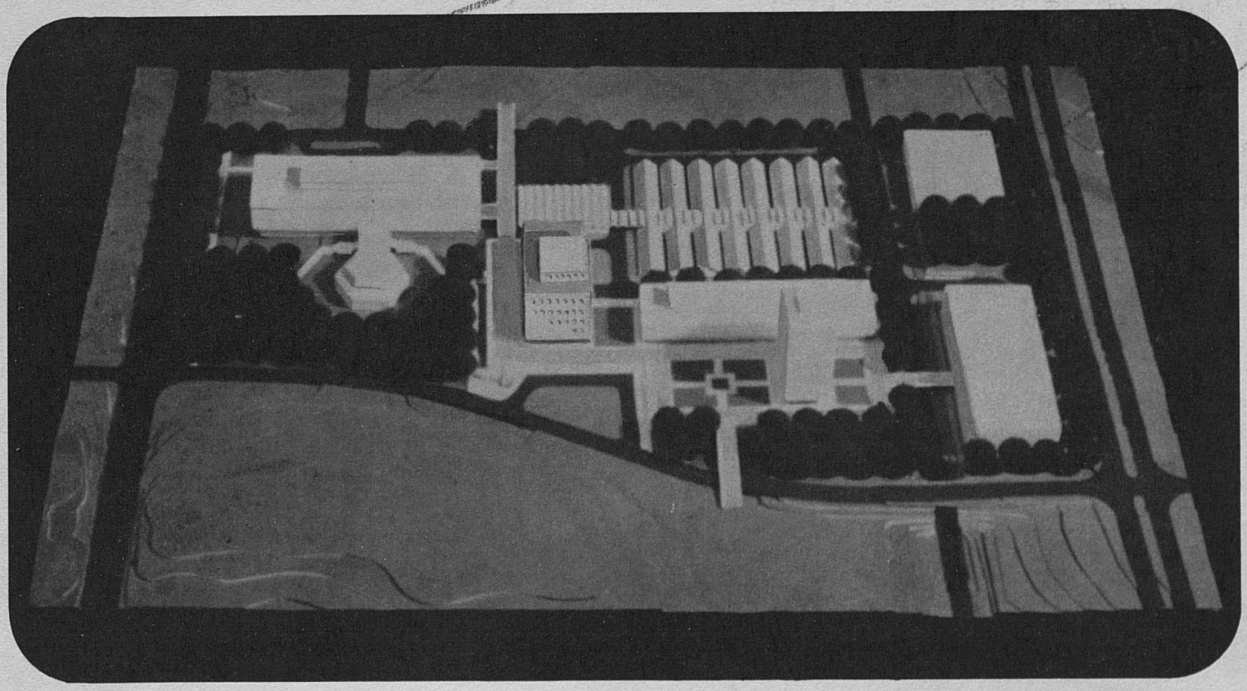

KENTUCKY ANIMAL SCIENCES RESEARCH REPORTS

UNIVERSITY OF KENTUCKY • AGRICULTURAL EXPERIMENT STATION • PROGRESS REPORT 170

1967

PROGRAMS FOR 1967 ANIMAL SCIENCES FIELD DAYS

DAIRY FIELD DAYS

June 19, 1967 Western Kentucky University Farm, Bowling Green

June 20, 1967 University Coldstream Dairy Center, Lexington

- Demonstrations and exhibits of recommended practices and current problems facing the dairy industry beginning at 10 a.m.
- Lunch provided by American Dairy Association of Kentucky, Mammoth Cave Production Credit Association, Dairy Products Association, Aubrey Feed Mills, Kyana Milk Producers, Inc., Sealtest Foods and Southern States Cooperative.
- Address -- "The Business Side of Dairying" - Mr. L. P. Lango, author in "Hoard's Dairyman" and dairyman, Glastonbury, Conn.

LIVESTOCK FIELD DAYS

July 12, 1967 University Coldstream Farm, Lexington

July 14, 1967 Western Kentucky Substation Farm, Princeton

- Conducted tours showing beef, sheep and swine research at regular intervals beginning at 9 a.m.
- Lunch provided by Bluegrass Stockyards, Lexington, and Field Packing Co. and Owensboro Milking Co., Owensboro.
- Address -- "Can We Produce Enough?" - Dr. A. L. Neumann, head, Department of Animal Science, New Mexico State University, University Park, New Mexico.

THE COVER ILLUSTRATION shows a model of the proposed layout of the University of Kentucky Agricultural Research Center. Included are the existing Agricultural Science building with auditorium (upper left) and greenhouses (upper right), a new Animal Sciences building to be constructed (center), and projected additional laboratory, office and parking facilities (lower right). The sum of $4 million has been allocated for construction of the new Animal Sciences building, which will contain approximately 110,000 square feet of floor space. Preliminary program requirement plans have been prepared, architectural design has been begun, and occupancy is forecast for the fall of 1970.

KENTUCKY

ANIMAL SCIENCES RESEARCH REPORTS

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PROGRESS REPORT 170

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UNIVERSITY OF KENTUCKY

AGRICULTURAL EXPERIMENT STATION

CONTENTS

ANIMAL FOODS

ANIMAL NUTRITION SECTION

ABOMASAL NITROGEN IN STEERS FED SOYBEAN MEAL OR UREA

G. D. Potter, C. O. Little and G. E. Mitchell, Jr.

It is well established that ruminal synthesis of protein from nonprotein nitrogen sources in the ration does occur; however, the objectives in many of the reports on this subject have been such that little quantitative information has been obtained. The objective of this study was to identify quantitatively the nitrogenous compounds reaching the abomasum of steers fed soybean meal (SBM) or urea in a finishing ration.

Procedure

Four mature steers with permanent abomasal fistulas were used. Rations of ground ear corn supplemented with soybean meal or urea and containing chromic oxide as an indicator were fed at 12-hour intervals at a level of 5.0 kg per animal each day. Minerals were added to the urea ration to approximate the composition of the soybean meal ration. The steers had access to water and a salt, bonemeal, limestone mixture at all times. Following a 10-day preliminary period, samples of abomasal contents were collected through the fistulas once in each 12-hour period for 6 days to provide samples taken at each 2-hour interval after both the morning and afternoon feedings. A treatment reversal pattern was followed so that each steer received each ration during the experiment, providing four observations per treatment at each time.

The nitrogenous components of abomasal fluid were separated into protein and nonprotein fractions, the latter being further fractionated into free amino nitrogen, bound amino nitrogen, purine-pyrimidine nitrogen and ammonia nitrogen. Quantities of each nitrogen fraction reaching the abomasum were calculated by nitrogen:chromic oxide ratios relative to intake. The amino acid composition of samples of abomasal contents was determined after complete hydrolysis by ion-exchange chromatography.

Results and Discussion

The quantities of the different nitrogen fractions reaching the abomasum of steers fed SBM or urea are summarized in Table 1. The values reported are averages of all times for each treatment and, thus, approximate the composition of abomasal contents throughout the period from one feeding until the next.

Less total nitrogen reached the abomasum of steers when the urea ration was fed than when SBM was the supplemental nitrogen source. This indicates that more nitrogen was being absorbed anterior to the abomasum with the urea supplement than with SBM. Fractionation of the nitrogen constituents in abomasal contents revealed that the difference in total nitrogen could be accounted for mainly as protein nitrogen. The quantities of nonprotein nitrogen fractions in the abomasal contents with either nitrogen source were similar.

Analysis of individual amino acids in abomasal contents (Table 2) did not reveal differences in the amino acid patterns of proteins and free amino acids that reached the

abomasum when SBM or urea was fed. The main difference in the nitrogen reaching the abomasum in steers fed SBM or urea was quantitative, and this quantitative difference was in the protein nitrogen fraction.

Table 1.--Nitrogen Reaching the Abomasum of Steers Fed Soybean Meal or Urea

	Soybean Meal		Urea	
	gm/day	% of ration N	gm/day	% of ration N
Nitrogen intake	94.4		90.4	
Nitrogen in abomasal contents				
Total N[a/]	73.7	77.6	58.6	65.1
Protein N[a/]	37.7	39.7	25.9	28.8
Bound amino N	19.4	20.4	16.9	18.8
Free amino N	5.0	5.3	4.8	5.3
Ammonia N	1.0	1.1	1.2	1.3
Purine-pyrimidine N	3.4	3.6	3.2	3.5

[a/] Differences between soybean meal and urea significant ($P < 0.05$)

Table 2.--Essential Amino Acids in Abomasal Contents of Steers Fed Soybean Meal or Urea (molar percent)

	Soybean Meal	Urea
Threonine	6.01	6.31
Valine	7.49	7.26
Methionine	1.93	1.99
Isoleucine	6.06	5.93
Leucine	10.48	11.69
Phenylalanine	3.83	4.07
Lysine	5.89	6.34
Histidine	1.78	1.95
Arginine	3.72	3.95

PLASMA AMINO ACIDS IN STEERS FED UREA SUPPLEMENTS

C. O. Little, N. W. Bradley and G. E. Mitchell, Jr.

There is a continuing effort in research to develop procedures and methods for measuring the nutritional adequacy of different rations. This is particularly true for proteins and protein supplements for ruminants. Results of recent work with non-ruminant species have suggested that plasma amino acids are influenced by the dietary levels and thus the quantities available for absorption. In previous reports from this station, results

with purified rations in ruminants showed a relationship between amino acids in abomasal fluid and the free amino acids in plasma. Thus, it was of further interest to study the amino acids in the plasma of feedlot steers fed different finishing rations supplemented with different sources of nitrogen.

Procedure

Plasma samples were collected from 80 yearling steers at the termination of 133- and 125-day feeding experiments. The steers received different energy feeds with soybean meal or urea nitrogen supplements during these feeding periods. In experiment I, 40 steers were fed ground ear corn with 20 receiving soybean meal and 20 urea supplements. In experiment II, 20 steers received ground shelled corn at 1½% of the body weight and corn silage ad libitum and 20 steers received ground shelled corn at 1% of body weight and corn silage ad libitum. Soybean meal was fed to half of the steers on each corn level, and urea replaced the soybean meal on an equal nitrogen basis in the rations of the others. Plasma samples were deproteinized with sulfosalicylic acid, and free amino acid levels were determined by ion-exchange chromatography.

Results and Discussion

Feedlot performance results of these experiments have been previously reported in "Animal Science Research Reports-1965" (Ky. Agr. Exp. Sta. Prog. Rept. 150). The concentrations of each amino acid expressed as micromoles per 100 ml are summarized in Table 1. On the different energy rations, urea supplements reduced total plasma amino acid levels 8, 7 and 8%, respectively. The individual amino acids most consistently affected by substitution of urea for soybean meal were: lysine reduced 12, 19 and 18%; isoleucine reduced 11, 15 and 12%; valine reduced 10, 14 and 12%; proline reduced 19, 10 and 29% and methionine reduced 8, 13 and 4% on the respective energy rations.

Table 1.--Plasma Amino Acid Levels (u mol/100 ml) in Steers Receiving Soybean Meal (SBM) or Urea Supplements

	Ear Corn[a]		1½% Corn+Silage[b]		1% Corn+Silage[b]	
	SBM	Urea	SBM	Urea	SBM	Urea
Valine	27.1	24.3	34.8	30.0	34.3	30.2
Methionine	2.4	2.2	3.9	3.4	2.7	2.6
Isoleucine	11.6	10.2	13.4	11.4	13.0	11.3
Leucine	22.2	18.8	24.8	22.7	21.4	21.5
Phenylalanine	4.6	5.4	6.6	6.0	5.9	5.3
Lysine	15.1	13.3	15.6	12.7	15.1	12.4
Histidine	7.6	8.9	12.0	10.5	9.5	9.5
Arginine	14.5	13.1	8.0	8.7	7.7	8.0
Aspartic acid	3.1	2.7	1.0	0.7	1.3	1.8
Glutamic acid	15.5	15.6	11.8	9.8	10.7	12.5
Proline	18.5	15.0	13.3	12.0	22.0	15.6
Glycine	18.8	16.6	29.7	33.5	30.0	28.8
Alanine	26.0	25.8	27.9	28.7	35.2	31.3
Tyrosine	6.1	4.8	7.4	6.5	7.0	7.0
Total	215	199	230	214	236	218

a/ Experiment I, 133 days.

b/ Experiment II, 125 days.

These results suggest that plasma amino acids, both individual concentrations and total level, are affected by sources of dietary nitrogen. Whether this is a reflection of quantity of specific amino acids or total amino acid nitrogen that is passing from the rumen available for absorption from the small intestine was not determined. However, the possibility of using these parameters to estimate the nutritional adequacy is encouraged and is being investigated in greater detail.

SOURCE OF NITROGEN FOR SUPPLEMENTING GROUND EAR CORN RATIONS FOR FEEDLOT CATTLE - 1966

G. H. Brown, J. R. Overfield, N. W. Bradley and C. O. Little

Previous trials with ground ear corn rations have shown variable results when a part of the natural protein supplement was replaced with urea. In most experiments gains have shown a slight depression and additions of trace minerals, alfalfa meal or complex supplements have not improved feedlot performance. During 1966 this station reported an experiment in which a slightly greater depression of steer performance was found when urea replaced all the supplemental nitrogen in ground ear corn rations. However, addition of 0.5 lb per head daily of molasses to these urea rations appeared to reduce these depressions until performance was nearly comparable to natural protein sources.

The economic feasibility of using urea in beef finishing rations would be greatly increased if small inexpensive ration additions could be found that would improve the efficiency of utilization similar to that of plant proteins.

One hundred and twenty yearling steers, weighing an average of 684 lb, were divided into replicated lots of 10 steers each to evaluate the following rations:

1. Ground ear corn + soybean meal
2. Ground ear corn + soybean meal + sulfur
3. Ground ear corn + soybean meal + molasses
4. Ground ear corn + urea
5. Ground ear corn + urea + sulfur
6. Ground ear corn + urea + molasses

Urea replaced all the soybean meal on an equivalent crude protein basis in rations 4, 5 and 6. Flowers of sulfur was added at the rate of 0.1% in rations 2 and 5 and molasses was added to rations 3 and 6 at a rate to provide 0.5 lb per head daily. The complete ration composition is shown in Table 1.

All rations were fed to all lots of steers on a free-choice basis during a 119-day feeding period. Combined soybean meal and urea ration results for the feedlot trial are summarized in Table 2. The individual ration results are shown in Table 3.

Replacing all the soybean meal with urea significantly decreased average daily gains by 0.32 lb and feed efficiency by 92 lb per 100 lb of gain. These results are in agreement with results reported in 1966 when gains were reduced by 0.29 lb per day and feed efficiency by 159 lb per 100 lb of gain when urea replaced all the supplemental nitrogen.

In the current experiment steers consumed significantly less feed per day on urea rations than with soybean meal rations. These steers also weighed significantly less at

slaughter. However, soybean meal rations produced carcasses with significantly more fat as demonstrated by a larger percent kidney fat, fat covering the carcass and a smaller percent of lean cuts.

Table 1.--Composition of Rations Used in Feedlot Trial

Ingredients, lb/ton	Ration No.					
	1	2	3	4	5	6
Ground shelled corn	1430	1428	1365	1590	1590	1538
Ground corn cobs	358	358	358	358	358	358
Soybean meal 44%	186	186	204	-	-	-
Urea 281	-	-	-	26	26	28
Flowers of sulfur	-	2	-	-	2	-
Blackstrap molasses	-	-	46	-	-	46
Ground limestone	7.2	7.2	7.2	7.2	7.2	7.2
Plain salt	20	20	20	20	20	20

a/ Vitamin A was added to provide 30,000 I U per head per day.

b/ 1- Soybean meal
2- Soybean meal plus sulfur
3- Soybean meal plus molasses
4- Urea
5- Urea plus sulfur
6- Urea plus molasses

Table 2.--Feedlot Performance and Carcass Data of Steers Fed Two Sources of Nitrogen for a 119-Day Trial

Performance Data	Soybean Meal	Urea
No. of steers	60	60[1]
Initial average weight, lb	685	683
Average daily gain, lb[2]	2.23[a]	1.91[b]
Average daily feed consumed, lb	21.7[a]	20.4[b]
Feed/100 lb gain, lb	976	1068
Carcass Data		
Weight at slaughter	943[a]	905[b]
Cold carcass weight[2]	590	562
Percent cooler shrink	1.4	1.5
Dressing percent	62.6	62.1
Percent kidney fat	2.8[a]	2.7[b]
Marbling score	5.8	5.7
Conformation grade	13.6	13.5
Carcass grade	13.0	13.0
Ribeye area (sq. in.)	11.41	11.25
Fat thickness, in.	.53[a]	.46[b]
Percent estimated retail cuts	50.0[a]	50.6[b]

[1] Average values were calculated for one steer removed due to illness.
[2] Means on the same line not bearing the same superscript are significantly different. ($P < 0.05$).

Sulfur additions to rations 2 and 5 did not appear to contribute any consistent improvement in feedlot performance or carcass traits.

Molasses additions to rations 3 and 6 significantly increased ration consumption for both sources of nitrogen and this would appear to be correlated with average daily gains. These results are in close agreement with a similar experiment reported by this station in 1966.

The results of these experiments would seem to indicate urea can be successfully used as the only supplemental source of nitrogen for ground ear corn finishing rations; however, steer gains may be reduced by as much as 0.3 lb per head daily.

Additions of molasses to these finishing rations would appear to increase feed intake and at least partially account for increased steer gains when included in such small amounts.

Table 3.--Feedlot Performance and Carcass Data Summarized for Steers Fed Two Sources of Nitrogen With Ration Additions for a 119-Day Trial

Feedlot Data	Soybean Meal			Urea		
	1	2	3	4	5	6
No. steers	20	20	20	20	20[1]	20
Initial av weight, lb	685	688	683	685	680	685
Av daily gain, lb	2.13[a]	2.18[ab]	2.37[b]	1.79[d]	1.87[cd]	2.07[ac]
Av daily feed, lb	21.0[ad]	21.3[ac]	22.9[b]	19.7[a]	19.3[a]	22.2[bc]
Feed/cwt gain	987	974	966	1098	1030	1074
Carcass Data						
Weight at slaughter, lb	932	937	959	894	896	925
Cold carcass weight, lb	586	584	602	554	562	570
Cooler shrink, %	1.45	1.49	1.38	1.50	1.38	1.55
Dressing, %	62.9	62.2	62.7	61.9	62.7	61.6
Kidney fat, %	2.8	2.7	2.9	2.7	2.7	2.8
Marbling score	6.2	5.4	5.7	5.5	5.6	6.0
Confor. grade	13.9	13.4	13.5	12.9	13.8	13.9
Carcass grade	13.5	12.5	13.0	12.6	13.2	13.3
Rib eye area sq. in.	11.26	11.70	11.26	11.33	11.27	11.16
Fat thickness, in.	.57	.45	.57	.44	.41	.53
Est. retail cuts, %	49.7	50.8	49.5	50.8	50.9	50.0

[1]Average values were calculated for one steer removed from experiment due to illness.

[2]Means on the same line not bearing the same superscript are significantly different. ($P < 0.05$).

VITAMIN A TURNOVER IN STEERS FED ADEQUATE VITAMIN A

B. W. Hayes, G. E. Mitchell, Jr. and C. O. Little

A study reported in "Kentucky Animal Science Research Reports—1966" (Ky. Agr. Exp. Sta. Prog. Rept. 164) indicated that liver vitamin A reserves in sheep are in a dynamic state, even when the animals are receiving adequate dietary vitamin A. Average half-time for tritium-labeled vitamin A in livers of six ram lambs receiving alfalfa hay and corn was estimated to be 75 days. The results reported here are from a similar experiment using steers.

Procedure

Six Hereford steers, averaging 170 kg, each received jugular injections of tritium-labeled vitamin A acetate. Daily rations consisted of alfalfa hay and minerals fed free choice and 1.4 kg of ground shelled corn supplemented with 10,000 I.U. of vitamin A palmitate per steer. Liver samples were taken by aspiration biopsy on the 9th day after treatment and then at 3-week intervals. Jugular blood was sampled at the time of each liver biopsy, and feces and urine were collected for a 24-hour period immediately prior to each liver biopsy.

Liver samples were saponified with alcoholic potassium hydroxide and these along with serum samples were extracted with petroleum ether. Vitamin A was then determined with trifluoroacetic acid, and tritium activity was determined with a liquid scintillation counter.

Results and Discussion

Average tritium activities of daily eliminations of urine and feces are shown in Table 1. Similar amounts of tritium activity were excreted in the urine and in water soluble products of the feces. Considerably less activity was recovered from the ether extractable portion of the feces, and only trace amounts of tritium could be detected in either the water or ether extracts of the feces 72 days after treatment.

Table 1.--Tritium Activity (10^5DPM) Recovered From Daily Excreta of Steers

		Feces	
Day	Urine	Ether Extract	Water Extract
9	50	6	73
30	21	1	15
51	11	1	10
72	7	-	--
93	6	-	--

Liver and serum data are presented in Table 2. While the concentration of vitamin A in the liver was relatively constant, tritium activity decreased with time. This apparent continuous decrease in tritium activity of the liver and the detection of tritium in the blood throughout the trial provide strong evidence of continuous turnover of vitamin A stores. From the specific activity of vitamin A given in Table 2, the half-time for vitamin A in the liver of these steers is estimated to be 49 days, which is somewhat less than the half-time of 75 days estimated previously for sheep.

