[d]	2.4	2.5	2.45**	2.2	2.0	2.10**	1.8	2.0	1.90

[a] Color Score:
1. extremely pale
2. pale
3. uniformly grayish - pink
4. moderately dark
5. very dark

[b] Firmness Score:
1. very soft
2. soft
3. firm
4. very firm

[c] Marbling Score:
1. devoid
2. small
3. moderate
4. abundant
5. extremely abundant

[d] Texture Score:
1. coarse
2. medium
3. fine

** $P < 0.01$

Table 2.—Proximate Composition

	Live Weight Groups (lb)								
	160			190			220		
	Barrows	Gilts	Total	Barrows	Gilts	Total	Barrows	Gilts	Total
1. Percent ash	1.12	1.15	1.14	1.08	1.13	1.11	1.09	1.11	1.10
2. Percent ether extract	4.65	3.94	4.29	4.82	4.45	4.63	5.50	4.88	5.19
3. Percent protein	20.14	20.05	20.09	19.53	19.26	19.39	19.33	19.52	19.42
4. Percent water	73.23	73.09	73.16**	72.74	72.63	72.68**	71.93	72.11	72.02**

** $P < 0.01$

SWINE SECTION

EFFECT OF SULFONAMIDE SUPPLEMENTATION OF FEED ON THE PERFORMANCE OF PIGS

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Sulfonamides have been used previously in the treatment of scours of baby pigs, usually by administering large oral doses for a few days and then withdrawing the medication. The objective of these experiments was to study the effect of supplementing the sow's ration with sulfonamides on the control of scours of pigs and also their influence on her reproductive performance. The drugs studied were fed from 2 weeks before farrowing until 3 weeks after farrowing. Forty Hampshire and Yorkshire gilts were used in the first experiment and were allotted to the following five treatments: (I) no medication (negative control), (II) 150 g furazolidone (positive control), (III) 227 g sulfadimethoxine, (IV) 454 g sulfadimethoxine and (V) 454 g sulfisoxazole. The foregoing levels of drugs were on a per-ton basis. When scours was observed, cultures were made to determine organisms present. Other criteria for evaluating the response of these drugs were number of pigs farrowed, number of live pigs farrowed, birth weight, number of pigs weaned and 3 week weight of pigs. The results of this experiment are presented in Table 1.

Table 1.—Average Performance of Sows and Pigs to Weaning in Experiment I

Treatment	No. Sows	Av No. Farrowed Per Litter	Av No. Stillborn Per Litter	Av No. Farrowed Live Per Litter	Av Birth Weight, lb	Av No. Weaned Per Litter	Av Weight at 3 Weeks, lb
I	4	8.5	0.50	8.0	2.95	7.2	10.08
II	4	9.5	1.25	8.2	2.23	6.8	8.46
III	5	10.0	1.20	8.8	2.20	6.8	8.23
IV	5	10.6	1.60	9.0	2.50	7.6	10.19
V	4	9.2	.75	8.5	2.53	6.5	10.06

The differences among treatments for number of pigs farrowed, live pigs farrowed, with weights, pigs weaned and 3-week weights were not statistically significant. Pigs scoured in all ration treatments groups. However, the highest incidence of scours was by the pigs whose dams were on the furazolidone-treated rations, but scouring did not occur for any extended period of time. The major groups of organisms found when the feces were cultured were Proteus and Coliform.

Experiment II

Experiment II was conducted, using 39 sows under the same feeding and management conditions as the previous experiment. The drug level was modified in treatments (III), (IV), and (V) by being reduced as follows: (III) 50 g sulfadimethoxine, (IV) 100 g sulfadimethoxine and (V) 100 g sulfisoxazole. The results are given in Table 2.

Table 2.—Average Performance of Sows and Pigs to Weaning in Experiment II

Treatment	No. Sows	Av No. Farrowed Per Litter[a]	Av No. Stillborn Per Litter	Av No. Farrowed Live Per Litter	Av Birth Weight, lb	Av No. Weaned Per Litter	Av Weight at 3 Weeks, lb
I	7	12.6	1.62	10.7	2.37	7.7	10.35
II	7	10.4	1.29	9.1	3.04	7.3	11.52
III	9	10.7	1.11	9.6	2.60	7.4	10.54
IV	8	10.8	.88	9.9	2.63	7.5	10.64
V	8	12.5	1.25	11.2	2.62	8.1	10.56

[a] I and V are significantly different than II, III, IV ($P < 0.05$).

The number of pigs farrowed by the sows receiving treatments I and V were significantly ($P < 0.05$) larger than those in the other three treatments. There were no significant differences in number of live pigs farrowed, birth weights, number of pigs weaned or 3-week weight among these ration treatments. Only a limited amount of scours occurred, which was similar to the same trend of the first experiment.