Table 2.--Vitamin A and Tritium Activity of Liver and Serum of Steers

Day	Liver Vitamin A (Mcg/gm)	Liver Tritium Activity (10^3DPM/gm)	Specific Activity of Liver Vitamin A (10^2DPM/mcg)	Serum Tritium Activity (10^2DPM/ml)
9	62.2	229	41	28
30	55.4	175	29	14
51	59.5	137	23	7
72	60.1	102	17	4
93	59.4	80	13	4

INFLUENCE OF LOW DIETARY PROTEIN ON VITAMIN A TURNOVER IN STEERS

B. W. Hayes, G. E. Mitchell, Jr. and C. O. Little

The level of dietary protein has been reported to influence the status of liver vitamin A reserves in most animals studied. Dietary protein deficiency usually decreases the storage of vitamin A in the liver and increases the rate at which stored vitamin A is depleted. Protein is also known to be involved in normal vitamin A transport. These observations suggest that protein status may affect the turnover rate of vitamin A stores. The present study was designed to test the possible influence of low dietary protein on the turnover of vitamin A in the liver of steers.

Procedure

Six Hereford steers with previously established hepatic stores of tritium-labeled vitamin A were randomly divided into two groups. The steers averaged about 240 kg and each received 5.4 kg of feed daily. During the first 56-day trial, steers in group I received a ration (52% corn and 48% cobs) containing 6% crude protein; those in group II received a ration (17% soybean meal, 35% corn and 48% cobs) containing 12% crude protein. The rations were supplemented with sufficient vitamin A palmitate to maintain the steers' liver vitamin A reserves, and the steers had free access to minerals. The study involved four trials. Prior to the second, third and fourth trials, the rations were reversed. Sampling and analytical procedures were similar to those described in the preceding paper.

Results and Discussion

Excretion of tritium activity was mainly through the urine. Only traces of radioactivity could be detected in fecal samples during the first trial and none was detected

during the second, third and fourth trials. Average tritium activity of the daily excretion of urine is presented in Table 1.

Table 1.--Average H^3-Activity (10^5 DPM) of Daily Urine Excretion of Steers Receiving Rations Containing 6% or 12% Crude Protein

Trial	Ration	
	6% Crude Protein	12% Crude Protein
I	4	5
II	4	2
III	3	4
IV	1	1

Average vitamin A and tritium activity of serum samples are given in Table 2. Vitamin A in the serum remained relatively stable, whereas tritium activity declined for both treatments. This would be expected in view of the continuous decline of labeled vitamin A in the liver. Treatment did not significantly alter total plasma protein, plasma albumin or plasma globulin fractions.

Table 2.--Average Serum Vitamin A and H^3-Activity of Steers Receiving Rations Containing 6% or 12% Crude Protein

Trial	Ration			
	6% Crude Protein		12% Crude Protein	
	Vit A (mcg/ml)	DPM/ml	Vit A (mcg/ml)	DPM/ml
I	0.58	313	0.51	302
II	.49	82	.52	89
III	.48	31	.54	50
IV	.46	23	.50	17

Half-times for labeled vitamin A in livers of the steers are shown in Table 3. Steers receiving the ration containing 6% crude protein appeared to exhibit a longer half-time for vitamin A in the liver than steers on the 12% crude protein ration; however, the difference was not statistically significant.

When the actual values for different treatments are compared with each other and with the values presented in the preceding report, it is apparent that the turnover rate for vitamin A in the liver of steers is highly variable. Within the limits studied, differences in protein intake do not appear to account for a major portion of this variation.

Table 3.--Average Half-Times (Days) for H^3-Labeled Vitamin A in Livers of Steers Receiving Rations Containing 6% or 12% Crude Protein

Trial	Ration	
	6% Crude Protein	12% Crude Protein
I	36	53
II	80	65
III	108	78
IV	160	155
Average	96	88

EFFECT OF VITAMIN E ON PRE-INTESTINAL DISAPPEARANCE OF VITAMIN A

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

Results of previous experiments have indicated that there may be considerable destruction of the ingested vitamin A before it reaches the small intestine. The usefulness of vitamin E in protecting vitamin A from oxidative destruction in feeds suggests that it might be useful in reducing pre-intestinal destruction. This report gives the results of an experiment conducted to study this possibility.

Procedure

Three mature steers previously fitted with permanent abomasal fistulas were used in a multiple switch-back experiment with each steer receiving each treatment twice. Each steer was fed 5 kg daily of a ground mixed ration containing 20% shelled corn, 76% alfalfa hay, 3% animal fat, and 1% salt and minerals. A 2-week preliminary period was followed by recovery trials at 1-week intervals.

Pre-intestinal destruction of vitamin A was estimated by administering approximately 1,000,000 I U of vitamin A acetate dispersed in 20 ml of 20% aqueous Tween "80" and 20 gm of chromic oxide in a gelatin capsule with or without 40,000 I U of vitamin E. Twenty-four hours after dosing, abomasal contents were collected through the abomasal fistula and analyzed in triplicate for vitamin A and chromic oxide. 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.

Results and Discussion

Table 1 gives the calculated pre-intestinal disappearance of vitamin A. As previously observed, a major portion of the administered vitamin A disappeared before reaching the abomasum. Results for individual steers and individual periods were highly variable. However, the data give no indication that high levels of supplemental vitamin E significantly affected the vitamin A disappearance. This suggests that ruminal destruction of vitamin A may not be an oxidative process.

Table 1.--Pre-Intestinal Disappearance of Vitamin A, in Percent

Week	Steer Number	Vitamin A Only	Steer Number	Vitamin A and Vitamin E
1	13	53.4	17	66.2
2	17	73.2	21	55.2
3	21	51.2	13	44.7
4	21	57.1	13	64.4
5	17	40.7	21	49.3
6	13	85.2	17	81.0
	Average	60.1		60.1

EFFECTS OF THIABENZOLE, INJECTABLE VITAMIN A AND LEVEL OF DIETHYLSTILBESTROL IMPLANT ON STEER PERFORMANCE

D. B. Laster and N. W. Bradley

The objective of this feedlot trial was to determine the effects of vitamin A, thiabenzole and 24 versus 36 mg of diethylstilbestrol on the average daily gains of steers.

Twenty-four Angus steers were group fed free-choice alfalfa silage with ground ear corn added at the time of ensiling. Enough additional ground shelled corn was fed to give approximately 8 lb of shelled corn per head per day. All steers received 10,000 I U of vitamin A daily in the salt and also received steamed-bone meal and water free-choice. The salt and vitamin A were changed every 7 days to prevent loss of the vitamin.

The steers, averaging 704 lb each, were randomly allotted, after blocking for weight, to eight treatments in a 2 x 2 x 2 factorial arrangement with 3 steers per treatment.

The primary treatment comparisons were: 24 or 36 mg DES; 1 million I U vitamin A intramuscularly or no vitamin A; and three thiabenzole boluses or no thiabenzole. The steers were subjected to these treatments at the beginning of the trial.

During the 155-day feedlot trial individual steer weights were taken every 28 days. The steers were individually weighed on and off the experiment after a 12-hour shrink off feed and water.

Each group of steers received one of the following treatment combinations:

1. 24 DES - thiabenzole - vitamin A
2. 24 DES - thiabenzole - no vitamin A
3. 24 DES - no thiabenzole - vitamin A
4. 24 DES - no thiabenzole - no vitamin A
5. 36 DES - thiabenzole - vitamin A
6. 36 DES - thiabenzole - no vitamin A
7. 36 DES - no thiabenzole - vitamin A
8. 36 DES - no thiabenzole - no vitamin A

The results of the study are summarized in Table 1.

There were no significant differences in average daily gain in respect to the different treatments and treatment interactions.

Table 1.--Effect of Treatments on Average Daily Gains (ADG)

	Treatments					
	24 DES	36 DES	Inj. Vit A	No Inj. Vit A	Thia-benzole	No Thia-benzole
Number of steers	12	12	12	12	12	12
Initial weight, lb	691	717	705	704	700	709
Final weight, lb	969	1007	992	984	996	980
Total gain, lb	278	289	287	280	296	271
ADG, lb	1.79	1.86	1.85	1.80	1.91	1.74

EVALUATING FORAGE CROPS FOR BEEF PRODUCTION[1/]

W. C. Templeton, Jr.[2/], C. F. Buck, N. W. Bradley, J. L. Menees[2/] and D. B. Laster

A 5-year grazing trial to study the effects of three pasture programs on steer gains and on time and amount of feed production was completed in 1966. The experiment was conducted on Maury and Donerail silt loam soils in Woodford county.

Each of the three programs consisted of 16 acres (2 replications of 8 acres each). Crops and fertilization treatments for each program were as follows:

Program No.	Crops and Acreage	Annual fertilization lb/A
1	Kentucky bluegrass and Ladino clover, 16A	0-60-60
2	Kentucky bluegrass and Ladino clover, 8A	0-60-60
	Balbo rye, 8A	100-0-0
	Sudangrass, 4A	200-60-60
	Korean lespedeza, 4A (1962-64)	0-60-60 (1962) 100-60-60 (1963-64)
	Hybrid sudangrass-sorghum, 4A (1965-66)	200-60-60

(Continued on next page)

[1/]A cooperative project of the Department of Agronomy and Department of Animal Sciences.

[2/]Department of Agronomy.

3	Kentucky bluegrass and Alfalfa, 8A	0-120-120 B
	Balbo rye, 8A	100-0-0
	Sudangrass, 4A	200-60-60
	Korean lespedeza, 4A (1962-64)	0-60-60 100-60-60 (1963-64)
	Hybrid sudangrass-sorghum, 4A (1965-66)	200-60-60

All pastures were limed in 1962 at the rate of 2 tons per acre. The heavy rates of nitrogen applied to some pastures resulted in marked reductions in pH, and variable rates of lime, depending on soil test, were applied in 1965.

The bluegrass-clover pastures were seeded with 1 1/2 to 2 lb Ladino clover per acre each spring. Bluegrass-alfalfa pastures were obtained by disking old bluegrass pastures and seeding 15 lb per acre of Narragansett alfalfa in the spring of 1962.

Lespedeza proved unsuccessful in this experiment, and its use was discontinued after 1964. Volunteer crabgrass was prevalent in the lespedeza areas in 1963 and 1964, and 100 lb of nitrogen per acre was applied. Most of the grazing during 1963-64 was furnished by crabgrass rather than lespedeza.

Sudangrass was seeded at the rate of 30 lb per acre in May or early June. After the completion of sudangrass and lespedeza grazing, Balbo rye was seeded in the stubble with a grassland drill at the rate of 3 bu per acre.

Good-to-choice Angus steer calves weighing 350 to 450 lb each were used to graze the pastures on a put-and-take, rotational basis. Shade, fresh water, salt, ground limestone and steamed-bone meal were provided in each pasture. No supplemental feed was fed. The steers were implanted with 12 mg diethylstilbestrol immediately prior to the pasture season.

Data on days of grazing per acre, average daily gains, and liveweight gains per acre are shown in the following table:

Year	Program 1	Program 2	Program 3
		Steer Days of Grazing per Acre	
1962[a]	314	374[c]	313[c]
1963	407	425	462
1964	210	264	310
1965[b]	199	364	496
1966[b]	286	380	488
Average	283	361	413
		Average Daily Gain per Steer, lb	
1962[a]	1.08	0.90	1.19
1963	1.10	1.08	1.12
1964	1.38	1.51	1.53
1965[b]	1.46	1.18	1.30
1966[b]	1.16	1.30	1.04
Average	1.24	1.19	1.24
		Liveweight Gains per Acre, lb	
1962[a]	380	411[c]	375[c]
1963	448	459	517
1964	288	399	474
1965[b]	291	430	645
1966[b]	332	496	510
Average	348	439	504

[a] Rye was not available for grazing in programs 2 and 3 in 1962 as the experiment was not initiated until spring of that year.

[b] In 1965 and 1966 hybrid sudangrass-sorghum was substituted for lespedeza in programs 2 and 3.

[c] Using 4-year-average value for rye.

The number of days of grazing per acre furnished by each of the crops and mixtures is shown as follows:

Year	Bluegrass and Clover	Bluegrass and Alfalfa	Rye	Lespedeza	Sudangrass	Hybrid Sudangrass-Sorghum
1962	314	191[a]		148	284	
1963	407	485	167	281[b]	254	
1964	210	326	181	82[b]	162	
1965	199	533	266		196	242
1966	286	490	218		205	302

[a] Alfalfa seeded in disked bluegrass sod in spring of 1962.

[b] Herbage in these pastures was mostly crabgrass. Nitrogen fertilizer was used at the rate of 100 lb N per acre.

Observations and Points of Interest

1. Balbo rye was ready for grazing 2 to 3 weeks prior to Kentucky bluegrass-Ladino clover. Rye changes from a leafy, vegetative stage to the stemmy, boot or head stage relatively fast, and failure to utilize the pasture in the leafy stage results in excessive wastage. Also, it appears that a low degree of utilization of the rye is very detrimental to establishment of lespedeza seedlings. In addition, animal performance on too-mature rye is, undoubtedly, inferior to what it would be on rye grazed earlier.

2. Sudangrass made excellent growth during 1962 and 1966 but in 1963, 1964, and 1965 it grew very slowly during the first month after seeding. The causes of poor growth (1963-65) are believed to have been root disease(s) which may have been associated with cool weather following planting and damage from thrips.

3. Korean lespedeza was moderately successful in 1962 when seeded on a prepared seedbed, although the pastures were very weedy during most of the grazing season. Seeding in rye resulted in stand failures in 1963 and 1964. Shading of the seedlings by rye and spring drought are thought to be the most likely reasons for lespedeza failure.

4. Bluegrass-Ladino clover pasture productivity varied directly with rainfall. This kind of pasture is relatively easy to manage and provides moderate amounts of high quality feed. Wastage is quite low if the pastures are adequately stocked. Maintenance of clover in the pastures is favored by heavy grazing during spring, frequent reseeding and adequate fertilization with lime, phosphorus, and potassium.

5. The bluegrass-alfalfa pastures were highly productive. When the spring growth of this mixture is grazed wastage is so high that it is doubtful whether the practice is a sound one. Harvesting of the first growth for hay or silage and rotational grazing of the succeeding growths if needed for pasture appears to be a good way to utilize this mixture. Alfalfa-weevil infestation was high in 1965 and again in 1966. Three sprayings were required in 1966 to give fair control.

6. The data on average daily gains indicate that all of the crops being studied provided satisfactory pasturage for growing beef steers. Also, crabgrass was eaten readily and was reasonably productive during the summer of 1963 when precipitation was favorable for its growth.

7. No steers were lost because of bloat on either the bluegrass-clover or bluegrass-alfalfa pastures. A few cases of mild bloat were observed on both mixtures.

8. The results of this experiment indicate that sudangrass may be a relatively expensive pasture compared with well-managed bluegrass-Ladino clover or bluegrass-alfalfa pastures. Program 2 produced approximately 90 lb more liveweight gain per acre than did program 1, but the additional gains cost approximately 30 cents per lb. Cost of additional gains resulting from the use of alfalfa instead of Ladino clover with bluegrass was approximately 16 cents per lb. Expenditures for additional land preparation, seed, seeding, fertilizers and alfalfa weevil-control were used in arriving at these comparisons.

PRE-ABOMASAL AND POST-ABOMASAL CELLULOSE DIGESTION IN STEERS

G. E. Mitchell, Jr., C. O. Little, M. R. Karr and B. W. Hayes

Cellulose digestion in cattle and other animals is attributed to the activity of micro-organisms in the gastro-intestinal tract. In cattle and other ruminants the greatest concentration of microorganisms is found in the rumen where most cellulose digestion presumably takes place. In roughage consuming non-ruminants such as horses and rabbits extensive microbial digestion of cellulose takes place in the cecum and colon. These sections of the gastro-intestinal tract of cattle are also heavily populated with micro-organisms. The present experiment was designed to study the relative significance of different segments of the gastro-intestinal tract in cellulose digestion in steers.

Procedure

Eight Angus steers weighing about 360 kg were paired and fitted with ruminal and either abomasal or ileal cannulas. Four pairs of steers and four alfalfa, corn, soybean meal rations balanced for protein, calcium, phosphorus and vitamin A and containing 32.2, 23.6, 13.3 and 7.0% cellulose were arranged in a Latin-square design. Thirty-day preliminary and 6-day collection periods were used for estimating cellulose digestion in each segment of the digestive tract by following changes in chromic oxide to cellulose ratios.

Results and Discussion

Results of the experiment are summarized in Table 1. As observed previously by many workers, increasing grain and reducing cellulose in the ration reduced both the amount and the percent of cellulose digested either in the rumen (oral to abomasum) or overall (oral to rectum). The greatest depression occurred when the cellulose content of the ration was reduced from 23 to 13%. Apparent overall cellulose digestion averaged 50.8%. Less than 4% of this apparently occurred posterior to the abomasum. Contrary to expectations apparent digestion coefficients were positive for the small intestine and negative posterior to the ileum. Pending further evidence, this is attributed to errors inherent in the indicator procedure. Under the conditions of this experiment, action anterior to the abomasum accounted for more than 90% of the observed cellulose digestion.

Table 1.--Daily Cellulose Digestion in Different Sections of the Digestive Tract of Steers

	Ration			
	1	2	3	4
Cellulose intake, %	32.2	23.6	13.3	7.0
Cellulose intake, gm	1754	1286	673	298
Cellulose Recovered, gm				
Abomasum	771	590	366	205
Posterior ileum	428	210	239	121
Rectum	702	569	370	176
Cellulose disappearance, gm				
Oral to:				
Abomasum	993	698	294	89
Posterior ileum	1326	1076	447	181
Rectum	1052	716	319	124
Digestion coefficient, %				
Oral to:				
Abomasum	56.6	54.0	44.5	30.3
Posterior ileum	75.6	83.7	65.2	60.0
Rectum	60.0	55.8	46.7	41.3

DIGESTION OF STARCH INFUSED INTO THE ABOMASUM OF STEERS

C. O. Little, G. E. Mitchell, Jr. and C. M. Reitnour

Because starch is a predominant energy source in grain rations, considerable interest has developed in research directed toward starch utilization. Until recently it was commonly assumed that dietary starch was (a) completely digested by rumen microbial action, (b) the end-products of this microbial digestion were volatile fatty acids, and (c) these ruminal products provided the energy supply of the animal.

Results of recent studies at this station indicate that these assumptions do not hold true with all feeding systems. With high-grain intakes considerable quantities of starch may pass from the rumen undigested, necessitating post-ruminal digestion if the energy is to be fully utilized. Therefore, it was the objective of this study to determine the digestibility of starch in the small and large intestines of steers.

Procedure

Four mature Angus steers with permanent abomasal and intestinal fistulas were used. The abomasal fistula was located in the pyloric region of the abomasum and the intestinal fistula in the posterior ileum just anterior to the ileo-cecal junction. A basal ration of 4 kg of ground alfalfa hay was fed in equal portions twice daily. Purified corn starch with 10 gm of chromic oxide was also administered into the abomasum in a warm water slurry twice daily. Levels of 200, 400 and 600 gm were administered in increasing and then in decreasing order during 7-day preliminary and a 7-day collection periods. Intestinal fluid

and fecal samples were collected at times to represent each 2-hour interval after both the morning and afternoon feedings and starch disappearance was estimated from changes in chromic oxide: starch ratios between the infusion mixture and the samples.

Results and Discussion

The quantities of starch recovered in the posterior ileum and feces are summarized in Table 1. With the higher levels of infusion, considerably more starch was recovered in the posterior ileum, indicating reduced digestibility of these higher levels. Recovery of starch in the feces was relatively low, but it was also increased with the higher levels of infusions. There was no apparent difference in post-ruminal digestion of starch between the increasing and decreasing orders of administering the different levels. Disappearance of starch seemed to follow a pattern similar to starch recovery — that is, as more was infused more disappeared. However, it appears that with higher levels of infusion a smaller portion of that quantity was digested. This is more evident when these values are expressed as % apparent starch digestion.

Table 1.--Digestibility of Starch Infused into the Abomasum of Steers

	Treatment Period					
	1	2	3	4	5	6
Infusion level, gm	200	400	600	600	400	200
Starch recovered, gm						
Posterior ileum	80	276	340	310	234	85
Feces	13	72	224	178	66	10
Starch disappearance, gm						
Small intestine	120	124	260	290	166	115
Large intestine	67	204	116	132	168	75
Apparent starch digestion, %						
Small intestine	60	31	43	48	42	58
Large intestine	84	74	34	43	72	88
Total (abom. to rectum)	94	82	63	70	83	95
Blood sugar, mg/100 ml						
0 hr	54	56	58	56	63	56
1 hr	55	55	54	56	66	60
2 hr	60	56	56	57	67	56
4 hr	47	59	56	56	64	52

Jugular blood samples were also taken at several times after the infusion of starch. Previous observations had indicated that abomasal administration of glucose was followed by marked increases in peripheral blood sugar levels. The blood sugar levels at 0, 1, 2 and 4 hours after starch infusion are also shown in Table 1. These values are very consistent, giving no indication of changes at the various times after infusion. Neither was there a definite pattern with the different levels of infusion.

Results of this study suggest that starch digestive processes in both the small and large intestines of these steers were inadequate to utilize fully the higher levels of starch post-ruminally. Previously reported results from this station have shown that the quantities of starch infused into the abomasum in this study can be expected to pass from the rumen

of steers on high-grain finishing rations. Therefore, post-ruminal digestion of starch must be considered as a factor for maximum energy utilization. The blood sugar levels did not reflect differences due to infusion levels or time after infusion, suggesting that starch was not rapidly hydrolyzed to glucose in the intestines of these steers.

DIGESTION OF PURIFIED CORN STARCH IN WETHERS

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

Other work at this station indicates that significant quantities of starch may be digested posterior to the rumen when high-grain rations are fed. This study was carried out to determine ruminal and post-ruminal digestion of purified corn starch in wethers when fed different levels. The effect on blood glucose was also observed.

Procedure

Four mature wethers with abomasal fistulas were used in a Latin-square design. The rations contained ground alfalfa hay with 0, 10, 20 and 30% purified corn starch. Protein was equalized with soybean protein and calcium, and phosphorus were equalized with bone-meal and limestone. The animals were fed 450 gm of the rations twice daily during 7-day preliminary and 6-day collection periods. Abomasal and fecal samples were collected twice daily to provide samples at each 2-hour interval after feeding. Hourly samples of jugular blood were taken on the last day of each collection period. Starch digestion was estimated from changes determined in using the chromic oxide:starch ratios between ration and samples.

Results and Discussion

Starch disappearance data and digestion coefficients are shown in Table 1. Both ruminal and post-ruminal disappearance of starch increased with increasing quantities of

Table 1.--Digestion of Purified Corn Starch Fed to Wethers

	Percent Corn Starch in Ration			
	0	10	20	30
Starch intake, gm	49.2	142.5	221.4	322.8
Starch disappearance, gm				
Rumen	39.7	125.6	182.6	281.9
Posterior to rumen	1.4	8.6	24.8	31.8
Starch digestion, %				
Rumen	80.70	85.69	82.48	87.32
Posterior to rumen	21.82[a]	50.54[b]	80.36[c]	73.72[c]
Oral to feces	83.55	93.30	96.86	97.18

Means on the same line with different superscripts are significantly different ($P < 0.05$).

starch in the ration. Although some starch escaped ruminal fermentation, no consistent trends were observed. Digestion of starch posterior to the rumen was significantly increased with higher levels reaching the abomasum. Overall digestion of starch tended to increase with increasing dietary level. Blood glucose concentrations are shown in Table 2. On all rations glucose levels increased up to 5 hours after feeding and declined afterward. No differences between rations were evident.

Table 2.--Blood Glucose Levels (mg/100 ml) in Wethers After Feeding Different Levels of Purified Corn Starch

Hours after Feeding	Percent Corn Starch in Ration			
	0	10	20	30
0	48.2	49.2	46.6	49.1
1	48.8	50.1	46.9	50.0
2	53.6	52.2	47.8	53.2
3	53.9	55.5	54.2	55.7
4	54.4	54.4	56.1	56.2
5	54.4	55.6	56.7	56.6
6	53.9	54.9	54.8	54.7
7	52.4	54.4	52.9	53.8
8	52.3	52.9	51.5	51.3
9	51.1	52.8	51.4	51.7
10	50.9	50.6	50.1	51.2
11	48.6	49.9	48.8	52.2

ACTION OF CATTLE, SHEEP AND SWINE AMYLASES ON VARIOUS STARCHES

J. J. Clary, G. E. Mitchell, Jr. and C. O. Little

Previous Kentucky experiments have shown that substantial amounts of starch pass out of the rumens of steers and wethers fed high-concentrate diets. Under these conditions pancreatic amylase would have an important role in the utilization of starch by ruminants. In the present studies the action of pancreatic amylases from cattle and sheep have been compared with the action of pancreatic amylase from swine.

Procedure

Crystalline alpha amylase prepared from swine pancreatic tissue was obtained commercially for comparison with acetone powder preparations from homogenized steer pancreas and the pancreatic secretions of wethers. The action of these enzyme preparations on solubilized corn, rice, wheat, potato and protozoal starches was compared by determining breakdown of starch-iodine complexes, maltose production and glucose production under standardized conditions. The amount of each enzyme preparation used was adjusted to equal activity against potato starch by the starch-iodine method.

Results and Discussion

The results obtained using the starch-iodine method are summarized in Table 1. The data have been converted to index values with the action against potato starch assigned 100. Using this method, each enzyme was most active against protozoal starch followed by potato starch, rice starch, wheat starch, and corn starch in that order. The swine enzyme was most effective in breaking down protozoal and corn starches, but sheep enzyme was most effective against wheat and rice starches. These data suggest interesting differences in the action of these enzymes on different starches. However, it must be remembered that the starch-iodine method measures only the initial steps in starch digestion and does not indicate how completely the starch is broken down.

Table 1.--Relative Action of Swine, Cattle and Sheep Alpha Amylases on Different Starches (Starch-Iodine Method)[a/]

	Kind of Starch				
Enzyme Source	Potato	Corn	Wheat	Rice	Protozoal
Swine	100	60	68	76	150
Cattle	100	48	63	71	124
Sheep	100	43	74	92	110

[a/] The action of each enzyme on potato starch was assigned a value of 100. Enzyme levels were adjusted to equal activity against potato starch.

Since maltose is the normal end-product of complete starch breakdown by amylase, its production may provide a more useful measure of overall amylase activity than the starch-iodine method. Results obtained using maltose production as the measure of activity are summarized in Table 2. This method provides a much different comparison of the enzymes and substrates. Maltose production was most rapid from potato starch for all enzymes followed by corn starch, protozoal starch (except for cattle amylase), rice starch and wheat starch. Sheep amylase resulted in more rapid maltose production in most cases with the relative activity of cattle and swine amylases varying with the kind of starch. Although most of the observed differences were statistically significant, the magnitude of differences was much smaller than when the starch-iodine method was used, and the differences in maltose production from corn starch, representing our most common feed grain, were not large. The differences in results using the starch-iodine and maltose methods suggest that ruminant amylases are more effective in breaking down starch fragments but are less effective in attacking intact starch molecules than swine amylases.

Table 2.--Relative Action of Swine, Cattle and Sheep Alpha Amylases on Different Starches (Maltose Method)[a/]

	Kind of Starch				
Enzyme Source	Potato	Corn	Wheat	Rice	Protozoal
Swine	100	90	71	80	82
Cattle	106	86	73	84	78
Sheep	114	89	78	85	89

[a/] The action of porcine enzyme on potato starch was assigned a value of 100. Enzyme levels were adjusted to equal activity against potato starch by the starch-iodine method.

Only trace amounts of glucose were detected, and no trends between enzymes or starches were noted. Results of Michaelis constant and activation energy determinations did not indicate that these kinetic parameters accounted for the differences in action of these enzymes on the starches studied.

DIGESTION OF STARCH IN WETHERS AS INFLUENCED BY DIETARY LEVEL OF GRAIN

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

Various levels of grain are commonly fed in finishing rations for sheep. The utilization of these rations depends on the digestion, absorption and metabolism of the nutrients contained. Starch is the primary energy source in high-grain rations; thus its digestion is essential for efficient utilization of such rations. This study was conducted to determine the digestibility of starch in wethers fed different dietary levels of grains. Estimations were made on both ruminal and post-ruminal digestion.

Procedure

Experiment I.—Four wethers fitted with abomasal cannulas were fed rations containing alfalfa hay, corn, soybean meal, 3% animal fat, 0.5% chromic oxide indicator, vitamins, and minerals, formulated to meet NRC requirements. In a Latin-square design, rations containing 20, 40, 60, 80% corn were fed. The four rations were formulated to be equal in crude protein (12%) by varying the levels of alfalfa hay and soybean meal. The rations were fed at 12-hour intervals at a level of 908 gm per day. Following a 14-day preliminary period, samples of abomasal fluid and feces were collected at 12-hour intervals for 6 days to represent each 2-hour interval after feeding. From a composite sample approximating the composition of abomasal fluid and feces throughout the period, starch digestion was estimated from changes in chromic oxide:starch ratios between the ration and samples.

Experiment II.—In this experiment, the same rations were fed in first increasing levels of grain followed by decreasing levels during 14-day preliminary and 2-day collection periods. Abomasal fluid and feces collections were made at 4-hour intervals.

Results and Discussion

The results of Experiment I are summarized in Table 1. Larger quantities of starch appeared to be passing out of the rumen with the higher grain rations; however the quantities disappearing also increased. Percent ruminal starch digestion was not significantly affected by level of intake. The starch reaching the abomasum was apparently well digested post-ruminally.

The results of Experiment II are summarized in Table 2. As in the first experiment, with higher levels of dietary grain, more starch was recovered in the abomasum and more disappeared post-ruminally. There was a significant difference in the ascending and descending sequence of rations. Since the greatest difference in this comparison was with the 80% corn level, this may have been due to increased adaptation to the highest starch level. The total digestion in this experiment exceeded 98% with all rations, indicating that the overall capacity of the wethers to digest starch was highly efficient at the levels fed.

Table 1.--Ruminal and Post-Ruminal Digestion of Starch with Different Dietary Levels of Corn

	Percent Corn in Ration			
	20	40	60	80
Starch intake, gm	172	326	460	576
Starch recovered, gm				
Abomasum	38.1	105.2	126.0	121.0
Feces	24.1	26.0	23.9	20.1
Starch disappearance, gm				
Rumen	133.9	220.8	334.0	455.0
Posterior to rumen	14.0	79.2	102.1	100.9
Starch digestion, %				
Ruminal	77.8	67.7	72.6	78.9
Post-ruminal	36.7	75.3	81.0	83.0
Total (oral to feces)	86.0	92.1	94.8	96.5

Table 2.--Starch Digestion with Increasing and Decreasing Dietary Levels of Corn

	Percent Corn in Ration							
	20	40	60	80	80	60	40	20
Starch intake, gm	172	326	460	576	576	460	326	172
Starch recovery, gm								
Abomasum	43.5	102.7	134.1	198.1	109.4	157.7	80.0	25.2
Feces	2.7	2.9	2.8	1.2	10.3	5.5	8.1	1.7
Starch disappearance, gm								
Rumen	128.5	223.3	325.0	377.9	466.6	302.3	245.2	146.8
Posterior to rumen	40.8	99.8	131.3	196.9	99.1	152.2	72.7	23.5
Starch digestion, %								
Ruminal	74.7	68.5	70.85	65.6	81.0	65.7	75.2	85.3
Post-ruminal	93.8	97.2	97.9	98.9	90.6	96.5	89.9	93.2
Total (oral to feces)	98.4	99.1	99.4	99.8	98.2	98.8	97.5	99.0

PANCREATIC AMYLASE SECRETION BY SHEEP FED DIFFERENT LEVELS OF GRAIN

J. J. Clary, G. E. Mitchell, Jr. and C. O. Little

Experiments with fistulated steers and wethers have shown that large amounts of starch escape digestion when high levels of grain are included in the diet. A primary mechanism for the digestion of this starch is the action of amylase secreted by the pancreas into the small intestine. Ruminants normally have much less amylase in the pancreatic secretions than do monogastric animals, but previous analyses of steer pancreas indicate that amylase activity is greater for grain-fed steers than for steers on pasture. Rats are known to rapidly adjust

amylase production to the level of starch in the diet. The purpose of this experiment was to investigate the effect of diet on pancreatic secretion and amylase activity in sheep.

Procedure

Thirteen yearling wethers were fitted with re-entrant polyethylene cannulas designed to allow collection of pancreatic secretions. Six wethers were fitted with cannulas designed to collect only pancreatic juice. This involved installing a by-pass in the common bile duct from a point dorsal to the pancreatic duct to the small intestine. The by-passed section of the common bile duct was then ligated at one end and fitted at the other end with polyethylene tubing leading outside the animal and returning to the small intestine, permitting collection of pancreatic secretions. Seven wethers were fitted with polyethylene tubing leading from the common bile duct at a point ventral to the pancreatic duct to the outside of the animal and back to the small intestine, permitting collection of mixed bile and pancreatic secretions. Most cannulas remained functional from 1 to 3 weeks. One remained functional for 7 months. Volume and amylase activity measurements were made by total collection in 15- or 20-minute segments for 24-hour periods. Daily samples were also checked for specific amylase activity. The rations studied were alfalfa hay and ground mixed rations containing 20, 40, 60 and 80% corn. These rations were fed in sequence with ration changes at 4- or 7-day intervals in different experiments.

Results and Discussion

Volume of pancreatic juice collected ranged from 71 to 340 ml in 24 hours. Volume of combined bile and pancreatic juice ranged from 558 to 1,480 ml. Volume of fluids collected, protein concentration in the fluid, and amylase activity of the protein varied widely between animals and collection times. Observations of the influence of dietary change on amylase activity of the protein were limited by the short period of usefulness of most of the cannulas. In individual animals, amylase activity of secreted protein increased with increasing corn in the ration and decreased with decreasing corn in the ration. The time required for complete adaptation was not accurately determined, but it seemed to be longer than other workers have reported for rats.

RESPONSE OF IN VITRO STARCH DIGESTION BY RUMEN MICROORGANISMS TO DIFFERENT LEVELS AND SOURCES OF SULFUR

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

Although starch is a major component of most high-energy rations fed to cattle and sheep, information concerning factors affecting its utilization in the rumen is limited. The development of an in vitro technique suitable for rapid preliminary study of these factors has been previously reported and results of its application to the evaluation of nitrogen sources were presented in "Animal Science Research Reports—1966" (Ky. Agr. Exp. Sta. Prog. Rept. 164). Little previous attention has been given to the mineral requirements of this system. Since many previous workers have shown sulfur to be of major importance in promoting in vitro cellulose digestion, the present experiments were designed to study the influence of sources and levels of added sulfur on in vitro starch digestion by rumen microorganisms.

Procedure

The in vitro procedure employed washed cell suspensions of rumen microorganisms from a 450-kg steer fed 4.05 kg ground shelled corn and 0.45 kg wheat straw daily with salt and water available ad libitum. Redistilled deionized water was used in the in vitro system. Two basal mineral mixtures were employed. The complex mineral mixture was based on McDougall's analysis of saliva with trace minerals supplied as chloride salts to eliminate sulfur. In the simplified mixture trace minerals were eliminated and sodium salts were substituted for potassium salts. Methylene blue was added so that reduction of the medium could be readily observed. Corn starch was added to the media at a level of 10 gm. per liter. Its digestion was used to differentiate between treatments.

Results and Discussion

When either organic (cysteine or methionine) or inorganic (sodium sulfate, sodium sulfite, calcium sulfate, ammonium sulfate and magnesium sulfate) were added to sulfur-free medium, dramatic increases in starch digestion were observed. The optimum levels of added sulfur appeared to be between 1 and 2.5 mcg per ml in simplified medium and between 3 and 5 mcg per ml in complex medium. No major differences in the availability of different sources were established. Although some evidence of mild toxicity was obtained, added sulfur levels 1,000 times the indicated optimums were not consistently toxic.

Sulfur appears to be an important mineral requirement for the digestion of starch by rumen microorganisms, but the indicated requirement is much lower than has been reported for cellulose digestion. The margin between required levels and toxic levels is substantial.

VOLATILE FATTY ACID UTILIZATION STUDIES WITH RATS

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

Volatile fatty acids produced in the rumen during microbial fermentation of feeds are important energy sources for the nutrition of ruminants. Quantitative studies of the utilization of these energy compounds is complicated in the functioning rumen with continuous production and absorption. The possible use of monogastric laboratory animals in studying the metabolism of volatile fatty acids was pursued in this experiment.

Procedure

Acetic, propionic and butyric acids in the form of their triglycerides were substituted for starch and glucose to provide 24% of the gross energy of the ration for weanling rats. All rations were of equal glycerol content. Digestible and metabolizable energy were determined from a 5-day collection of feces and urine with 6 rats per treatment. Growth and energy balance data were obtained from 9 rats per treatment fed 20 days at one kcal gross energy per gm metabolic body weight per day.

Results and Discussion

The results are summarized in Table 1. The level of propionate in this ration appeared to interfere with normal metabolic function to the extent that it had to be dropped from the experiment. The energy of the short chain fatty acids was digested and metabolized

as well as the energy of starch and glucose for which it was substituted. Lower efficiency of weight gain of rats on the acetate ration can be attributed to lower caloric intake and slightly fatter carcasses. Lower gain and efficiency of weight gain of rats on the butyrate ration can be accounted for by fatter carcasses. Net energy values indicated no differences in the utilization of acetate and butyrate substituted for starch and glucose for maintenance and carcass energy gain. The fatter carcasses of the rats on the butyrate ration indicates a trend toward lipogenises.

Table 1.--Utilization of Short Chain Fatty Acids by Rats

	Control	Acetate	Butyrate
Gross energy, kcal/gm	4.10	4.47	4.70
Digestible energy, %	94.8	95.5	94.8
Metabolizable energy, %	92.7	93.7	93.1
20-day intake			
Ration, gm	122.3	107.2	106.5
Metabolizable energy, kcal	466.8	449.7	466.3
Growth results			
Gain, gm	50.4	44.6	40.6*
Kcal metabolizable energy/gm gain	9.4	11.3*	11.8*
Energy utilization			
Gain, kcal	92.2	84.6	93.5
Maintenance, kcal[a/]	238.4	231.8	238.7
Net energy, kcal	330.6	316.4	332.2
Net energy, % of metabolizable	71.5	71.4	72.0
Carcass composition			
Energy, kcal/gm	5.74	5.78	5.97
Protein, %	52.8	50.5	50.7
Lipid, %	29.2	31.3	37.9

* ($P < .05$)

[a/] Calculated as basal metabolism plus 25%.

PLASMA AND URINE CHANGES IN VITAMIN A-DEFICIENT SHEEP

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

Previous Kentucky experiments have demonstrated marked polyuria and apparent preferential uptake of vitamin A by adrenal glands of vitamin A-deficient sheep. The experiments reported here were designed to obtain additional information concerning renal responses to vitamin A deficiency in sheep.

Procedure

Four mature wethers with chronic vitamin A deficiency and four controls (average weight 48 kg) were used in replicated experiments. In each experiment feed and water were withheld three days. Plasma vitamin A averaged 15.4 mcg per 100 ml for the deficient wethers and 47.8 mcg per 100 ml for the controls ($P < .01$).

Prior to each experiment each wether was fed 908 gm daily of a ration containing ground corn cobs, 60%; ground milo, 12%; glucose, 8%; soybean meal, 20% and minerals 17.7 gm per kg. In addition, controls received 1100 I U of vitamin A per kg of ration.

Total urine collections were made in stanchion-type metabolism crates every 12 hours for the 3-day period, and samples were frozen for later analysis. Plasma samples were obtained at the beginning and at the end of each experiment and frozen.

Results and Discussion

Analyses of several key constituents of the plasma and urine of the vitamin A-deficient wethers revealed varied degrees of difference when compared with control wethers. As shown in Table 1, plasma sodium did not change significantly from the first day to the third day in either deficient or control wethers. Initial plasma sodium levels were similar, but control wethers had significantly higher plasma sodium on the third day. Urine output of sodium decreased significantly in both vitamin A-deficient and control wethers from the beginning to the end of the experiments. The vitamin A-deficient animals were excreting significantly less sodium on the first day, but the difference was not significant after removing feed and water for 3 days. This decreased sodium excretion by the deficient wethers suggests increased salt retention.

Table 1.--Constituents of Plasma From Vitamin A-Deficient and Control Wethers

	Day	Deficient	Control
Sodium (meq/1)	1	150	153
	3	152*	157
Potassium (meq/1)	1	5.74	5.58
	3	5.95	5.75
Chloride (mg/100 ml)	1	434.84	443.91
	3	417.96*	437.49
Inorganic phosphate (mg/100 ml)	1	6.68	5.76
	3	7.97	6.97
Urea (mg/100 ml)	1	19.20*	14.95
	3	25.96**	18.68
Creatinine (mg/100 ml)	1	1.10	1.01
	3	1.23*	1.21

*Significantly different from controls, $P < 0.05$
**Significantly different from controls, $P < 0.01$

The plasma chloride of vitamin A-deficient wethers declined significantly from the first to the third day. Control wethers were excreting significantly more chloride in the urine on the first day but not on the third day. The amount excreted by the control wethers was approximately 1 gm per day greater than that excreted by deficient wethers. The decline in excretion from the first to the third day was significant for both groups. The decreased excretion of chloride by the deficient wethers also suggests increased salt retention.

Differences in plasma potassium levels (Table 1) between deficient and control sheep were not significant. Likewise, potassium excretion was not significantly affected. Potassium excretion for all animals decreased significantly from the beginning to the end of the experiment.

Vitamin A-deficient wethers had plasma inorganic phosphate levels higher than did control wethers throughout the experiment, but the differences were not significant. A marked elevation in the excretion of inorganic phosphate in the urine of vitamin A-deficient wethers was observed throughout the trial. The increased inorganic phosphate excretion by the vitamin A-deficient wethers may indicate some alteration in bone metabolism which resulted in the release of phosphate.

Table 1 shows that the vitamin A-deficient sheep had more urea in their plasma, both on the first day and on the third day. Significant increases in concentrations of plasma urea were observed by the third day in both groups. The excretion of urea in the urine by the deficient group was also higher throughout the experiments, but the differences were not significant. The elevated plasma urea and the tendency to excrete more urea might be interpreted as indications of increased protein catabolism in these fasting vitamin A-deficient wethers.

Concentrations of plasma creatinine were higher for the vitamin A-deficient wethers throughout the trial and were significantly higher at the end. Again, an increase in plasma concentration from the first day to the third is seen in both the deficient and the control wethers. Observed differences in urinary creatinine excretion were not significant.