When 25 pigs from each ration treatment group reached 3 weeks old, they were weaned and allotted to five starter ration treatments. These treatments were: (1) basal, (2) 150 g furazolidone, (3) 50 g sulfadimethoxine, (4) 100 g sulfadimethoxine and (5) 100 g sulfisoxazole. These levels were on a per-ton basis. These pigs were self-fed their respective rations for a period of 10 weeks. The average daily gain and feed efficiency are presented in Table 3.

Table 3.—Average Daily Gain and Feed Conversion of Postweaning Experiment (3 Weeks Weaning to 13 Weeks)

Postweaning Pig Treatment	Preweaning Sow Treatment					
	I	II	III	IV	V	Ave
1	0.79[a]	0.85	0.82	0.95	0.92[d]	0.87
	2.56[b]	2.60	2.45	2.85	2.60	2.61
2	0.93	0.96	0.81	1.03	0.78	0.90
	2.63	2.69	2.54	2.49	2.68	2.61
3	0.88	0.89	0.83	0.99	0.92	0.90
	2.51	2.66	2.63	2.46	2.35	2.52
4	0.87	0.76	0.86[c]	1.11	0.88	0.90
	2.60	2.73	2.76	2.52	2.62	2.65
5	0.92	0.88	0.83	1.04	0.90[e]	0.91
	2.46	2.60	2.51	2.54	2.48	2.52
Ave.	0.88	0.87	0.83	1.02	0.88	
	2.55	2.66	2.58	2.57	2.55	

[a] Average daily gain for lot, lb.
[b] Feed per pound of gain for lot, lb.
[c] Pig removed after 28 days - rectal prolapse.
[d] One pig died after 17 days - not posted.
[e] One pig died after 11 days - not posted.

Excellent gains were made by all groups of pigs in this experiment. The postweaning treatment had no significant effect on the performance of the pigs. However, pigs coming from sows on the 100 g sulfadimethoxine treatments gained significantly ($P < 0.05$) faster than pigs from the other preweaning treatments.

PROTEIN SUPPLEMENTS FOR GROWING-FINISHING PIGS ON CONCRETE

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One hundred-twenty Yorkshire pigs, averaging approximately 50 lb, were used in this experiment. They were randomly allotted according to sex and weight to six ration treatments with two replicate lots of 10 pigs each. The protein supplements used, self-fed with yellow shelled corn, were: (1) a complete mixed supplement, (2) soybean meal, (3) soybean meal + 5% alfalfa meal, (4) soybean meal + 10% alfalfa meal, (5) soybean meal + 20% alfalfa meal and (6) a complete mixed ration (control). Minerals and vitamins were added to the supplements at the same level as the protein supplement given in Ky. Misc. 68-A, "Swine Ration Formulas." Pigs in all ration treatments were self-fed a 16% protein ration until the lots averaged 75 pounds. Then the pigs were changed to the above ration treatments. The pigs were weighed bi-weekly, and the experiment was terminated when the lot average was 200 pounds.

Table 1.—Results of Pig Performance Fed Different Protein Supplements

Ration	No. Pigs	Av Initial Wt, lb	Av Final Wt, lb	Av Daily Gain lb	Corn	Supple-ment	Com-plete Mix	Total	Feed Cost Per 100 lb Gain[a]
Complete supplement	20	49.3	200.4	1.54	277.9	31.7	53.8	363.4	10.80
Soybean meal	20	49.3	204.2	1.56	275.6	32.0	52.5	360.1	10.73
Soy. + 5% alf. meal	20	49.3	198.0	1.48	289.0	25.7	64.6	379.0	11.19
Soy. + 10% alf. meal	20	49.4	201.9	1.50	291.6	29.4	54.1	375.1	11.07
Soy. + 20% alf. meal	20	49.5	190.0	1.54	309.4	25.8	57.7	392.9	11.47
Complete mix	20	49.4	202.0	1.72			365.5	365.5	12.62

[a] May 1965 feed prices.

The pigs receiving the complete mixed rations made the fastest gains, 1.72 pounds per day. A rather marked reduction in gains was noted in the pigs receiving the corn and protein supplement rations. However, feed efficiency of the pigs receiving the complete and soybean meal supplements was slightly better than that of the pigs receiving the complete mixed ration. It should also be observed that the pigs receiving the soybean meal supplements did not consume an excess of protein. Further, the gains made by those on this ration treatment were the most economical of all, followed by those on the complete mixed supplement. The complete mixed ration was the most expensive ration fed.

PROGRESS REPORT ON ARTIFICIAL INSEMINATION OF SWINE

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A program of artificial insemination was initiated at the U.K. Agricultural Experiment Station at Lexington and the West Kentucky Substation at Princeton in July 1964. This program was begun to determine the feasibility of maintaining an "SPF" (specific pathogen free) herd by introducing new lines into the herd through artificial breeding rather than by natural service, thus eliminating the risk of bringing disease into the herd through purchased boars.