These data suggest relationships between vitamin A-deficiency and adrenal metabolism which seem worthy of further experimental evaluation. Further investigation of observed alterations in GFR and histological changes should also be of value.

Table 2.--Constituents of Urine of Vitamin A-Deficient and Control Wethers

Constituent	Day	Amount Excreted	
		Deficient	Control
Sodium, gm/day	1	.950*	1.751
	3	.328	.422
Potassium, gm/day	1	4.364	4.014
	3	1.256	1.566
Chloride, gm/day	1	2.655**	3.664
	3	.858	.973
Inorganic phosphate, gm/day	1	407.76*	70.15
	3	112.05	31.46
Urea, gm/day	1	8.366	7.430
	3	6.859	6.785
Creatinine, gm/day	1	1.105	1.154
	3	1.019	1.150

*Significantly different from controls, $P < .05$
**Significantly different from controls, $P < .01$

EFFECT OF REDUCING SOYBEAN PROTEIN SOLUBILITY BY DRY HEAT ON THE PROTEIN UTILIZATION OF YOUNG LAMBS

H. A. Glimp, M. R. Karr, P. G. Woolfolk and L. W. Hudson

The influence of processing methods on protein utilization in older lambs has been studied extensively. Since the protein requirement of lambs weighing less than 50 lb is not known, these studies were initiated to determine the effects of protein level and reducing soybean protein solubility on rate and efficiency of gain and nutrient utilization in early weaned lambs.

Composition of the rations used in both the growth and metabolism studies is shown in Table 1. The soybean meal was a commercially prepared, solvent-extracted meal. One-half of the soybean meal was layered 1 inch deep in aluminum trays and heated at 149°C for 4 hours in a forced-air oven. Nitrogen solubilities were 72% for the unheated soybean meal, 35% after heating and then grinding through a 60-mesh screen in a Wiley mill, and 29% after heating and without grinding. Neomycin was added to one-half of the diets at a level of 70 mg per lb of diet.

Table 1.--Composition of Rations

Percent Crude Protein	12.1	17.2
Ingredient		
Straw, ground wheat	10	10
Alfalfa hay, ground	10	10
Corn, ground shelled	60	48
Soybean meal, 44% C.P.	10	22
Molasses	8	8
Bone meal, steamed	1	1
Salt, trace mineralized	1	1

Growth Trial

The first trial was a growth study involving 24 Hampshire-sired and 24 Southdown-sired crossbred twin ewe lambs. The lambs were weaned at 35-45 lb body weight (42-56 days old) and randomly assigned within breed to the previously mentioned treatments. The lambs were self-fed in pens of three each, with one replicate from each sire breed group. Bi-weekly weights and feed consumption data were obtained until the lambs reached a body weight of 85-90 lb. Rumen fluid samples were collected approximately 3 hours after the morning feeding after 35 days on the trial and were prepared for volatile fatty acids analysis. The data were analyzed statistically by analysis of variance.

Results of the growth trial are shown in Table 2. Since neither neomycin nor any of its interactions significantly affected lamb performance, they were removed as factors in analysis of the data. The three-factor interaction of protein level x heating soybean meal x breed of sire was significant for rate of gain ($P < 0.05$). Lambs sired by Southdown rams gained faster when the soybean meal was heated at the 12% protein level. Heating the soybean

meal increased performance on the 12% protein level but made little difference at the 17% protein level. This interaction was also significant ($P < 0.01$). The interaction between protein level and heat treatment was approaching significance ($P < 0.08$) for feed efficiency.

Table 2.--Lamb Performance

Trait	Av Daily Gain (lb)	Lb Feed/ Lb Gain
12.1% C.P., Unheated		
Hampshire	0.67	5.15
Southdown	0.53	5.48
12.1% C.P., Heated		
Hampshire	0.74	4.89
Southdown	0.74	5.33
17.2% C.P., Unheated		
Hampshire	0.74	5.27
Southdown	0.73	5.53
17.2% C.P., Heated		
Hampshire	0.68	4.59
Southdown	0.74	5.15

The effects of protein level and heating soybean meal on molar % of iso-valeric and valeric acids in the rumen after the lambs had been on the trial 35 days are shown in Table 3. Heating the soybean meal reduced levels of iso-valeric and valeric acids in the rumen at 3 hours after feeding. Since reduction of the levels of these two acids should indicate decreased protein degradation these data clearly support the suggestion that reducing soybean protein solubility by heat decreases the rate of intraruminal protein degradation. Although the data are not shown in this table, molar % acetate and butyrate were higher and propionate lower in lambs fed the 17% protein ration.

Table 3.--Molar Percentages of Volatile Fatty Acids in the Rumen at 35 Days

Volatile Fatty Acid	i-Valeric	Valeric
12.1% C.P.		
Unheated	0.36	1.52
Heated	0.15	1.00
17.2% C.P.		
Unheated	1.19	1.81
Heated	0.14	0.73

Digestion Trial

For the digestibility and nitrogen retention trial, 24 Hampshire-sired crossbred lambs, weighing approximately 45 lb each, were randomly assigned in pens of three each to the eight rations previously described. The lambs were fed approximately 0.86 lb each

twice daily for a 3-week preliminary period. The two most uniform lambs from each lot were then placed in metabolism stalls and fed 0.70 lb each twice daily for 7-day preliminary and 7-day collection periods.

The results of this trial are shown in Table 4. Retention of nitrogen was increased by heating the soybean meal. The increased nitrogen retention in this trial was due to the response at the low protein level, as shown by the significant interaction ($P < 0.01$) between protein level and heat treatment. Retention of nitrogen was not increased by heating the soybean meal at the 17% protein level, but was highest when the meal was heated at the 12% level. This suggests that a controlled rate of proteolysis in the rumen is more critical at lower protein intakes. The data also show an increase in cellulose digestibility because of heating the soybean meal. A slower rate of protein degradation may result in more nitrogen being available to the rumen microbial population when cellulose degradation occurs, which should be maximum from 6 to 8 hours after feeding.

Table 4.--Effect of Protein Level and Heating Soybean Protein on Digestibility of Ration Components and Nitrogen Retention in Young Lambs

Treatment	No. Lambs	Dry Matter Digest	Gross Energy Digest	Cellulose Digest	Nitrogen Digest	Nitrogen Retention	Percent Digestible N Retained
		%	%	%	%	gm	%
RSBM[b]	8	78.72	78.41	54.80[e]	74.38	2.50[d]	22.53[d]
HSBM[c]	8	79.66	79.25	58.60	74.74	3.44	31.87
12%	8	79.40	79.00	57.70	71.93[e]	2.38[d]	27.38
17%	8	79.00	78.65	55.70	77.19	3.57	27.02
RSBM X 12%	4	78.96	78.69	55.79	72.64	1.46[d]	16.96[d]
HSBM X 12%	4	79.83	79.34	59.60	71.22	3.29	37.78
RSBM X 17%	4	78.49	78.14	53.81	76.11	3.54	28.08
HSBM X 17%	4	79.75	79.16	57.59	78.27	3.59	26.00

[b] Regular soybean meal

[c] Heated soybean meal

[d] $P < .01$

[e] $P < .05$

EFFECT OF PROTEIN LEVEL AND SOLUBILITY ON YOUNG LAMB PERFORMANCE

L. W. Hudson, H. A. Glimp, P. G. Woolfolk and C. O. Little

Growth and digestion trials were conducted to study the effects of protein level and solubility on lamb performance, nutrient digestibility and nitrogen retention. Crude protein levels of 10, 12, and 14% were used. Solvent-extracted soybean meal (SBM) was heated for 4 hours at 149°C in a forced-air oven to reduce solubility from 72 to 35%. Fifty-four cross-bred lambs weaned at approximately 35 lb were blocked according to date of weaning and

randomly allotted to the previously mentioned treatments for the growth trial. The lambs were self-fed in pens of three with three replications per treatment. Biweekly weights and feed consumption were collected until the lambs weighed 85-90 lb. After being on feed for 56 days, the lambs were held off feed and water and then allowed to eat and drink. Rumen samples (taken with a stomach tube) and venous plasma samples were taken 3 and 6 hours, respectively, after feeding.

The results of the growth trial are shown in Table 1. There were significant ($P < 0.05$) increases in average daily gain with each increased increment of crude protein. Gains were improved but not significantly by heating the SBM. Feed efficiency also showed a significant ($P < 0.05$) level difference, with the 12 and 14% levels being significantly more efficient than the 10% level. Heating the SBM decreased significantly ($P < 0.05$) the feed required per lb gain at all levels of protein.

Table 1.--Lamb Performance

Percent Crude Protein	10	12	14
Average Daily Gain, lb			
Unheated SBM	0.40	0.51	0.53
Heated SBM	0.44	0.48	0.57
Feed Efficiency, lb feed/lb gain			
Unheated SBM	6.69	5.75	5.69
Heated SBM	5.92	5.70	5.20

Rumen ammonia concentrations at 56 days are shown in Table 2. The concentrations increased significantly ($P < 0.01$) as the protein levels increased, indicating a larger amount of protein degradation in the rumen. The heated SBM had significantly ($P < 0.05$) lower ammonia levels than did the unheated SBM, which agrees with the observation that a less soluble protein is not readily attacked by rumen bacteria. Venous urea-nitrogen increased significantly ($P < 0.01$) as the amount of protein in the diet increased. The heat treatment had no effect on urea-nitrogen concentrations.

Table 2.--Effect of Level and Solubility on Rumen Ammonia and Venous Urea

Percent Crude Protein	10	12	14
Rumen Ammonia, mg/100 ml			
Unheated SBM	4.2	10.1	17.3
Heated SBM	4.1	7.9	11.4
Venous Urea-N, mg/100 ml			
Unheated SBM	9.0	10.8	16.7
Heated SBM	8.8	11.7	16.4

For the digestion trial, 24 crossbred lambs weighing approximately 50 lb were allotted to the previously mentioned treatments. The lambs were housed in metabolism crates and fed 300 gm of the same rations used in the growth trial twice daily for a 7-day preliminary and 7-day collection period. The digestion trial is summarized in Table 3. Protein digestibility for the 12 and 14% protein levels was significantly ($P < 0.01$) higher than for the 10% level. There was no effect due to heating the SBM. Nitrogen retention followed the same pattern as protein digestibility. There was also a significant ($P < 0.01$) increase in cellulose digestibility from the 10% level to the 12 and 14% levels. The heated SBM did improve cellulose digestibility some but not enough to be significant.

Table 3.--Summary of Digestion Trial

Percent Crude Protein	10	12	14
Protein Digestibility			
Unheated SBM	70.3	79.6	80.0
Heated SBM	71.0	77.0	79.7
Cellulose Digestibility			
Unheated SBM	62.0	64.6	68.0
Heated SBM	62.0	72.2	68.6

A TECHNIQUE EMPLOYING THE DOPPLER SHIFT FOR MEASURING PORTAL BLOOD FLOW AND PORTAL-CAROTID DIFFERENCES FOR ABSORPTION FROM THE GASTROINTESTINAL TRACT

S. B. Carr and D. R. Jacobson

Quantitative measurements of the absorption of different metabolites in the ruminant are complicated by the physiology of the forestomachs. The microbial population inhabiting the forestomachs and, to a lesser degree, the caecum alter the ingested diet, and many of the nutrients available to the host ruminant are the end-products of the microbial metabolism. One technique employed to estimate the magnitude of digestion and absorption of metabolites in ruminants has been the measurement of venous-arterial differences in conjunction with estimates of blood flow passing the sites of absorption. The objective of this study was to develop a suitable technique for obtaining portal blood flow and portal-carotid blood concentration differences for reliable absorption estimates from a small number of animals.

Procedure

Nine male Holstein calves ranging from 3 to 22 weeks of age and weighing from 45 to 120 kg body weight were employed in this study. The calves were fed a whole milk diet at rate of 5% of their respective body weights, at approximately 12-hour intervals. Blood flow measurements were obtained by surgically implanting transducers around the portal vein and telemetering blood flow information from the animals. Telemetry of the portal flow information permitted repeated observations on unrestrained and unattended animals.

The Doppler Ultrasonic Blood Flow System employs the principle of the Doppler shift for measuring the velocity of flow in a vessel. By converting the frequency shift to velocity and combining this with an estimate of the cross-sectional area of the portal vein, blood flow rates were obtained from unattended animals in a relatively normal environment. Concentration differences in portal and carotid blood were obtained for total reducing sugars, glucose, beta-hydroxybutynic acid (BHBA), and volatile fatty acids (VFA). The absorption estimates for these metabolites were made by multiplying the portal-carotid differences by the blood flow rate.

Results and Discussion

The velocity of flow was significantly increased by 9.7% from zero to 1 hour post-prandial. The relative velocity indexes at seven time intervals of the day ranged from 111 to 93. There was a significant druinal variation present. Variation was observed in the relative velocity of blood flow when the animals were changing position or when actively moving about. Statistical comparisons of the relative velocity before and after changing positions, i.e., standing or lying, ruminating, or exhibiting active movement from a passive state were not significantly different. These changes in relative velocity were, therefore, only transitory and of little consequence to mean flow. The mean portal blood flow was 40.9 ml $min^{-1}kg^{-1}$ (range 34.1 to 48.6) in seven calves.

Concentration differences in glucose and total sugars between portal and carotid blood were determined at hourly intervals in two calves. The net absorption of total sugars as glucose calculated over a 12-hour interval accounted for 60% of the lactose intake in the two animals. In the same manner, glucose accounted for 41% of the lactose intake. The difference between the net absorption of total sugars and glucose indicated that galactose or lactose was absorbed per se. The data also indicate that from 20 to 40% of the sugar fed was not accounted for as absorbed sugars which suggests utilization in the gut wall.

The consistent portal concentrations of VFA and BHBA with time and portal-carotid differences with time indicated that these metabolites arise from endogenous sources on a diet of milk. The concentrations of BHBA in the 1:10 filtrates in both portal and carotid blood were small and approached the limits at which the method would detect these concentrations with accuracy.

The application of the Doppler shift principle to measure blood flow in combination with telemetry has merit for determining quantitative absorption measurements on animals in a normal environment. These results indicate that this method of obtaining blood flow information in the ruminant under normal conditions is quite possible. The application of the Doppler shift principle for blood flow measurements with concentration estimates of arterial and venous blood metabolites is adaptable to repeated determinations on a small number of animals for absorption estimates and for determining the contribution of different metabolites to the overall nutrition of the ruminant.

HOW RATE OF STOCKING AND RATE OF GRAIN FEEDING AFFECTED GRAZING RESULTS ON TWO KINDS OF PASTURE

D. M. Seath, W. C. Templeton, Jr., L. M. Caldwell and T. Cooper

Results for 2 years, 1965 and 1966, of a dairy pasture experiment conducted at the U.K. Western Kentucky Substation, at Princeton, have been summarized. The trial involved comparisons between 2 rates of stocking (1 vs. 1½ milk cows per acre) and two levels of grain feeding (1 lb grain to 3 lb milk vs. 1 to 6 ratio) on both nitrated orchardgrass and ladino clover-orchardgrass pastures. Weekly rotation of cows was used on 4 replicates involving 16 plots over a period of 12 weeks in 1965 and 15 weeks in 1966.

Yields of TDN per acre as calculated from milk yields plus contributions toward body maintenance and gains in weight showed 2,269 lb per acre for heavy stocking, an increase of 25% over low stocking. The low stocking, however, resulted in cows averaging 94% in 4-week persistency of milk production as compared with 91% for high stocking. Economic returns over feed cost favored heavy stocking.

The high level of grain feeding enabled cows to average 93.6% in persistency of milk production, just 2 percentage points above that resulting from low grain feeding. This was not enough more to justify feeding at the higher rate. Cows on the orchardgrass alone averaged 92.6% in persistency, almost identical to the 92.5% for cows on the ladino-orchardgrass mixture.

The average botanical composition of herbage, based on two samplings each year, for the orchardgrass pasture was 91.4% grass, 0.7% ladino clover and 8.4% weeds. For the ladino-orchardgrass the average was 65.6% grass, 23.8% ladino clover, and 9.3% weeds. Very little variation in composition or in persistency of milk production was found between years.

VOLUNTARY FEED INTAKE, MILK PRODUCTION, RUMEN CONTENT AND PLASMA FREE AMINO ACID LEVELS OF LACTATING COWS ON LOW SULFUR AND SULFUR SUPPLEMENTED DIETS

D. R. Jacobson and J. W. Barnett

Sulfur nutrition of the lactating dairy cow has, in general, yet to be investigated. The assumption that practical rations fed to lactating cows today will meet their sulfur requirement has gone uncontested. There is no published sulfur requirement for lactating cows. Since the high-producing dairy cow secretes large amounts of sulfur into her milk in relation to the sulfur ingested, the possibility of a naturally occuring deficiency exists. By lowering the amount of dietary sulfur, the relationship between low dietary sulfur and blood and rumen sulfur amino acids with voluntary dry matter intake and milk production was studied.

Procedure

Twenty-four mature, lactating Holstein cows were balanced according to milk production and body weight and assigned equally to 2 experimental groups for 9 weeks. The

unsupplemented group received a concentrate mix low in sulfur (0.10% on a dry matter basis). The sulfur-supplemented group received the same concentrate mixture, except that 0.9% wheat standard middlings was replaced by $Na_2S0_4.10H_20$. The concentrate mixture was formulated to meet adequately the protein, energy, and mineral requirements of lactating cows. Corn silage was fed to both groups, and the total diet was fed ad lib. Silage and concentrate mixture were mixed before feeding in a constant ratio of 6.3 to 1.0. The total diet was fed once a day (11 am) with a check made at 5 am to determine if additional increments of diet might be consumed. The net intake from the previous feeding determined the amount fed at the next feeding. Approximately 10% over consumption was fed. Jugular blood and stomach tube rumen samples were taken at 3-5 hours after feeding at the beginning and at the end of the experiment. The experiment was terminated at 63 days because of a limited supply of low-sulfur corn silage.

Analyses were conducted on the total sulfur in feed, rumen fluid and blood; the amino acids in hydrolyzed feed and rumen fluid and deproteinized plasma; total nitrogen in rumen fluid; and on the volatile fatty acids in rumen fluid.

Results and Discussion

Voluntary dry matter intake was significantly higher ($P< 0.05$) by the ninth week of the trial for the sulfur-supplemented group. Fluctuations which occurred in intake were due, at least partially, to the necessity of feeding corn silage from three different silos. Statistical analysis showed that the sulfur-supplemented group had a significantly higher ($P< 0.05$) intake for the experiment than did the low-sulfur group. From weeks 5 to 9, the increase in dry matter intake was greater for the sulfur-supplemented group ($P< 0.05$).

No significant difference in milk production existed between the groups the preliminary week, but the difference between groups the 9th week was significant ($P< 0.01$). The sulfur-supplemented group produced more milk. The difference between groups in change from 0 to the 9th week approached significance, whereas the difference between groups in change from the 5th to the 9th week was significant ($P< 0.05$). The average 28-day persistency of milk production was only 87% for the sulfur-supplemented and 80% for the low-sulfur group. Changes in body weight for both groups were very small and not statistically significant.

A significant difference ($P< 0.05$) existed between groups at zero day in the rumen sulfur levels. The low-sulfur group by chance was much higher. No significant difference was found between groups at 63 days, but a highly significant change ($P< 0.05$) occurred between groups from 0 to 63 days.

Blood sulfur levels exhibited no statistically significant difference between groups at 0 or 63 days or change from 0 to 63 days. Nevertheless the low-sulfur group reduced its blood sulfur level from 0 to 63 days, whereas the sulfur-supplemented group increased its blood sulfur level.

Remarkable agreement was noted between the experimental groups in respect to amino acid concentrations in the deproteinized plasma or rumen content both at the beginning and at the end of the experiment. Since there were no significant differences between treatments regarding blood or rumen amino acids, it can only be concluded that the supplemental sulfur had little or no effect upon rumen levels of amino acids.

Seven of the plasma-free amino acids of both groups (all animals considered together) decreased significantly with time, perhaps the most notable of these being cystine. Again it would appear that net rumen synthesis was not sufficient to maintain blood levels of these.

Curiously, plasma-free glutamic acid content increased, whereas the remainder were not significantly altered. Both sulfur-containing amino acids decreased to levels as low as the lowest of the other amino acids, namely aspartic acid, tyrosine, and phenylalanine. Six of the eight essential amino acids analyzed decreased significantly, suggesting that a deficiency of sulfur caused a reduced synthesis of not only the sulfur amino acids but most of the others as well.

In relation to published values (19), the plasma-free amino acids analyzed in this study were of the same order of magnitude or distinctly lower. Tyrosine, phenylalanine, isoleucine and leucine were quite low at week 9. Values of all of these dropped significantly during the experiment except that of tyrosine, which was low initially. That of the essential sulfur-containing amino acid, methionine, decreased to about half the initial level, a level however, which is only slightly below that previously reported (19). Cystine dropped by far more (to about one-seventh the initial level) than any other amino acid. Considered together, the sulfur-containing amino acids dropped more than any other amino acids, an effect attributed to the low-sulfur diet or to poor conversion or insufficient sulfur supplementation in the other group.

The data show that a low-sulfur diet can lead to reduced plasma-free amino acids including the sulfur-containing amino acids and that reduced quantities of amino acids available to the host can cause reductions in voluntary dry matter intake and milk production. Though sulfur supplementation, at the level employed, had no effect on plasma-free or rumen content amino acid levels, there was a beneficial effect on both dry matter intake and milk production.

Since the experimental formulations fed to both groups of cows did not differ in any way except for sulfur level, any effects observed were apparently due to the difference in level of sulfur offered in the diet.

The significant differences in voluntary feed intake, milk production at the end of the trial, the low persistency of milk production, and, especially, the decreases in plasma-free amino acids seem to make it very clear that a sulfur deficiency existed in the low-sulfur group. This work demonstrates that lactating cows need more than 0.10% sulfur in the diet.

PROGRESS ON ASSAY FOR FESCUE TOXICITY

D. R. Jacobson, S. B. Carr and R. H. Hatton

Thirty experiments were conducted on male Holstein calves of 64 to 317 kg body weight to evaluate the mode of administration and response parameters for bioassay of toxic fescue extracts. Each experiment was designed for paired comparisons employing two pairs of animals housed in a constant temperature laboratory. Data were obtained each half hour in the morning and afternoon from acclimated standing animals on preliminary, treatment, and two subsequent days.

One orchard grass, two different toxic fescue 80% ethanol extracts, and three mold cultures of toxic fescue were tested. In four trials, reduction of feed caused a significant reduction in tail temperature, heart and respiration rates. At the levels employed, intraperitoneal administration appeared to be more effective than oral. Differences due to treatment were statistically significant more consistently for tail temperature than for

pulse amplitude, heart or respiration rates, or rectal temperature. However, all measurements were affected by the toxic materials. Maximum effects were obtained at 1 day after treatment for oral doses and on the treatment day for intraperitoneal doses. The same extracts were administered to approximately 100 rats. There was a significant reduction in deep body temperature within 2 hours and an increase in skin temperature of the tail within 15 minutes after intraperitoneal administration.

EFFECTS OF NITRATE AND NITRITES IN FEED ON THE UTILIZATION OF CAROTENE IN SWINE

R. I. Hutagalung, C. H. Chaney and D. G. Waddill

The effects of nitrate and nitrite on vitamin A nutrition of swine have been studied. Results indicate that these ions will reduce liver vitamin A stores even when preformed vitamin A is the supplemental source. Lowered liver vitamin A stores, as a result of feeding nitrate, are usually accompanied by increased methemoglobin levels. The effects of nitrate on carotene utilization is complicated by the finding that nitrate depresses thyroid function and that an active thyroid is necessary for the conversion of carotene to vitamin A.

Earlier work at the University of Kentucky ("Animal Science Research Reports-1966," Ky. Agr. Exp. Sta. Prog. Rept. 164) showed data concerning the effects of nitrate and nitrite in water on the carotene utilization in swine. The experiment reported herein concerning the effects of nitrate and nitrite in feed was a continuation of the previous study.

Experiment 1. Forty pigs, averaging 57 lb, were allotted to five diet treatments on the basis of breed, weight and sex with replicated lots of four pigs each. The treatments were diets containing the following amounts of nitrate from KNO_3, in percent: (1) 0.00, (2) 0.75, (3) 1.50, (4) 3.00 and (5) 0.300. The source of supplemental vitamin A was beta-carotene, 3,520 I U/kg of diet treatments 1 through 4 and vitamin A palmitate, 1,172 I U/kg for treatment 5. The results of trial I are presented in Tables 1 and 2.

Experiment 2. Forty pigs, averaging 58 lb, were used in this experiment with the same design as described for experiment 1 except that nitrite (KNO_2) was added to the diets instead of nitrate (KNO_3). The levels of nitrite added were, in percent, (1) 0.00; (2) 0.075; (3) 0.150; (4) 0.300 and (5) 0.300. The results of this experiment are shown in Tables 3 and 4.

The feeding of 3% NO_3 (from KNO_3) significantly ($P < .01$) depressed gains and caused a marked reduction in feed consumption. No adverse effects were observed of the nitrate treatments on liver vitamin A stores, serum vitamin A values or methemoglobin levels.

Serum vitamin A values were significantly ($P < .05$) reduced by feeding 0.3% NO_2 (from KNO_2). Weight gains of pigs were significantly ($P < .01$) reduced when 0.3% NO_2 was included in the diet regardless of the source of supplemental vitamin A fed.

Adding potassium nitrite to the diet gave measurable increases in methemoglobin at the higher levels of nitrite. A definite trend toward a decrease in liver vitamin A stores was observed when the nitrite level in the diet increased. However, none of the nitrite treatments significantly reduced liver vitamin A stores of the pigs. Hemoglobin and hematocrit values remained relatively constant throughout both experiments.

Table 1.--Effect of Nitrate in Feed on Pig Performance, Serum Vitamin A and Liver Vitamin A[a/]

Item	Level of NO_3, %				
	0	0.75	1.50	3.00	3.00[b/]
Daily gain, lb	1.54	1.54	1.55	1.21**	1.20**
Feed/gain	3.46	3.43	3.92	3.97	4.76
Serum vit A, mcg/100 ml					
0 day	37.5 ± 9.9[c/]	22.7 ± 8.7	21.0 ± 4.3	36.3 ± 3.8	31.7 ± 5.2
42 day	17.6 ± 3.0	17.7 ± 1.1	18.9 ± 2.8	17.1 ± 6.5	18.3 ± 1.3
80 day	23.7 ± 7.7	20.7 ± 8.6	20.5 ± 7.7	17.7 ± 3.6	17.5 ± 3.4
Liver vit A mcg/100 ml	28.0 ± 18.6	22.4 ± 2.2	21.2 ± 4.0	23.4 ± 2.8	20.1 ± 6.6

[a/] Eight pigs per treatment. Average initial weight was 57 lb.

[b/] Source of vitamin A for this group was vitamin A palmitate; source of vitamin A for the other group was beta-carotene.

[c/] Mean and standard deviation.

**Significantly ($P < .01$) different from the control.

Table 2.--Effect of Nitrate in Feed on Methemoglobin, Hemoglobin and Hematocrit

Item	Level of NO_3, %				
	0	0.75	1.50	3.00	3.00[a/]
Methb, gm/100 ml	0.04 ± 0.08[b/]	0.07 ± 0.12	0.27 ± 0.24	0.68 ± 0.89	0.32 ± 0.29
Hb, gm/100 ml	10.7 ± 0.3	10.6 ± 1.0	10.5 ± 0.6	10.4 ± 1.0	10.3 ± 0.0
Hematocrit, %	42 ± 1.9	40 ± 2.5	39 ± 1.5	39 ± 1.4	39 ± 0.7

[a/] Source of vitamin A for this group was vitamin A palmitate; source of vitamin A for the other group was beta-carotene.

[b/] Mean and standard deviation.

Table 3.--Effect of Nitrite in Feed on Pig Performance, Serum Vitamin A and Liver Vitamin A

Item	Level of NO_2, %				
	0	0.075	0.150	0.300	0.300[b]
Daily gain, lb	1.49	1.43	1.38	1.21**	1.13**
Feed/gain	3.90	3.77	3.73	3.65	3.90
Serum vit A mcg/100 ml					
0 day	28.7 ± 2.6[c]	31.2 ± 6.6	30.9 ± 9.0	38.8 ± 9.7	33.3 ± 3.4
42 day	17.9 ± 1.7	16.0 ± 6.4	15.1 ± 4.0	12.8 ± 1.9	15.1 ± 4.3
87 day	20.3 ± 2.4	19.7 ± 5.9	17.3 ± 2.4	16.0 ± 2.4	11.7 ± 0.4*
Liver vit A mcg/gm, 87 day	21.1 ± 5.9	17.2 ± 7.4	11.9 ± 5.3	13.3 ± 5.5	9.5 ± 5.4

[a] Eight pigs per treatment. Average initial weight was 58 lbs.

[b] Source of vitamin A for this group was vitamin A palmitate; source of vitamin A for the other group was beta-carotene.

[c] Mean and standard deviation.

*Significantly ($P < .05$) different from the control.

**Significantly ($P < .01$) different from the control.

Table 4.--Effect of Nitrite in Feed on Methemoglobin, Hemoglobin and Hematocrit

Item	Level of NO_2, %				
	0	0.075	0.150	0.300	0.300[a]
Methb, gm/100 ml	0.20 ± 0.16[b]	0.20 ± 0.16	0.25 ± 0.25	1.44 ± 0.64**	1.35 ± 0.38
Hb, gm/100 ml	10.0 ± 0.9	10.4 ± 1.1	9.5 + 1.3	8.9 ± 1.1	8.0 ± 1.7
Hematocrit, %	40 ± 2.2	39 ± 1.1	38 ± 3.4	37 ± 2.2	35 ± 3.9

[a] Source of vitamin A for this group was vitamin A palmitate; source of vitamin A for the other groups was beta-carotene.

[b] Means and standard deviation.

**Significantly ($P < .01$) different from the control.

EFFECTS OF PROTEIN LEVEL AND SOURCE ON THE SERUM PROTEIN PROFILE OF SOWS AND THEIR PIGS

R. D. Wood, C. H. Chaney and D. G. Waddill

The pig is born with extremely low concentrations of albumin, beta- and gamma-globulin. Little or no gamma-globulin is produced through the first 3 weeks of life, and maximum production is not reached until the pig is from 2 to 6 months old. The sow, with colostrum and milk, provides proteins which are rapidly absorbed unaltered by the pig. The level of the circulating serum proteins may increase 200% during the first 24 hours of the pig's life. Serum gamma-globulin diminishes rapidly from a maximum at 24 hours after birth to 21 days of age, at which time some synthesis begins to occur. This experiment was designed to study the effects of protein level and source on the serum protein profile of sows and their pigs.

Procedure

Forty gravid Yorkshire sows were used in this experiment. A randomized design with a 3 x 3 factorial arrangement of treatments was employed. The factors were three protein sources: fish meal (FM), soybean meal (SBM) and cottonseed meal (CSM) and three levels of protein: 10, 15, and 18% (Table 1). Five sows were allotted to each of the three 18% diets and to the single 10% CSM diet. Sows were maintained on grass-legume pasture from breeding to the 77th day after breeding at which time they were placed on concrete and allotted to a diet treatment. The sows were hand-fed 2.72 kg of their respective diet daily. On the 110th day after breeding blood samples were taken from the anterior vena cava, and the sows were placed in farrowing crates. Experimental diets were changed to a well balanced, self-fed lactation diet as each sow farrowed. Blood samples from the anterior vena cava of two pigs from each litter were collected and pooled at each of the following times: birth (prior to nursing), 1 day, 8 days, 21 days and 35 days of age. All analyses were conducted in duplicate, and blood serum was used exclusively. Electrophoretic separation of blood serum into albumin, alpha-, beta- and gamma-globulin was accomplished on a Shandon model 2549, cellulose acetate system.

Table 1.--Effect of Protein Level and Source Fed to Sows on the Serum Protein Concentrations (gm/100 ml) of Sows and Their Pigs[1]

Level of Protein	Sow	Zero Hour	24 Hour	8 Days	21 Days	35 Days
10	7.85	2.50	6.05	5.48	5.36[b]	5.44
15	7.85	2.39	6.03	6.28	5.37[b]	5.99
18	7.73	2.43	5.59	5.87	4.34[a]	5.63
Source of Protein						
CSM	7.45[b]	2.42	5.14[b]	5.67	4.99	5.52
SBM	7.83[b, c]	2.37	5.25[b]	5.94	5.25	5.80
FM	8.15[a, c]	2.54	7.26[a]	6.03	4.83	5.74

[1]Values in the same column which do not share the same superscript are significantly ($P < .05$) different.

Table 2.--Effect of Level of Protein on Serum Protein Profile of Sows and Their Pigs

Time of Bleeding	Level %											
	10				15				18			
	Average Serum Protein (% of Total)				Average Serum Protein (% of Total)				Average Serum Protein (% of Total)			
	Albumin	Alpha-globulin	Beta-globulin	Gamma-globulin	Albumin	Alpha-globulin	Beta-globulin	Gamma-globulin	Albumin	Alpha-globulin	Beta-globulin	Gamma-globulin
Sows Pre-farrow	52.90[b]	21.38	10.75	15.54[a]	56.90[b]	21.26	9.16	12.88[b]	64.71[a]	16.97	9.71	9.67[b]
Pigs Birth	19.73	51.37	20.50	8.72	20.90	52.11	17.55	9.39	23.44	53.43	13.95	7.64
1 Day of Age	20.81	15.59	16.86	46.86	20.76	16.09	18.17	45.44	22.17	11.28	16.47	50.03
8 Days of Age	47.65	21.62	14.14	16.55	47.93	24.08	12.75	15.29	47.77	22.93	13.60	15.67
21 Days of Age	60.24	19.60	11.99	7.80[a/]	57.57	20.23	11.77	10.47[b/]	59.30	17.78	12.23	10.79
35 Days of Age	61.37	18.55	11.18	8.89	60.87	19.20	11.17	8.76	57.06	20.08	11.95	10.87

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

Table 3.--Effect of Source of Protein on Serum Protein Profiles of Sows and Their Pigs

Time Bleeding	Source											
	CSM				SBM				FM			
	Average Serum Protein (% of Total)				Average Serum Protein (% of Total)				Average Serum Protein (% of Total)			
	Albumin	Alpha-globulin	Beta-globulin	Gamma-globulin	Albumin	Alpha-globulin	Beta-globulin	Gamma-globulin	Albumin	Alpha-globulin	Beta-globulin	Gamma-globulin
Sows Pre-farrow	57.85	21.05	10.19	11.70	59.18	19.94	9.13	12.94	57.50	18.62	10.30	13.44
Pigs Birth	21.90	46.65	19.57	7.06	23.48	54.21	16.47	9.07	18.69	56.06	13.93	9.63

Summary of Results

Sows fed FM diets from 77 days after breeding to farrowing had significantly ($P < .05$) more serum protein at 110 days after breeding than did sows receiving CSM diets. Pigs from sows receiving FM diets had significantly more serum protein at one day of age than did pigs from sows fed SBM ($P < .05$) or CSM ($P < .01$) diets, respectively. Pigs from sows fed 18% diets had significantly ($P < .01$) less serum protein at 21 days of age than did pigs from sows fed the 10 or 15% protein diets. Level of protein appeared to have more effect on the relative percentages of the serum fractions than did protein source. In sows at 110 days after breeding and pigs at one day of age the 10% protein level led to a significantly ($P < .05$) higher percentage of gamma-globulin, while the 15% level was intermediate and sows and pigs on the 18% level had the lowest percentage of the gamma-fraction. Pigs from sows fed SBM and FM rations had a significantly ($P < .05$) higher percentage of gamma-globulin at 21 days than did pigs from sows fed CSM diets.

FACTORS AFFECTING SERUM CHOLESTEROL LEVELS IN SWINE

R. W. Megibben, C. H. Chaney and D. G. Waddill

The association of cholesterol with circulatory diseases has focused considerable attention on the necessity of experimentation to reduce serum cholesterol levels. The purpose of this experiment was to determine the effect of different feeding intervals, source and level of protein, and oral administration of neomycin on serum cholesterol levels in swine. Average daily gain and feed efficiency results were also recorded.

Procedure

Trial I - Thirty-six pigs averaging 25 lb were allotted to the following four treatments: I - controls, fed ad libtum; II - fed twice daily, at 7:00 am and 4:00 pm for one-half hour each time; III - continuous access to feed for 12 hours daily, 11:00 am to 11:00 pm; and IV - fed three times daily, at 7:00 am, 3:00 pm, and 11:00 pm for one-half hour each time. Blood samples were collected, and body weights and feed consumption data were recorded at 2-week intervals until the experiment was terminated when the animals in the treatment groups averaged 202 lb. The results of trial I are shown in Table 1.

Trial II - Twenty-four pigs averaging 40 lb were allotted to six treatment groups. Soybean meal, fish meal, and soybean meal-fish meal were the sources of protein which were fed at 16 and 15% crude protein levels until the pigs averaged 104 lb (day 37). Then crude protein levels in each group was reduced 2 percent. Half the pigs in each treatment received neomycin (0.04% of diet) 3 weeks (day 92) before the trial was terminated, at which time the pigs averaged 222 lb. Blood samples for serum cholesterol determinations were collected, and pig weights and feed consumption were recorded. The results of this trial are presented in Tables 2 and 3.

Table 1.--Average Serum Cholesterol Levels (mg/100 ml) and Pig Performance (Trial I)

Treatment	No. of Pigs	Serum Cholesterol Initial (Day 0)	(Day 56)	Terminal (Day 140)	Pig Performance Av Initial Wt (lb)	Av Final Wt (lb)	Av Daily Gain (lb)	Feed per lb Gain (lb)
I	9	99.22	107.00	112.22	22.88	208.33	1.32	3.49
II	9	84.22	98.00	121.66	22.80	196.55	1.25	3.33
III	9	94.77	107.78*	109.00	23.16	204.77	1.29	3.53
IV	9	98.55	98.11	104.55	22.88	196.25	1.24	3.33

*Significant difference ($P < .05$).

Table 2.--Average Serum Cholesterol Levels (mg/100 ml) and Pig Performance (Trial II)

	Source of Protein					
	Soybean Meal		Fish Meal		Soybean Meal Fish Meal	
Level of Protein, %	High (16-14)	Low (14-12)	High (16-14)	Low (14-12)	High (16-14)	Low (14-12)
Item						
Pigs per treatment	4	4	4	4	4	4
Serum cholesterol						
Day 37	125.50	153.00	118.25	125.00	146.25	147.75
Day 92	108.25	120.00	117.75	113.75	120.50	140.75
Days 93-113	124.87	124.25	139.12	115.50	151.50	135.12
Initial wt (lb)	39.00	40.75	39.75	39.25	40.00	39.75
Final wt (lb)	224.25	233.75	229.00	203.25	218.75	221.75
Av daily gain (lb)	1.63	1.70	1.67	1.45	1.57	1.61
Feed/lb gain (lb)	3.85	3.99	3.49	3.55	3.53	3.94

Table 3.--Effect of Neomycin on Serum Cholesterol Levels (mg/100 ml)

No. of Pigs	Days after Administration	Received Neomycin	Average Cholesterol
12	14	Yes	139.00
		No	128.50
12	21	Yes	132.66
		No	127.58

Summary of Results

In trial I pigs fed for 12 continuous hours had significantly higher ($P < .05$) cholesterol levels at day 56 than those receiving feed twice and three times daily. At the terminal bleeding, treatment II showed the highest cholesterol values. Pigs in treatment I gained slightly faster than the other groups. Those in treatments II and IV had the best feed efficiency.

In trial II pigs receiving the soybean meal-fish meal source of protein had the highest average cholesterol levels. Those on the low protein level of the soybean meal ration had best average daily gains but required the most feed per lb of gain.

CORN SILAGE FOR BRED SOWS

Gene McMurry, C. H. Chaney and C. W. Nichols

Experiments conducted earlier at this station have indicated that sows fed good quality corn silage make adequate gains during the gestation period. However, the amount of supplemental protein needed has not been determined. This experiment was designed to determine the amount of supplemental protein needed for sows fed corn silage during the gestation period.

Procedure

Twenty-eight Yorkshire sows were randomly allotted to the four following dietary treatments:

I - 6 lb gestation diet per sow daily throughout the gestation period.

II - 1 lb 36% protein supplement per sow daily.

III - 1.5 lb 36% protein supplement per sow daily.

IV - 2 lb 36% protein supplement per sow daily.

Animals in treatments II through IV were fed 12.5 lb corn silage the first 70 days of gestation, and then the amount was increased to 15 lb until farrowing. The results are given in Table 1.

Results

Sows fed the corn silage supplemented with 1 lb of protein supplement farrowed and weaned the largest number of pigs in this trial. Weight gained by these sows was also adequate.

Table 1.--Reproductive Performance of Sows

Treatment	No. Sows Farrowing	Average No. Pigs	Average Litter Weight, lb	Average Pig Wt at Birth, lb	Average No. Live Pigs	Litter Wt at 3 Weeks, lb	No. Pigs at 3 Weeks	Average Wt Gained Per Sow, lb
IV	7	9.2	31.4	3.4	8.6	93.0	7.7	105.7
III	8	9.8	30.3	3.0	8.7	89.0	7.7	80.3
II	6	11.2	37.7	3.4	10.7	117.0	9.3	85.2
I	6	10.2	31.2	3.1	9.5	94.0	8.5	105.7

INFLUENCE OF PROTEIN LEVEL, SEX AND SIRE ON PERFORMANCE AND CARCASS CHARACTERISTICS OF SWINE

R. D. Kline, C. H. Chaney and James D. Kemp

Recent studies have shown that higher dietary protein levels may increase muscling in swine carcasses. This experiment was designed to study the effect of protein level and sires on performance and carcass characteristics of swine.

Procedure

Sixty-six Yorkshire pigs averaging 58 lb each were used in 3 x 2 x 4 factorial arrangement of treatments. The factors were: (1) levels of protein; high (19-17-15%), medium (16-14-12%) and low (13-11-9%); (2) sex (barrows and gilts) and (3) sires (4). The dietary protein was reduced 2% when the pigs weighed 75 lb and then further reduced 2% when an average weight of 125 lb was reached. Three barrows and 3 gilts were used from each litter selected for the experiment. Pigs within sex from each litter were allotted to the 3 levels of protein fed. The experiment was terminated when the pigs weighed 200 lb.