Procedure

Young boars have been purchased that had never been used in natural service. These boars are easily and quickly trained to mount dummy sows made of padded steel or wood. The semen is collected in a prewarmed (37°C) thermos jar or in an insulated beaker. It is evaluated on the basis of volume, sperm concentration, motility and percentage abnormal sperm.

The semen may be used fresh without diluting or it may be diluted and used immediately or stored at 46°F for 24 hours. No attempts have been made to use the semen after 48 hours' storage, although it can be successfully stored for this length of time with reasonably good success.

Semen is successfully diluted with a variety of extenders, ranging from simple milk extenders to more complex egg-yolk citrate buffers.

The following diluter has been used with good results:

A. Stock Solution
- 1,000 ml distilled water
- 42.6 g dextrose
- 2.1 g sodium bicarbonate

B. Final Extender
- 70% stock solution
- 30% egg yolk
- Streptomycin (1,000 mcg per cc)
- Penicillin (500 units per cc)

The extender is warmed to the same temperature of the semen and the two are mixed. The amount of extender added is determined by the concentration of sperm in the semen determined by counts made with a hemocytometer and microscope. The average mature boar ejaculates 200-250 cc of strained semen (plug removed), containing an average of 40 to 80 billion sperm depending on frequency of collection from the boar. The semen is extended so that 50-60 cc of fluid will contain a minimum of 4 billion sperm. Fifty to sixty cc of diluted semen is the minimum amount to inseminate for normal litter size.

Sows are inseminated when they are in a solid standing heat. The sows are checked daily for signs of heat and when they will stand motionless for a man to sit on their back they are inseminated.

Insemination is made using a plastic pipette which is inserted into the cervix. With a little experience it is not difficult to tell when the pipette passes into the cervix. Care must be used here to avoid injury to the sow. Semen may be deposited, using a syringe or a plastic bottle which is squeezed to force the semen through the pipette and into the uterus of the sow.

Results

Two groups of sows totaling 122 have been inseminated from July 1964 to June 1, 1965. The first group was composed of 54 Hampshire sows and gilts. This group was inseminated in the fall of 1964. Thirty-four of these sows and gilts farrowed a total of 322 pigs. This amounts to 63 percent of the sows inseminated farrowing an average of 9.45 pigs each. No differences were observed between the sows receiving 50-60 cc and those getting 100 cc, either in percentage of conception or in litter size.

The second group of sows and gilts was inseminated during the spring of 1965. Sixty-five percent of these have settled, including both sows and gilts.

Conclusion

As the techniques have been improved and more experience gained the conception rate continues to improve. The authors are confident that, under controlled conditions and with groups of sows of known fertility, 75 to 80% conception rates may be realized with artificial insemination and that litter size will equal that resulting from natural service.

THE USE OF CORN SILAGE AND RYE PASTURE FOR BRED SOWS

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University of Kentucky

Ten purebred Hampshire and 34 purebred Yorkshire sows were randomly allotted by breed and weight to five different treatments (5 lots), four lots of nine sows each, and one of eight sows. The treatments were as follows:

Lot 1 - Corn silage plus 3.5 lb of complete gestation ration per head daily.

Lot 2 - Balboa rye pasture plus 4.0 pounds of the gestation ration per head daily the first 2 weeks of the experiment[1] then continued on rye pasture but fed only 2.0 lb of ration for the next 2 weeks when they were returned to the original feeding level of 4.0 lb of gestation ration and rye pasture.

Lot 3 - Sows were confined to dirt dry-lot and fed 6.0 lb of the gestation ration per head daily.

Lot 4 - Corn silage plus 3.0 lb of gestation ration and 0.5 lb of protein supplement per head per day the first two weeks of the experiment[1] then changed to silage plus 1.0 lb of ration and 1.5 lb of supplement for the next two weeks. The sows were then returned to their original treatment of 3.0 lb of gestation ration and 0.5 lb of protein supplement for the remainder of the gestation period.

Lot 5 - Sows were confined to concrete feeding floor and fed 6.0 lb of gestation ration per head per day.

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1 The rations of Lots 2 and 4 were decreased because the sows were gaining weight too rapidly but were raised to the original level at the next weigh period to keep the sows from losing weight.

After varying the amount of silage fed the first week of the experiment, the sows in pens receiving silage consumed approximately 10.0 lb of silage per sow daily. The sows sorted out the silage and did not eat the coarser parts of it. All sows were hand-fed their rations twice daily in long wooden troughs. They received their water from automatic waterers.