Results

The results of this experiment are presented in Table 1. Pigs fed the high level of protein were equal or superior in all traits measured except length and backfat of carcasses. Pigs fed the low protein level were longer and had less backfat than those in the other two groups, which was a result probably of this slower rate of growth. The gilts were superior to barrows in all criteria used except that of average daily gain. Sire effects showed the greatest difference in average daily gains.

Table 1.--Results of Pig Performance and Carcass Data on Different Levels of Protein

	No. Pigs	Av. Daily Gain, lb	Feed Conv, lb	% Lean Cuts	Loin eye (sq. in.)	Backfat in.	Length in.	Dressing %	Ham & Loin of Slaughter Wt, lb	Ham & Loin of Packer Wt, lb
Protein										
High	22	1.72	3.83	55.99	4.46	1.38	30.55	78.15	27.96	39.39
Med	22	1.73	3.83	54.27	4.21	1.46	30.73	79.44	27.39	38.19
Low	21*	1.38	4.26	53.23	3.70	1.46	30.99	78.72	26.06	36.94
Sex										
Male	33	1.78		52.96	3.86	1.54	30.50	78.80	26.28	36.90
Female	32*	1.45		56.12	4.42	1.33	31.01	78.74	28.05	39.52
Sire										
1	24	1.59		54.77	4.01	1.41	30.66	77.89	27.02	38.43
2	12	1.49		54.96	4.36	1.38	30.40	77.93	27.16	38.61
3	17*	1.73		54.04	4.15	1.52	25.64	79.14	27.21	38.01
4	12	1.60		54.23	4.12	1.41	30.78	80.84	27.34	37.58
Average		1.63		54.52	4.13	1.44	30.75	78.77	27.15	38.19

*One pig was removed from the experiment.

EFFECTS OF PROTEIN AND IRON SOURCES ON CERTAIN BLOOD CONSTITUENTS OF SWINE

H. W. Brown and C. H. Chaney

Research data have shown that supplementing a balanced lactation diet with iron increased milk iron values. The level of iron in the milk appears to be highly correlated with the level in blood plasma. It is known that iron entering the bloodstream is bound to B-globulin, a plasma protein. If different sources of dietary protein produce different quantities and kinds of amino acids needed for plasma protein synthesis, it may be possible to increase the plasma protein level of the blood by feeding certain protein supplements. Increasing the plasma protein level could provide a greater capacity for the binding of iron. It is also known that some iron sources are absorbed faster than others. If absorption can be increased by feeding certain iron sources, more iron should be available for binding to the B-globulin.

This study was undertaken to determine the effects of feeding different protein sources in combination with different iron sources on the hemoglobin, hematocrit, unbound iron-binding capacity, total iron-binding capacity and serum iron level of growing-finishing pigs. If the serum iron level and iron-binding capacities can be increased in pigs, it may be possible to increase the transfer of iron from sows to their pigs through the milk by this means.

Procedure

Fifty Yorkshire pigs were randomly allotted by sex and weight to 10 ration treatments. The pigs in this trial were started on test at an average weight of 66.5 lb and were continued on the experimental rations for 7 weeks. They were fed a complete 16% protein ration. The basal ration was corn-soybean meal mixture supplemented with the necessary vitamin and mineral premixes. The other rations were composed of corn plus either fish meal, soybean oil meal, or cottonseed meal and 600 mg/lb of one of the following iron sources: ferrous sulfate, ferrous fumarate or ferrous citrate. These rations were supplemented with the necessary vitamins and minerals. The 600 mg/lb of the previously mentioned iron sources was the only iron added. The pigs were weighed and bled, and feed efficiency data were collected on days 0, 21, and 49 of the experimental period. All blood samples were analyzed for hematocrit, hemoglobin, serum iron, unbound iron-binding capacity and total iron-binding capacity. The pigs were housed in 4 x 22 feet concrete penswith 10 feet under roof. A feeder and waterer were available to the pigs at all times.

Results

At the 21-day bleeding, serum iron and hemoglobin levels were not affected by the ration fed. When cottonseed meal was fed, unbound iron-binding capacity, hematocrit, and total iron-binding capacity were lowered at both the 21-day and 49-day bleedings. Serum iron levels were slightly lowered at the final bleeding when ferrous citrate was the iron source fed regardless of the source of protein. The feeding of cottonseed meal also lowered the hemoglobin level at the final bleeding. Source of iron fed had no effect on rate of gain and feed efficiency. However, daily gain and feed efficiency were markedly decreased when cottonseed meal was the protein source fed regardless of the iron source.

Table 1.--Results of Performance and Blood Values of Pigs Fed Different Iron and Protein Sources

Item	Control	Ferrous Fumarate			Ferrous Citrate			Ferrous Sulfate		
		Source of Protein								
		SBM[a]	FM[b]	CSM[c]	SBM	FM	CSM	SBM	FM	CSM
Initial wt, lb	66.4	66.4	66.2	66.2	66.0	66.8	67.0	66.8	66.8	67
Final wt, lb	142.4	143	141.8	116.6	142.4	139.6	123.4	144.2	142	119.6
ADG, lb	1.62	1.62	1.61	1.07	1.63	1.55	1.20	1.65	1.60	1.12
Feed/lb Gain, lb	3.44	3.29	3.17	4.57	2.93	3.57	4.51	3.45	3.11	4.95
Initial Bleeding (day 0)										
Serum Iron mcg/100 ml	176.75	193.5	167.2	168	168	176.2	176.5	158.3	174	166.8
UIBC[d] mcg/100 ml	372.85	326.64	374.4	382.96	364.25	389.24	406.7	403.8	378.6	378.96
TIBC[e] mcg/100 ml	549.6	526.20	542.25	540.00	563.40	565.44	583.2	591.2	547.2	545.76
Hb[f]	8.60	7.90	8.24	8.60	8.42	8.14	9.02	8.60	8.18	8.30
Hct[g]	34.0	32.2	34.8	34.0	36.4	34.2	36.5	34.8	35.2	34.6
Bleeding (day 21)										
Serum Iron mcg/100 ml	191.0	203.7	211.5	212.2	196.8	211.25	191.0	198.8	191.2	194.25
UIBC mcg/100 ml	333.24	297.95	311.7	284.6	326.4	355.15	292.36	328.72	339.2	282.6
TIBC mcg/100 ml	502.4	500.8	523.2	496.8	523.2	566.4	483.36	527.52	530.4	471.6
Hb	10.52	10.10	11.0	10.10	10.64	10.28	9.80	11.0	9.98	10.16
Hct	39.2	39.0	39.8	36.4	40.0	38.6	36.4	39.2	36.4	36.6
Final Bleeding (day 49)										
Serum Iron mcg/100 ml	195.00	207.00	196.60	173.35	178.00	167.75	192.20	200.20	224.00	179.8
UIBC mcg/100 ml	355.16	315.72	321.32	285.24	343.36	322.92	283.96	335.00	299.80	293.48
TIBC mcg/100 ml	550.56	522.72	517.92	470.40	523.20	505.92	476.16	535.20	521.40	473.28
Hb	10.70	10.64	10.58	9.56	10.58	10.40	9.44	10.46	10.28	9.50
Hct	40.80	40.80	40.00	37.60	39.2	39.8	35.80	40.60	39.6	35.80

[a] Soybean meal. [b] Fish meal. [c] Cottonseed meal. [d] Unbound iron-binding capacity. [e] Total iron-binding capacity [f] Hemoglobin. [g] Hematocrit.

EFFECT OF IMPLANTING STILBESTROL IN PIGS CASTRATED AT BIRTH ON CARCASS CHARACTERISTICS AND PERFORMANCE

R. D. Kline, C. H. Chaney and D. G. Waddill

Fifty-seven Yorkshire pigs were used to study the effects of early castration with and without stilbestrol implants on performance and carcass characteristics of hogs. One-half of the male pigs in each litter were randomly castrated at birth and one-half of those castrated at birth were implanted with a 3 mg stilbestrol pellet in the right flank immediately following castration. None of the gilts received stilbestrol implants. These pigs were weaned at 5 weeks old. At 6 weeks of age the remaining boars were castrated. Six of the pigs previously castrated and implanted at birth were picked at random and given a 6 mg stilbestrol implant in the right flank when they reached a liveweight of 100 lb. The pigs were fed corn-soybean rations throughout the experimental period. The pigs were weighed bi-weekly, and feed efficiency data were collected. The results of this trial are presented in Table 1.

The performance and the carcass measurements were similar in each treatment. However, the boars castrated and implanted at birth had the least backfat when compared with the other barrows or gilts. The feed conversion was best in those castrated at birth and given the 3 mg stilbestrol implant. There was a greater percent of U.S. No. 1 pigs in the groups castrated at birth and implanted with 3 mg of stilbestrol.

Table 1.--Results of Performance and Carcass Data

Treatment	No. Pigs	Av Daily Gain lb	Feed Conv, lb	% Lean Cuts	Length in.	Backfat Thickness in.	Loineye Area (sq. in.)	Days to 200 lb	U.S. No. 1	U.S. No. 2
Castrated at birth and 22 3 mg stilbestrol, plus 6 mg stilbestrol at 100 lb	5	1.74	3.22	54.66	30.8	1.44	4.35	165	4	1
Castrated at birth and 3 mg stilbestrol	7	1.51	2.94	53.15	31.1	1.36	4.66	166	6	1
Castrated at 6 wk	14	1.56	3.34	52.70	30.8	1.52	4.21	164	10	4
Castrated at birth	11	1.51	3.68	54.15	30.7	1.52	4.42	173	9	2
Gilts	20	1.42	3.15	55.24	30.8	1.40	4.58	176	20	

GENETICS - PHYSIOLOGY

METABOLISM OF LABELLED ESTRADIOL IN INTACT, OVARIECTOMIZED, AND HYSTERECTOMIZED EWES

C. J. Falcon and R. H. Dutt

In a previous study, it was observed that significantly fewer hysterectomized than intact ewes exhibited estrus when both types of ewes were injected with similar doses of estradiol benzoate. This study was designed to examine the possibility of a uterine influence on estrogen metabolism in ewes.

The excretion of radioactivity from intact (luteal phase), ovariectomized, hysterectomized, and hysterectomized-ovariectomized ewes was compared following the administration of estradiol-17-beta-4-C^{14}. Two ewes comprised each group, and each ewe received a subcutaneous injection of 17.5 uc of the isotope. Ewes were retained in metabolism crates to facilitate collections. Urine was collected via urethral catheters every 6 hours and feces were collected every 12 hours for the first 3 days, after which longer collection intervals were used. Collections extended over a 135-hour period and ewes were slaughtered 140 hours postinjection. Samples of the following organs were removed for counting: liver, spleen, kidney, adrenal, pituitary, hypothalamus, vagina, cervix and when intact—the uterus and ovaries. Ether extracts of tissue and feces were prepared for counting. Radioactivity in urine was determined without extraction by the use of p-dioxane scintillation fluid. All counts were made, using a Packard tricarb liquid scintillation spectrometer.

Total excretion of radioactivity during the entire 135-hour collection period is shown in Table 1. Differences between groups in 135-hour cumulative excretion were not significant when activity in urine, feces or urine plus feces was compared, although there was a tendency toward lower excretion in intact ewes. Likewise, comparisons of cumulative excretion of radioactivity at 12-hour intervals did not indicate significant differences in rate of excretion between treatment groups. Total radioactivity recovered from all ewes by 135-hour postinjection was 26.8% of the injected dose, and fecal excretion accounted for 59% of total activity.

Table 1.--Cumulative Excretion of Radioactivity 135 Hours After Administration of Estradiol-17-beta-4C^{14}

	Treatment Group							
Item			Hysterectomized		Ovariectomized		Ovariectomized-hysterectomized	
Ewe No.	1	8	4	6	2	5	3	7
Activity in feces, uc	1.77	1.32	2.04	4.39	3.72	3.22	1.03	4.60
Mean	1.55		3.22		3.47		2.81	
Activity in urine, uc	2.40	0.52	3.90	0.39	0.85	2.15	2.80	0.90
Mean	1.46		2.14		1.50		1.85	
Total activity, uc (urine plus feces)	4.18	1.84	5.94	4.78	4.58	5.37	3.82	5.50
Mean	3.01		5.36		4.97		4.66	

Radioactivity per gram of organs removed at slaughter (140 hour postinjection) is shown in Table 2. The liver contained the highest amount of radioactivity per gram of tissue, and this was true for all treatment groups. No significant differences were detected in activity levels in any of the tissues among treatment groups.

These data do not indicate any significant effect of the ovaries or the uterus on metabolism of labelled estradiol in the ewe.

Table 2.--DPM per Gram of Various Organs Obtained 140 Hours After Administration of Estradiol-17-beta-4-C^{14}

	Treatment Group							
	Intact		Hysterectomized		Ovariectomized		Ovariectomized-hysterectomized	
Organ	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Pituitary	46	20	49	53	70	35	60	71
Hypothalamus	9	4	20	4	12	11	18	17
Adrenal	146	47	60	9	61	0[a]	44	11
Liver	188	205	540	297	356	18	625	308
Kidney	29	12	45	8	36	8	46	19
Spleen	24	3	55	5	18	13	22	8
Serum	19	10	20	1	16	3	18	2
Ovary	58	61	32	13	-	-	-	-
Uterus	38	1	-	-	108	5	-	-
Cervix	72	31	22	11	52	17	52	45
Vagina	49	16	53	62	36	21	40	25

[a]/Adrenal from only one ewe in group was analyzed.

COMPARISON OF HEMOCYTOMETER AND COULTER COUNTER FOR COUNTING RAM SPERM CELLS

Charles R. Bradley and R. H. Dutt

Estimation of spermatozoa concentration is a useful criterion of semen evaluation. The hemocytometer method of counting has often been criticized as a lengthy, tedious process subject to rather large sampling and subjective errors. Because of these inaccuracies and the lengthy process inherent in the hemocytometer counting method, the use of the electronic particle counter has been investigated as an additional direct method for estimating spermatozoan concentration. This method permits a rapid, automatic and direct count of a much larger number of spermatozoa than does the hemocytometer count.

The principle of the Coulter Counter is based on electrical impedance. Particles are suspended in an electrolyte (saline) that passes through a circular orifice in a sample tube. By means of an electrode within the tube and another in the electrolyte reservoir, a constant current streams with the electrolyte through the orifice. As each particle enters, it creates a resistance and alters the voltage in proportion to its volume. The voltage fluctuation is amplified by an electronic counting device that records inpulse frequency and amplitude. Measurements were made with the amplifier set at 1.0 and the aperture current at 32.

Fifty semen samples were collected from several rams, and counts were made for sperm cell concentrations, using the hemocytometer and the Coulter Counter. For electronic counting, samples from the ejaculates were diluted 1:40,000 with saline. To prevent spermatozoa from clumping or adhering to particles of debris found in the ejaculates, a small quantity of saponin (3 drops) was added to each sample.

Microscopic counts were made with a Spencer Bright-Line hemocytometer. The semen samples were diluted 1:200 in a hypertonic saline solution (4.0% NcCl). Spermatozoa were counted in a volume equal to 0.02 mm^3. Average estimated concentration was slightly higher with the hemocytometer than with the particle counter (2.65 versus 2.59 million cells/mm^3), although the range for the hemocytometer counts was slightly lower (0.75 to 4.65 versus 0.83 to 5.07 million cells/mm^3).

The correlation between counts obtained with the hemocytometer and the Coulter Counter was 0.81 (Table 1). Although some question remains as to which method gives the more accurate estimate, it was found that variation between duplicate counts was lower with the electronic counting method. An advantage of the electronic counting method is the increased speed with which counts can be determined.

Table 1.--Estimates of Ram Sperm Cell Concentration With the Hemocytometer and the Coulter Counter

Method	Estimated Sperm Cell Concentration (million/mm^3)	
	Range[a]	Average
Hemocytometer	0.75 - 4.65	2.65
Coulter Counter	0.83 - 5.07	2.59
Correlation	-----	0.81**

[a] Fifty samples collected with an artificial vagina from Southdown rams.

**Highly significant.

EFFECTS OF HYSTERECTOMY IN THE ANESTROUS AND PREPUBERAL EWE

C. J. Falcon and R. H. Dutt

This study was undertaken to determine the effects of removing the uterus during the quiescent state of the ovaries (anestrous or prior to puberty) on the occurrence of estrus, ovulation and corpora lutea maintenance after onset of the breeding season or puberty.

Ten mature anestrous western-cross ewes, all of which had been observed in estrus the previous breeding season, were hysterectomized during the first week of July. The ewes were checked daily for occurrence of estrus immediately following hysterectomy and until December 30. At that time they were laparotomized, and existing corpora lutea were enucleated. Estrous checks were continued until early March when cyclic estrous activity terminated in 12 unbred control ewes of similar breeding.

To study the effects of uterine extirpation prior to puberty on subsequent estrous activity, 10 spring-born Southdown X western-cross ewe lambs were paired according to age into 2 groups of 5 lambs each. Hysterectomies were performed on five ewe lambs in September. Ages of all lambs at that time varied from 161 to 173 (av 168) days. The five control lambs were sham operated. Daily estrus checks with teaser rams were made immediately following surgery and until November 22, when the five sham-operated ewes had been in estrus at least once. The five hysterectomized ewe lambs were slaughtered at this time to determine whether ovulation had occurred. Results of observations on both treated groups are summarized in Table 1.

Table 1.--Ovulation and Estrus Activity in Ewes Hysterectomized During Anestrous or Prior to Onset of Puberty

Treatment	No. of Ewes	Percent of Ewes Showing Estrus	Percent of Ewes Ovulating
Hysterectomized anestrous ewes	10	10	100
Hysterectomized anestrous ewes, CL enucleated	10	50	90[a]
Hysterectomized prepuberal ewe lambs	5	0	100
Control ewe lambs	5	100	--[b]

[a] One unilaterally ovariectomized ewe had severe adhesions and a corpus luteum could not be identified on the remaining ovary.

[b] None of the control group was laparotomized; ovulation was assumed to have accompanied estrus.

Of the 10 ewes hysterectomized during the anestrous season, only 1 was observed in estrus prior to December 30. The average date of first estrus of 12 control ewes was September 17, and all had exhibited at least three (av 6) estrous cycles by December 30. The influence of hysterectomy on occurrence of estrus was significant ($P < .01$). At laparotomy on December 30 at least one (av 1.7) corpus luteum was found in each ewe. This indicated that ovulation had occurred after the start of the breeding season, and 9 of 10 ewes had undergone silent ovulations. All corpora lutea present at laparotomy were enucleated. Five of the 10 ewes exhibited estrus within 3 to 5 days (av 3.4) after enucleation. At slaughter on January 28, 28 days after corpora lutea enucleation, 9 of 10 ewes had at least one (av 2.1) active corpus luteum. One of the ewes which had been previously unilaterally ovariectomized had adhesions in the area of the reproductive tract, and a corpus luteum was not positively identified on the remaining ovary.

Of the five ewe lambs hysterectomized prior to puberty, none exhibited estrus prior to slaughter on November 22. The average date of first estrus of the five control ewe lambs was October 24, and all had been observed in estrus at least once prior to the time the treated lambs were slaughtered. At slaughter each of the five treated ewe lambs had at least one (av 1.6) active corpus luteum, indicating that ovulation had occurred even though estrus had not been observed.

Observations on the two groups of treated ewes indicate that hysterectomies performed while the ovaries are quiescent (during anestrous or prior to puberty) did not inhibit ovulation and formation and maintenance of active corpora lutea. With the exception of one mature ewe, ovulations in both groups were not accompanied by estrus.

AMINO ACID CONTENT OF PITUITARY GLANDS FROM EWES EXPOSED TO DIFFERENT PHOTOPERIODS

P. R. Dame and R. H. Dutt

Seasonal breeding activity of many mammals and birds lend support to the idea that light is one environmental factor which affects the synthesis or release of pituitary gonadotropins. Studies have shown that changes in the amount of light alter the ratio between the follicle-stimulating and the luteinizing hormones. Since the pituitary gonadotropins are proteins and proteins are composed of amino acids, there is a possibility that fluctuations in pituitary gonadotropin synthesis and release could be detected as changes in the relative amounts of one or more amino acids in the pituitary gland. Thus, if such changes do occur, they may serve as indicators of relative levels of the follicle-stimulating and luteinizing hormones. This study was conducted to determine whether exposing ewes to different photoperiods alters the amino acid content of their pituitary glands.

Pituitary glands were collected from 45 ewes which had been divided into three groups of 15 each and exposed to different photoperiods. One group served as controls, one was exposed to constant light (light group), and the other was kept in 22 hours of darkness (dark group) daily. Each ewe was started on treatment the first day of the estrous cycle and slaughtered the third day of the subsequent cycle. The pituitary glands and ovaries were removed at slaughter. Ovulation rates were obtained from the ovaries, and the pituitary glands were assayed for amino acid content and gonadotropic potency.

Mean ovulation rates were 1.4, 1.5 and 1.3 for the control, light and dark groups, respectively. These means were not significantly different. Eighteen amino acids were identified in the pituitaries. These were: proline, ornithine, glycine, alanine, valine, leucine, isoleucine, serine, threonine, aspartic acid, glutamic acid, arginine, lysine, cystine, methionine, phenylalanine, tyrosine and histidine. Means were calculated for all amino acids except proline and ornithine (Table 1). The means for threonine were 578, 421 and 393 micromoles per milligram of wet tissue for control, light and dark groups, respectively. Threonine levels for the two treatment groups were significantly ($P < .01$) lower than in the control.

The pituitaries were assayed for LH and FSH potency using immature, hypophysectomized male rats. Testes and ventral prostrate weights were used as measures of FSH and LH, respectively. These assays did not show any significant effect of the photoperiods on pituitary content of FSH or LH. However, the variance in FSH content of pituitaries from the dark group was significantly ($P < 0.05$) lower than in the control group at the intermediate level of the assay. Generally, both the light and dark treatments caused a lowered amino acid content and gonadotropin potency of the pituitary gland. Since the light-treated ewes tended to have a higher ovulation rate than dark-treated or control ewes, it is possible that the decrease in gonadotropin potency in both groups may have been the result of different mechanisms involving synthesis and release. Also, the reduced threonine content in both treatments suggests that the photoperiod may change levels of certain amino acids in the pituitary gland.

Table 1.--Amino Acid Concentrations in Pituitary Glands From Ewes Exposed to Different Photoperiods

Amino Acid[b]	Ewe Group[a]					
	Control		Light		Dark	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Aspartic acid	112.6	19.7	108.5	30.8	99.1	20.7
Threonine	57.8	13.0	42.1**	13.3	39.3**	14.4
Serine	61.4	12.7	65.4	17.9	58.6	9.3
Glutamic acid	109.0	20.2	110.7	28.8	97.4	25.9
Glycine	102.3	17.7	96.1	28.8	89.2	17.2
Alanine	84.7	16.8	84.6	22.8	74.6	12.8
Valine	65.2	13.1	59.6	16.3	51.6	12.0
Cystine	52.1	14.0	47.8	21.0	40.0	12.5
Methionine	19.9	7.0	21.6	12.5	15.0	4.6
Isoleucine	50.4	10.4	49.1	19.9	41.5	9.2
Leucine	106.2	19.8	112.4	31.3	97.0	15.6
Tyrosine	37.6	11.8	31.3	11.2	31.2	12.8
Phenylalanine	31.8	11.7	37.8	14.2	31.7	8.4
Lysine	72.0	14.1	72.7	18.6	65.2	12.0
Histidine	33.5	7.8	32.4	11.0	29.4	5.5
Arginine	68.3	15.0	66.0	19.5	62.0	13.2
Total concentration[b]	1,065.0	208.7	1,038.4	298.3	926.7	188.7

[a] 15 ewes/treatment group.

[b] Expressed as micromoles/mg of wet tissue.

**Mean significantly ($P < 0.01$) lower than control.

INFLUENCE OF SHORT-TERM EXPOSURE TO CONTINUOUS OR RESTRICTED LIGHT ON OVULATION, FERTILITY AND EMBRYO SURVIVAL RATES IN EWES

R. H. Dutt, C. J. Falcon and P. R. Dame

Studies reported previously show that exposing ewes during the breeding season to continuous light for one estrous cycle before breeding resulted in a slight but nonsignificant increase in ovulation and lambing rates. Technical advances offer the possibility of changing the environment to approach optimum conditions for maximum reproductive efficiency. The study reported herein was designed to determine the effects of short-term periods of continuous or restricted light on reproductive efficiency in cycling ewes. The study was conducted during October and November—normally a period of high reproductive efficiency in sheep.

Thirty ewes were kept in continuous light for one cycle before breeding; 30 ewes were kept without light (restricted-light group) for one cycle except for a 2-hour period each day when they were checked for estrus and fed; and 30 ewes were kept as controls. Yearling and two-year-old dark-faced Northwestern ewes were stratified among treatments. All ewes

were checked daily for estrus with aproned teaser rams. The constant-light group was kept in a pen equipped with fluorescent lighting, which provided light intensity 18 inches from the floor, ranging from 10 foot candles in corners to 40 foot candles beneath the lights. Control ewes were housed in a similar pen without artificial lighting, and the restricted-light group was kept in a darkened room equipped with fans for adequate air circulation.

Ewes in all groups were artificially inseminated, starting October 26. One-half of the ewes in each group were slaughtered 3 days after breeding for ovulation and fertility data, and the remaining ewes in each group were retained on their respective light treatments until 20 days after breeding. The latter ewes provided data for estimating the influence of light on embryo survival. Ewes were group fed similar amounts so that nutrition was probably not a factor affecting the results.

Ovulation and fertilization rates are shown in Table 1 and percentage of ewes lambing and embryo survival rates are shown in Table 2. Ovulation and lambing rates were 15% and 24% higher, respectively, for the ewes exposed to continuous light than for ewes kept on the restricted-light treatment. The lowest embryo survival rate occurred in the restricted-light ewes. This group of ewes was subjected to the restricted photoperiod for about 37 days. Lengthening the photoperiod during October and November had a beneficial effect on ovulation and lambing rate in ewes.

Table 1.--Ovulation and Fertility Rates in Ewes Exposed to Different Photoperiods

Item	Treatment Group		
	Control	Restricted Light[a]	Continuous Light[b]
No. of ewes	15	15	15
Ovulation rate	1.40	1.33	1.53
Ova fertilized, %	86.7	95.0	95.6

[a] Ewes exposed to 22 hours of darkness and 2 hours of light daily for one estrous cycle before breeding.

[b] Ewes exposed to continuous light for one estrous cycle before breeding.

Table 2.--Estimated Embryo Survival and Lambing Rates in Ewes Exposed to Different Photoperiods

Item	Treatment Group		
	Control	Restricted Light[a]	Continuous Light[b]
No. of ewes	15	15	15
Ewes lambing, %	86.7	86.7	100.0
Estimated embryo survival, %	95.4	78.9	95.4
Lambing rate	1.31	1.13	1.40

[a] Ewes exposed to 22 hours of darkness and 2 hours of light daily for one estrous cycle before breeding and for 20 days after breeding.

[b] Ewes exposed to continuous light for one estrous cycle before breeding and for 20 days after breeding.

EFFECTS OF INJECTED PROGESTOGENS ON THE SEXUAL AND CARCASS CHARACTERISTICS OF BOARS

Paul L. Swanson and R. H. Dutt

Progestogens have been shown to inhibit release of the luteinizing hormone and ovulation in females. The action of these agents in the male has not been studied extensively. It is possible that they may result in lower androgen production which, in turn, should affect growth and activity of the accessory glands. The effect of these agents on backfat thickness and characteristic "odor" in boar carcasses is also of interest.

Thirteen Hampshire boar pigs were used to determine the effect of injected progestogens. The boars were placed on test immediately after weaning and were reared in confinement until approximately 10 months of age. At that time they were placed on pasture. Treated boars were injected with 50 mg of 6 oc-methyl-17oc-acetoxyprogesterone (MAP) or 50 mg of melengestrol acetate (MGA) once every 28 days for the duration of the experimental period. Results of the study are shown in Table 1.

Libido was checked periodically after the boars became approximately six months of age and semen was collected by electroejaculation at about twelve months of age. Electroejaculation was necessary for semen evaluation since only one successful mating was recorded during the testing period. The percent motile sperm cells in the electroejaculation averaged 70% for controls, 60% for MAP treated boars and 26% for MGA treated boars. Percent of motility was lower ($P < .01$) for the progestogen treated groups. Averages for percent of sperm cells containing protoplasmic droplets were: controls 50%, MAP treated boars 55% and MGA treated boars 39%. These differences were not significant.

Table 1.--Weight of Accessory Glands, Semen Characteristics and Odor Test Scores for Boars Injected with Progestogens

Treatment Group	No. of Boars	Average Age at Slaughter (days)	Average Weight at Slaughter (lb)	Percent Motile Sperm Cells	Percent of Sperm Cells Containing Protoplasmic Droplets	Epididymal Sperm Cell Concentration (billion/ml)
Control	5	381	366	70	50	4.83
MGA[a]	5	376	351	26**	39	3.87
MAP[b]	3	378	390	60	55	3.70

	Weight of Testes (gm)	Weight of Seminal Vesicles (gm)	Weight of Bulbo-urethral Glands (gm)	Weight of Prostate Gland (gm)	Backfat Thickness (inches)	Odor Score[c]
Control	510.8	272.9	176.2	8.1	1.81	2.0
MGA[a]	477.6	161.2	122.4	7.1	2.09	1.73**
MAP[b]	429.9	147.3	144.7	8.7	1.84	1.95

[a] Melengestrol acetate (6-dehydro-16-methylene-6-methyl-17-acetoxyprogesterone).

[b] Provera (6 oc-methyl-17 oc-acetoxyprogesterone).

[c] Based on a score ranging from 0 (no objectionable odor) to 3 (strong objectionable odor).

**Significantly ($P < 0.01$) lower than control.

At slaughter the boars averaged 379 days of age and 369 pounds. Concentrations of sperm in the distal epididymides at slaughter was not significantly different among treatment groups.

The testes, epididymides, seminal vesicles, bulbo-urethral, and prostate glands were excised at slaughter. Differences in the weights of these tissues among the treatment groups were not significant. A histological examination of the testes revealed no differences in the interstitial cells or the spermatogenic process within the seminiferous tubules; however, there was a significant ($P < 0.01$) difference in the average diameter of the measured seminiferous tubules. The average diameter in microns for each group was: controls, 184.47; MAP group, 189.75; and MGA group, 199.32.

Samples of parotid gland and diaphragm muscle were heated in boiling water and evaluated by a three-member panel with a rating of 0 to 3. Numerical classifications were equivalent to none, slight, medium, and strong amounts of boar odor. Combining the results from both types of tissues, the average for controls was 2.0, MAP-treated boars averaged 1.95, and MGA-treated boars averaged 1.73. The differences were significant ($P < .01$).

These results indicate injected MGA had a greater inhibitory effect than MAP on gonadotropin secretion by the pituitary gland of boars. There was a tendency for boars treated with MGA to be fatter and to have significantly less "boar odor" in their carcasses. The significantly lower percentage of motile sperm cells in this group also suggests an inhibitory effect of MGA on gonadotropin production or release in males.

MEASUREMENT AND SELECTION OF ECONOMICALLY IMPORTANT TRAITS IN BEEF CATTLE - 1966

N. W. Bradley, L. V. Cundiff, J. D. Kemp, J. Ralph Overfield and A. W. Young

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 to develop a method of estimating a bull's transmitting ability for carcass characteristics as well as rate of gain and conformation.

The Hereford herd used in this project has increased to 430 head. During the 1967 calving season 153 calves were born. Presently 231 cows and heifers are being mated artificially to 4 superior, progeny tested bulls. All females failing to conceive at first service will then be pasture-mated to the 6 top producing herd sires now in this project.

Results of pre- and post-weaning performance of bull and heifer calves tested in 1966 are summarized according to sires in Tables 1 and 2, respectively. Although average performance was not good, a few top individuals were available for selection. The 11 bull calves selected for progeny testing should provide future herd improvement.

Also during the year, carcass data collection was completed on bull calves slaughtered from the 1965-calf crop. These data are presented in Table 3 and are summarized by sire groups.

Table 1.--Preweaning and Postweaning Performance of Bulls on Test in 1966

	Sire							
	E-2	Z-6	A41	C-30	PZ8	PZ4	HRH1	HH6
Preweaning								
Number	14	11	10	9	12	8	8	3
Weaning wt, lb[a]	328	345	325	309	361	320	324	378
Average daily gain, lb	1.29	1.36	1.29	1.19	1.47	1.29	1.27	1.61
Adj av daily gain, lb	1.27	1.33	1.28	1.17	1.45	1.24	1.25	1.53
Type[b]	10.4	10.5	11.2	10.6	10.8	10.1	9.5	11.7
Index[c]	84	88	89	82	94	82	80	101
Postweaning								
Number	14	11	9	9	12	6	7	3
Age in days	368	372	381	390	375	375	389	390
Final wt, lb	726	803	763	768	794	791	821	866
Average daily gain, lb	2.58	2.86	2.69	2.85	2.83	2.87	2.97	2.76
Wt./day of age, lb	1.97	2.15	2.00	1.97	2.12	2.12	2.11	2.22
Type[b]	10.6	10.7	11.6	11.3	11.3	11.0	10.1	10.7
Index[d]	126	136	133	135	137	136	134	135

[a] Actual weaning weights adjusted for sex of calf, age of dam and to 205-days.

[b] 10 = average good; 11 = high good; 12 = low choice.

[c] Preweaning index = (40 x Adj. ADG) - 18 + 5 (type score).

[d] Postweaning index = [(20 x ADG) + 20 x (WDA)] - 18 + 5 (type score).

Table 2.--Preweaning and Postweaning Performance of Heifers on Test in 1966

	Sire							
	E-2	Z-6	A41	C-30	PZ8	PZ4	HRH1	HH6
Preweaning								
Number	5	5	9	10	6	7	9	3
Weaning wt, lb[a]	354	339	354	350	330	334	348	358
Average daily gain, lb	1.28	1.20	1.27	1.27	1.25	1.24	1.28	1.36
Adj av daily gain, lb	1.44	1.32	1.43	1.40	1.32	1.32	1.39	1.43
Type[b]	10.0	10.8	10.9	10.7	10.8	10.6	9.9	10.7
Index[c]	89	89	93	91	89	88	87	93
Postweaning								
Number	5	5	9	10	6	7	8	2
Age in days	372	387	389	385	393	380	390	381
Final wt, lb	532	554	566	576	586	560	597	685
Average daily gain, lb	1.41	1.40	1.39	1.53	1.62	1.52	1.53	1.72
Wt/day of age, lb	1.43	1.43	1.45	1.50	1.49	1.47	1.53	1.81
Type[b]	10.6	10.8	11.4	11.4	11.0	10.9	10.9	11.0
Index[d]	91	92	96	99	99	96	97	107

[a] Actual weaning weights adjusted for sex of calf, age of dam and to 205-days.

[b] 10 = average good; 11 = high good; 12 = low choice.

[c] Preweaning index = (40 x Adj. ADG) - 18 + 5 (type score).

[d] Postweaning index = [(20 x ADG) + 20 x (WDA)] - 18 + 5 (type score).

Table 3.--Carcass Characteristics of Bulls by 7 Sires (1965 calves)

Item	Sire						
	181H	HP15	PZ8	A41	C-30	E-2	Z-6
Number	8	9	3	3	2	2	2
Wt at slaughter, lb	783	734	723	822	850	718	865
Cold carcass wt, lb	450	423	416	495	476	389	513
Dressing, %[a]	57.3	57.8	57.3	60.3	56.1	54.0	59.2
Conformation[b]	10.9	12.6	10.7	12.7	12.0	11.5	11.0
Marbling score[c]	3.3	3.7	2.7	3.7	4.0	3.0	3.5
Rib-eye-area, sq in.	10.2	10.4	10.3	11.4	10.9	10.3	11.6
Fat thickness, in.	0.4	0.4	0.3	0.4	0.4	0.3	0.2
Kidney fat, %	2.0	2.1	2.0	2.5	2.3	2.3	2.3
Cutability grade	1.9	1.7	1.6	1.8	2.0	1.8	1.6
Carcass grade[b]	8.8	9.6	8.3	8.7	9.5	9.0	9.5
Color of fat	2.0	2.1	2.0	2.3	2.5	2.0	2.0
Color of lean	4.8	4.8	3.7	5.3	5.5	5.0	3.5
9-10-11th rib separation							
% fat	22.6	24.8	20.7	26.4	28.4	23.1	25.1
% lean	59.2	57.2	60.4	55.9	58.4	58.3	59.3
% bone	15.8	16.8	16.1	15.2	15.8	15.9	15.8
Taste panel							
Flavor	7.3	7.3	7.2	7.1	7.0	7.3	7.5
Juiciness	7.2	7.0	7.0	6.8	7.1	7.1	7.3
Tenderness	6.8	6.8	7.1	6.6	6.2	6.9	6.9
Overall satisfaction	7.1	7.1	7.2	6.8	6.6	7.1	7.2

[a] Calculated using chilled carcass weight.

[b] 8 = high standard; 9 = low good; 10 = average good; 11 = high good.

[c] 3 = traces; 4 = slight; 5 = small.

EFFECTS OF DATE OF BREEDING AND AN ORALLY ADMINISTERED SYNTHETIC PROGESTOGEN ON BREEDING AND LAMBING PERFORMANCE OF CROSSBRED EWES

H. A. Glimp, W. P. Deweese and R. H. Dutt

Several experiments have shown that orally-administered synthetic progestins such as 6-methyl-17-acetoxyprogesterone (MAP) are quite potent in their ability to control estrus in the cycling ewe. For these compounds to synchronize estrus, most studies indicate that the ewe must be cycling. Just how early in the breeding season these compounds could be used and still effectively synchronize estrus has not been clearly elucidated. This experiment was designed to determine how early in August MAP could be used to effectively synchronize estrus in crossbred ewes in Kentucky. August is the time of the year when ewes will normally start exhibiting estrus in Kentucky.

Procedure

Two hundred and ten Northwestern dark-faced crossbred ewes were randomly allotted within age groups to six treatments. One-third of the ewes were allotted to each of three breeding groups, which were first exposed to the ram on August 1, August 14 or August 28, respectively. One-half of each of the foregoing three groups were fed 60 mg MAP per head per day for 14 days prior to turning in the rams. The MAP was fed in 0.5 lb corn daily. The remaining one-half of the ewes in each breeding group received 0.5 lb corn daily for the same 14 days as a control. All ewes were fed 0.5 lb corn daily for 7 days prior to the MAP feeding so they would become accustomed to eating. Upon completion of the 14-day MAP feeding period, both the control and MAP-fed ewes were turned to pasture with 5 Hampshire rams of known high semen quality for each breeding group of 70 ewes. Marking harnesses and crayons were used to detect estrus. Date of conception was determined as the marking date that was confirmed by lambing after a normal gestation length.

Results

The influence of MAP on date of first estrus and conception rate is shown in Table 1. Estrus was effectively synchronized by MAP administration, with 101 of 105 of the treated ewes exhibiting estrus within 5 days after MAP feeding was terminated. More of the MAP-treated ewes conceived during the first 5 days, but the average number of days to conception was different only for the first breeding date, August 1. Ewes receiving MAP for 14 days prior to August 1 required only an average of 6.0 days to conception, while their controls required an average of 21.2 days. Very few of the control ewes exhibited estrus during the first two weeks of August, while all of the MAP-treated ewes exhibited estrus upon removal from MAP administration. Other experiments have shown that ewes coming into the breeding season will first ovulate without exhibiting estrus, suggesting that progesterone priming by a functioning corpus luteum on the ovary is essential before the ewe will exhibit estrus. These data suggest that synthetic progestins, particularly MAP, may be able to replace the progesterone from the corpus luteum in this case. Just how early in the breeding season this phenomenon would be observed is not known. The failure of MAP administration to reduce the average days to conception at the other two breeding dates is due primarily to a reduction in first estrus conception rate with MAP feeding.

Table 1.--Date of First Estrus and Number of Conceptions by Periods of the Breeding Season

MAP Treatment[a/]	0			+		
Breeding Date	Aug. 1	Aug. 14	Aug. 28	Aug. 1	Aug. 14	Aug. 28
Number of ewes	35	35	35	35	35	35
First estrus						
0 - 5 days	2	13	8	35	33	33
6 - 17 days	18	22	26	0	2	2
After 17 days	15	0	0	0	0	0
Number of conceptions						
0 - 5 days	1	9	6	25	16	19
6 - 17 days	13	16	24	0	0	2
Second estrus	10	7	2	5	15	10
Third estrus	5	0	1	0	2	3
Total	29	32	33	30	33	34
Av days to conception	21.2	11.5	11.7	6.0	11.9	12.5

[a/] + ewes received 60 mg MAP/head/day in 0.5 lb corn for 14 days prior to turning in rams. Control ewes received 0.5 lb corn for the same 14 days.

Table 2 shows the effect of MAP feeding and date of breeding on lambing results. No significant differences due to MAP feeding were observed in lambing percentage, although lambing percentage was slightly higher for the MAP group for the first breeding date and slightly lower for the second breeding date. Both percentage of ewes lambing and lambing percentage tended to increase as the breeding date approached the more normal breeding season of September.

In summary, MAP feeding effectively synchronized estrus in all breeding groups but decreased the average number of days to conception only at the first breeding date.

Table 2.--Effect of MAP Treatment and Date of Breeding on Lambing Results

MAP Treatment	0			+		
Breeding Date	Aug. 1	Aug. 14	Aug. 28	Aug. 1	Aug. 14	Aug. 28
Number of ewes	35	35	35	35	35	35
Lambing rate	1.69	1.91	1.85	1.73	1.70	1.77
% of ewes lambing	83	91	94	86	92	97
Lambing %	140	174	174	149	156	172

ESTIMATES OF THE REPEATABILITY OF DATE OF LAMBING

S. E. Ruegg, Jr., H. A. Glimp, R. H. Dutt and P. G. Woolfolk

Although the repeatability of calving interval is very low, ranging from -0.09 to 0.02, this appears not to be the case with the seasonal breeding sheep. Little work has been done previously, however, to quantify the effect of lambing date as a limiting factor in the production of early lambs. Simple economics should justify selection for lambing date if the level of repeatability is substantial and early lambing is needed to meet changing consumer markets.

Procedure

The estimates of repeatability of date of lambing as a characteristic of the ewe were calculated as follows:

$$\text{Repeatability} = \frac{\sigma_B^2}{\sigma_B^2 + \sigma_W^2}$$

where

σ_B^2 is the variation due to differences among ewes and would include both genetic and permanent environmental differences, and

σ_W^2 is variation among lambing dates of the same ewe.

Several repeatability estimates of lambing date as a characteristic of the ewe were calculated. Lambing records from three flocks of ewes were studied.