All of the sows in the experiment had been hand bred previous to the start of the experiment. One of the Hampshire sows in Lot 1 was removed from the experiment because she was bred approximately a month before any of the other sows in the experiment and was not on treatment a sufficient length of time before farrowing.

The results of this experiment are presented in Table 1.

Table 1.—Summary of Litter Averages at Birth and When 3 Weeks Old

	I 3.5 lb Conc + Silage (concrete)	II 4.0 lb Conc + Rye (concrete)	III 6.0 lb Conc (dry lot)	IV 3.0 lb Conc 0.5 lb Supp (concrete)	V 6.0 lb Conc (concrete)
Number of litters farrowed	7.0	9.0	9.0	9.0	9.0
Av number of pigs farrowed	11.2	11.1	11.6	9.8	9.6
Av number of pigs farrowed alive	10.5	10.3	11.0	8.7	8.8
Av birth weight per pig, (lb)	2.9	2.6	2.7	2.8	2.9
Av number of pigs alive at 3 weeks	9.8	9.9	9.6	7.6	7.4
Av wt per pig at 3 weeks, (lb)	9.8	10.5	9.5	9.8	9.8

Summary

Results of this trial substantiate those of previous trials with rye pasture and corn silage. Rye pasture or corn silage can be used successfully to replace a portion of the gestation ration for mature sows. On the basis of this trial, feeding 3.5-4.0 lb of a mixed ration when sows are on good rye pasture or corn silage is needed to keep them in a thrifty, gaining condition during gestation. The feeding of corn silage appears to be feasible when it is available on the farm and pasture is not available.

ANTIBIOTICS FOR EARLY WEANED PIGS

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This experiment was conducted to study the performance of early weaned pigs when fed high levels of various combinations of antibiotics and sulfa. The pigs used in this experiment were weaned between 3 and 4 weeks of age. Fifty pigs were randomly allotted to five ration treatments with two replicate lots of five pigs each. They were fed a 19.6% protein starter ration until they reached 40 pounds and then changed to a 16% protein growing-finishing ration. The ration treatments were: (1) basal (no antibiotic), (2) 250 g aureo SP "250," (3) 100 g bacitracin MD, 100 g sulfamethazine and 50 g neomycin sulfate, (4) 50 g bacitracin MD and 50 g neomycin sulfate and (5) 100 g bacitracin MD and 50 g neomycin sulfate. The rate of supplementation was on a per ton basis. The results are presented in Table 1.

Table 1.—Results of Experiment I

Ration	Initial Wt, lb	ADG, lb	Feed Conv	Final Wt, lb
Basal	13.8	1.14	2.26	76.8
Aurea SP "250" 250 g	14.2	1.34	2.26	86.0
Bacit. MD 100 g Sulmet 100 g Neom. SO4 50 g	14.0	1.34	2.18	86.4
Bacit. MD 50 g Neom. SO4 50 g	14.0	1.30	2.44	83.9
Bacit. MD 100 g Neom. SO4 50 g	13.7	1.29	2.37	93.5

Gains were improved by all pigs receiving treated rations. These responses were somewhat uniform regardless of combination used. These data indicate that level of medication is responsible for response rather than combination of any given drug. It should also be noted that the feed efficiency was not improved to any extent and in some ration treatments a negative response resulted.

Experiment II

Seventy pigs were randomly allotted to 7 ration treatments with 2 replicate lots of 5 pigs each. A 16% protein ration was fed from the initiation of the experiment to 75 pounds average weight and then changed to a 14% protein ration for the remainder of the trial. The rations were self-fed and water was supplied with an automatic waterer. The ration treatments were: (1) basal (no antibiotic), (2) terramycin, (3) bacitracin, (4) Zn bacitracin, (5) Zn bacitracin and penicillin, (6) bacitracin MD and (7) bacitracin MD special carrier. These antibiotics were added at 5g per ton. The results of this experiment are presented in Table 2.

Table 2.—Results of Experiment II

Treatment[a/]	Initial Wt, lb	Final Wt, lb	ADG, lb	Feed Conv
1. Basal	33.8	125.6	1.74	2.91
2. Terramycin	33.6	126.7	1.76	3.00
3. Bacitracin	34.1	127.5	1.76	3.04
4. Zn Bacitracin	33.5	126.7	1.82	2.95
5. Zn Bacitracin and Penicillin	33.7	125.1	1.72	3.01
6. Bacitracin MD	33.5	130.3	1.80	2.82
7. Bacitracin MD, Special Carrier	33.0	126.8	1.80	3.02

[a/] Antibiotics were supplemented at 5 g per ton.

A small improvement in gains was made by most treatments receiving the antibiotics. Treatment 6 Bacitracin MD was the only antibiotic to make any improvement in feed efficiency at these low levels of supplementation.

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