University Southdowns and Hampshires.—In this flock were the purebred Southdown and Hampshire ewes on the U.K. farm from 1929 to 1948. The ewes were hand mated, beginning at the onset of estrual cycling, which was usually in August. The only selection practiced was for popular breed types, with no emphasis on improved fertility or early lambing.

Mercer Southdowns.—The Mercer Southdown flock was developed in 1956 from 8 different flocks for diversity of genetic material and has been closed since its origin. Three sires have been used each year, being the earliest born ram lamb from each sire. Rams are bred as yearlings, and for only the season. About one-third of the ewe flock is replaced each year by the earliest born yearling ewes from each sire, approximately 6-8 per sire. Half-sib and parent-offspring matings are avoided to keep inbreeding to a minimum. The ewes are re-randomized to sire groups each year. Culling has been based on failure to lamb, late lambing, and unsoundness.

Coldstream Crossbreds.—Ewes in this group were Northwestern dark-faced cross-bred ewes. Hampshire, Southdown or Hampshire X Southdown sires were used during the breeding season from 1962 to 1966. Each year the rams were turned in August 5 and remained with the ewes until November 1. All rams used had high semen quality, and were each mated to approximately 25 ewes.

Results

University Southdowns and Hampshires.—Results of the analysis are shown in Table 1. Repeatability estimates were obtained for each breed, and within breed on the basis of number of records per ewe. Repeatability estimates for date of lambing were high for both breeds, with a value of 0.36 for Southdowns and 0.42 for Hampshires. Hampshire ewes have a less restricted breeding season, probably accounting for the higher repeatability estimate. The data also show that repeatability estimates tend to be higher with fewer records per ewe.

Table 1.--Repeatability Estimates for University Southdowns and Hampshires

Breed	No. Records/Ewe	No. Ewes	Repeatability Estimate
Southdown	2	30	0.50**
"	3	31	0.26**
"	4	19	0.34**
"	5	19	0.27*
"	All ewes	99	0.36**
Hampshire	2	31	0.44**
"	3	23	0.52**
"	4	13	0.20
"	5	10	0.41**
	All ewes	77	0.42**

*P<0.05
**P<0.01

Mercer Southdowns.—Results of the analysis of the data from this flock are shown in Table 2. The overall repeatability estimate of 0.33 is similar to that reported for the University Southdowns. The unusually high estimates of 0.37 and 0.61 for ewes with 6 and 7 records, respectively, are probably somewhat biased upward, since ewes would not have been kept in the flock this long unless they consistently lambed early.

Coldstream Crossbreds.—Results of the analysis are shown in Table 3. An overall repeatability estimate of 0.21 was obtained for this flock. This lower estimate is probably due to the effect of heterosis obtained in crossbreeding. These ewes also were not allowed to mate prior to August 5, which indicates that the breeding season was partially restricted. This would also tend to lower the estimates of repeatability.

The results of these analyses suggest that date of lambing is a moderate-to-highly repeatable trait, particularly in purebred Southdowns and Hampshires. Culling of extreme late lambing ewes, even in crossbreds, should considerably reduce the length of the lambing season and provide a more uniform lamb crop.

Table 2.--Repeatability Estimates for Mercer Southdowns

No. Records/Ewe	No. Ewes	Repeatability Estimate
2	62	0.46**
3	27	0.41**
4	27	0.33**
5	20	0.14*
6	6	0.37**
7	4	0.61**
All ewes	146	0.33**

*P < 0.05
**P < 0.01

Table 3.--Repeatability Estimates for Coldstream Crossbreds

No. Records/Ewe	No. Ewes	Repeatability Estimate
2	6	0.27
3	66	0.15**
4	60	0.20**
All ewes	132	0.21**

*P < 0.05
**P < 0.01

EFFECT OF INDUCED CRYPTORCHIDISM AT DIFFERENT WEIGHTS ON PERFORMANCE AND CARCASS TRAITS OF LAMBS

L. W. Hudson, H. A. Glimp, P. G. Woolfolk, W. P. Deweese and J. D. Kemp

This study was continued to explore the possibility of using induced cryptorchidism in ram lambs as a method of obtaining a growth similar to that of rams and eliminating live animal market discrimination. Sixty-one crossbred lambs were randomly allotted according to breed of sire, type of birth and birth date into four treatment groups. Treatments consisted of wethers, lambs made cryptorchid at 15 lb or 30 lb and rams. The wethers were castrated at 15 lb with rubber rings. Cryptorchidism was induced by pushing the testes into the body cavity and ablation of the scrotum with a rubber ring. All lambs were allowed to run with their dams in drylot and while on pasture in the spring. A simple creep ration containing 89% cracked corn, 10% soybean meal, and 1% Aureomycin crumbles were available to the lambs at all times.

The lambs were slaughtered at a shrunk live weight of approximately 90 lb. After a 48-hour chill, carcasses were weighed, graded and split down the center. The right side was further separated. Loin-eye area and fat thickness were measured between the 12th and 13th ribs. The kidney and kidney knob fat as well as the trimmed leg were weighed. Testicles of the intact and cryptorchid lambs were removed from the carcasses. The tunica vaginalis was removed and the spermatic chord cut flush with the end of the testis. Testes were then weighed.

The data were analyzed by least squares analysis of data with unequal subclass numbers, using a model that included the main effects of type of birth, breed of sire and treatment. Significance was tested by Duncan's new multiple range test.

Results are shown in Table 1. Both of the cryptorchid treatment groups and the lambs left as rams gained faster ($P < 0.01$) than did the wethers. This suggests that, regardless of the weight of the lambs when cryptorchidism is induced, these lambs will gain as fast as will ram lambs and faster than wethers. Single lambs gained faster ($P < 0.01$) than twin lambs, 0.73 lb as compared with 0.66 lb.

Table 1.--Effect of Induced Cryptorchidism on Live Performance and Certain Carcass Traits

Treatment	Wether	15-lb Crypt	30-lb Crypt	Ram
Number of lambs	13	18	14	16
Birth weight, lb	10.1	9.7	8.8	9.9
Final weight, lb	92.0	95.5	93.0	94.6
Average daily gain, lb[a/]	0.64[c/]	0.71[d/]	0.72[d/]	0.72[d/]
Testicle weight, gm[a/]	0[c/]	87.9[d/]	87.4[d/]	220.5[e/]
Carcass conformation[b/]	13.2	13.3	12.9	12.8
Carcass grade[b/]	13.2	12.3	12.5	12.7
Loin eye area (sq. in.)	2.23	2.28	2.33	2.37
Percent leg	30.6	30.3	30.9	30.9
Loin fat thickness (in.)[a/]	0.30[c/]	0.25[d/]	0.23[d/]	0.25[d/]
Kidney and knob fat, %[a/]	2.63[c/]	2.17[d/]	1.82[e/]	1.94[de/]

[a/] All means not followed by the same superscript are significantly different ($P < 0.01$).

[b/] 15 = prime plus, 14 = average prime, 13 = prime minus, etc.

Testicle weights were significantly affected by treatment, with ram testicle weights being heavier than those from the induced cryptorchid lambs. No differences were observed as a result of the two cryptorchid treatments.

Both fat thickness over the loin and percentage kidney and knob fat were significantly different ($P < 0.01$) because of treatment. Mean differences indicate that wethers were fatter than lambs in the other treatment groups for both traits. No significant differences due to treatment, breed of sire or type of birth were observed in the other carcass traits measured in this trial. The results of this study indicate that cryptorchidism increases rate of gain and decreases carcass fat when compared with wethers.

CAUSES OF VARIATION IN CALVING INTERVALS OF DAIRY CATTLE

Tommye Cooper, D. Olds, and O. W. Deaton

A study of 6,194 calving intervals in Kentucky DHIA herds indicated that the average calving interval was 383.4 ± 57.8 (S.D.) days. The number of days from first service to conception accounted for 61% of the variation in calving intervals, and "lost days" accounted for about two-thirds of that. Lost days were those days beyond 25 between services.

While most dairymen generally plan to allow cows at least 60 days after calving before breeding, it was found in this study that breeding cows 10 days sooner resulted in calving intervals that were 10 days shorter. However, when the cows were bred at less than 40 days after calving, the calving interval was only 6 days shorter for each 10-day reduction in rest period after calving. When cows were bred at less than 30 days after calving, the efficiency was only 3.5 days out of 10 days. This increasing inefficiency was because cows require more services per conception when they are bred at less than 40 days after calving.

Economically, it was found that cows producing 13,000 lb of milk in 305 days would produce about 60¢ less income over feed cost for each day that their calving interval extended beyond 12 months.

Pregnancy was found to depress lactation slightly, starting at 95 days and more markedly after 185 days. Pregnancy during 220 days of a 305-day lactation appeared to lower production by about 1,320 lb of milk.

OBSERVATIONS ON THE SIZE OF BOVINE OVA

Durward Olds, A. P. Graden, C. R. Mochow, and L. R. Mutter

The first observations of bovine ova were made by Hartman *et al.* in 1931. Since that time, several workers have observed cow ova, and a few have reported measurements. Current interest in causes of fertilization failure and in embryonic deaths makes it very desirable to have specific information regarding the amount of variation that might be expected in the sizes of cow eggs. This would assist in deciding whether certain ova are normal or whether they are abnormal.

In this study, 104 ova were recovered from 150 cows at 2-5 days after heat. Measurements were made on 46 fertilized ova and 29 unfertilized ova, using a calibrated ocular micrometer at a magnification of about 200 times.

The average outside diameter (including the zona pellucida) of the 29 unfertilized ova was 171.5 ± 13.8 (S.D.) microns. The zona was 13.4 ± 1.4 microns thick, and the diameter of the vitellus averaged 120.2 ± 6.9 microns. There was no correlation between outside diameter of the ova and thickness of the zonas. Day of recovery appeared to have no effect on size of the ova.

Among the 52 fertilized ova, there was a general trend for the number of blastomeres to increase with increasing time after heat. However, there was considerable variation, ranging from two to eight blastomeres on the third day. The average outside diameter of 46 fertilized ova (including the zona) was 166.4 $\pm$ 16.1 microns, and the average thickness of the zona was 13.1 $\pm$ 1.8 microns. Neither day of recovery nor number of blastomeres appeared to have any effect on these measurements. The differences in size between fertilized and unfertilized ova were not statistically significant.

Five unfertilized ova were first measured in 0.9% sodium chloride solution and then transferred to either a 1.8% solution or to a 0.4% solution. It was found that the vitelli responded readily by shrinking in the higher concentration solution and swelling in the lower concentration. Therefore, osmotic pressure variations can cause rather marked changes in the size of the vitellus.

CAUSES OF FERTILIZATION FAILURE IN REPEAT BREEDING CATTLE

A. P. Graden, D. Olds, C. R. Mochow and L. R. Mutter

Several studies, involving 42 to 63 cows each, have indicated that 58 to 88% of the recovered normal ova from repeat breeder cows are fertilized. In first-service heifers, bred to bulls of high fertility, fertilization rates of 95% or more have been obtained. These results have led some to conclude that fertilization failure is rarely a cause of repeat breeding. The present study was undertaken in an effort to determine the frequency of fertilization failure and its causes in repeat breeding cattle.

Repeat breeding cows and heifers were purchased from dairymen in central Kentucky. All of the animals had been bred at least three times without conceiving, were having relatively normal estrous cycles, and showed no detectable abnormality upon rectal examination. All cows were checked every 8 hours for signs of heat. Successive animals were bred early (as soon as noticed), late (16 hours after being noticed), or both early and late. All of the animals were slaughtered 2-5 days after service and the ova recovered by flushing the oviducts.

A total of 104 ova were recovered from 150 cows (69.3%), and 58 of them were fertilized (55.8% of the ova). There were 20 instances in which ova were not recovered due to ovulation failure, oviduct obstructions, and ovarian adhesions. There were 26 other cases in which ova were not recovered for no apparent reason (20% of the animals).

The rate of fertilization for cows bred early (48.5%) was significantly lower than that for those bred late (68.6%) or those bred both early and late (66.7%). However, the difference did not seem to be any greater than would be expected in normal animals, based on Trimberger's data.

The frequency of abnormalities causing fertilization failure are shown in Table 1.

The presence of or absence of bacteria in the cervix and uterus had no effect on fertilization rate. Histological sections of the uterus indicated that fertilization rates were somewhat lower for cows having cystic uterine glands, unusually thin mucosa layers, or uterine inflammations. However, thickening of arterial walls associated with previous pregnancies, or edema associated with estrus did not affect fertilization rates.

Table 1.--Frequency of Abnormalities Causing Fertilization Failure in Repeat Breeding Cattle

Abnormality	Percent of Cows Bred	Percent of Fertilization Failure
Ovulation failure	8.7	13.1
Oviduct obstruction	6.7	10.1
Abnormal ova	3.3	5.1
Ovarian adhesions	2.0	3.0
Endometritis	3.3	5.1
Lost ova[a]	17.3	26.3
Unexplained	24.7	37.4

[a] Ova were considered to be lost when none could be found in cows showing no abnormality which might account for the absence of an ovum.

SELECTION FOR OXYGEN REQUIREMENTS IN CHICKENS

D. W. MacLaury and T. H. Johnson

Various performance characteristics indicate that different strains of chickens have different metabolic rates, thus indicating some genetic influence on this trait.

In a two-way selection trial, started from Athens-Canadian Randombred stock, the unselected progeny of selected parents differed significantly in their oxygen consumption three weeks after hatching.

The average rate for 141 males in the low-oxygen line was 2.55 ml of oxygen per 100 gm of body weight per minute. The 160 low-oxygen females averaged 2.64 ml. In the high-oxygen line 176 males averaged 3.29 and 174 females 3.27 ml. Differences between lines were very highly significant ($P < 0.001$).

Similar measurements among non-selected inbreds from the same base stock showed no effects of inbreeding on oxygen requirements.

HYPOXIA IN CHICK EMBRYOS

D. W. MacLaury and T. H. Johnson

Many of the malformations found in unhatched chicks are identical with those reported under conditions of low-oxygen incubation. Further study of the effects of decreased oxygen may aid in gaining better hatchability under assumed normal conditions.

About 600 three-day chick embryos were exposed to low levels of oxygen for 6 hours on the third day of incubation. Shortly after exposure half of the eggs were examined, while the remaining half was returned to normal incubation conditions for the balance of the 21-day incubation period. Equal numbers of control eggs were run and examined.

At 3 days the exposed embryos were shorter, showed more hemorrhage and exhibited smaller blood vessels than controls. All differences were statistically significant. Of the eggs allowed to continue incubation the exposed embryos had larger numbers of anophthalmia, microcephaly and all types of terata than controls. These differences were also highly significant statistically.

ANIMAL FOODS

EFFECT OF FRESH HAM QUALITY ON AGED HAM QUALITY

James D. Kemp, David L. Gammon and W. G. Moody

Forty-eight skinned hams of two weight groups (14-16 lb and 18-20 lb) were selected so that each weight group contained 12 high quality and 12 low quality hams. High quality hams were characterized by firm, well marbled lean of uniform color. Low quality hams were characterized by soft, exudative, two-tone lean with little marbling. Fresh ham characteristics were obtained, including percentage of water, protein and ether extract content of the lean and the pH of the light and dark muscles.

The hams were cured for 2 days per lb at 36° F, hung for 30 days at approximately 40° F, rinsed, dried, smoked for approximately 24 hours at 90-100° F and aged for 16 weeks at 75° F.

Weight losses were recorded at regular intervals during processing and aging. After aging, the hams were cut and observed for color, soundness, firmness and aroma. Two 1/2-inch slices were broiled for evaluation by a palatability panel, while one 1-inch slice was broiled and tested for tenderness by a Warner-Bratzler shear. Outside and seam fat samples were analyzed for free fatty acid (FFA) values. Cured lean samples were analyzed for salt, water, ether extract, and protein.

Results and Discussion

Table 1 gives a summary of the data. Chemical composition of the fresh lean of all the hams was more nearly equal than it appeared to be by observation. The high quality hams had slightly more ether extract, the difference being significant ($P < 0.05$) for the heavier hams. The pH of the light colored (gluteus medius) muscles was higher ($P < 0.01$) in the high quality hams for both weight groups, while the pH of the dark muscle (gluteus accessorius) was higher ($P < 0.01$) in the heavier group.

The high quality hams had less weight loss, the difference being greatest ($P < 0.01$) in the heavier hams, indicating that the darker firmer muscles have a greater water-binding capacity. There were only minor differences in the composition of the cured lean samples. However, protein values were significantly ($P < 0.01$) higher in the high quality heavier hams.

Free fatty acid values were similar in both groups.

All hams were reasonably tender. However, in all cases the average shear values were lower, denoting a more tender product, for the low quality hams. These differences were significant ($P < 0.05$) for the semimembranosus for both weight groups and for the biceps femoris for the heavier weight group. Flavor scores were similar in both groups.

In summary, cured aged hams produced from high quality fresh hams had less weight loss than did low quality hams. On the other hand, cured hams from low quality fresh hams were more tender. Protein content was less in high quality hams. Palatability scores and other physical and chemical characteristics were quite similar.

Table 1.--Characteristics of Fresh and Cured Hams of Different Weight and Quality

Variable	Light Weight (14-16 lb)		Medium Weight (18-20 lb)	
	Low Qual[a]	High Qual[a]	Low Qual[a]	High Qual[a]
Fresh lean content				
Water	71.5	71.6	72.2	71.5
Ether extract	7.6	8.7	6.3	8.2*
Protein	19.5	20.3	20.4	19.6
pH—Fresh				
Light muscle (gl m)	5.4	5.8**	5.4	5.9**
Dark muscle (gl a)	5.7	5.9	5.7	6.2**
Wt loss % - 16 wk	29.9	28.2	27.9	23.8**
Cured lean content				
Salt	9.5	9.3	8.6	8.0
Water	51.2	51.0	54.5	54.8
Ether extract	8.9	9.8	7.9	9.5
Protein	27.2	26.7	27.5	24.2**
FFA values				
Outside	9.0	9.2	9.1	9.0
Seam	5.5	6.5	5.4	5.4
Warner-Bratzler shear				
Semimembranosus	13.1	17.0*	8.6	17.1*
Semitendinosus	13.2	14.0	11.9	15.4
Biceps femoris	13.7	13.8	11.2	14.0*
Palatability scores				
Flavor	7.0	7.0	6.9	7.0
Saltiness	7.3	7.3	7.3	7.6*
Tenderness	6.5	6.3	7.0	6.6
Overall satisfaction	6.7	6.6	6.8	6.8

[a] Based on Wisconsin quality standards
*P< 0.05
**P< 0.01

QUALITY OF AGED HAMS AS AFFECTED BY ALTERNATING AGING TEMPERATURES

James D. Kemp, Robert H. Smith and W. G. Moody

The use of controlled temperature to accelerate the aging of dry-cured hams has been widely accepted. Various aging times with constant temperatures have been used. In the process of natural aging the temperature fluctuates greatly owing to night and day as well as to climatic changes. The rate of enzyme activity is influenced by temperature. This experiment was designed, therefore, to determine the effect of alternating aging temperatures on the quality and acceptability of aged hams.

Materials and Methods

Two trials were conducted. Trial 1 included 2 groups of 10 hams each. All hams were dry-cured at 10% of fresh weight, using a mixture of 73.6% salt, 24.5% white sugar, 1.2% potassium nitrate, and 0.6% sodium nitrite. Equal portions of the cure were applied at 3-day intervals, and the hams remained in cure for 2 days per lb at a temperature of 36-40°F. After curing they were brushed of excess salt, hung at the same temperature for 30 days, soaked for approximately 1 hour in lukewarm water, hung in a smokehouse, allowed to dry, and were smoked at 100° F for approximately 24 hours. Group 1 was aged 5 months at 65° F, and group 2 was aged for 5 months at weekly alternating temperatures of 65 and 95° F.

After aging, the hams were cut, observed for soundness, color and aroma. Two center slices of one-half inch thickness were broiled and evaluated by a six-member palatability panel for flavor, saltiness, tenderness, and overall satisfaction. A one-inch slice was broiled and one-inch cores from the semimembranosus, semitendinosus and biceps femoris muscles were evaluated for tenderness with a Warner-Bratzler shear. Outside and seam fat samples from each ham were analyzed for free fatty acid (FFA) values.

Trial 2 included 2 groups of 12 hams each. They were treated as in trial 1 except they were cured at 8% of fresh weight instead of 10%, and group 3 was aged 4 months at 75° F, while group 4 was aged 2 months at 75° F and 2 months at 95° F. Since the data from trial 1 significantly favored the alternating temperature group the change was made to determine if only one change in temperature would have a similar effect.

Data were analyzed by analysis of variance.

Results and Discussion

Trial 1.—Observation of the cut surface of the hams revealed no appreciable differences. Most were normal in color and had a normal aged ham aroma.

Table 1 gives a summary of the quantitative data. There was no significant difference in weight loss at any aging period, although the average loss was slightly greater for the alternating temperature group after 5 months aging. There was a dramatic improvement in tenderness ($P < 0.01$) as measured by the Warner-Bratzler shear, owing to the alternating temperatures in all three muscles studied, with only slight differences between muscles. Since enzyme activity is accelerated by higher temperatures it is assumed that this is the reason for the improved tenderness. This increased tenderness was also detected by the palatability panel ($P < 0.01$). Flavor was improved ($P < 0.10$) and overall satisfaction was improved ($P < 0.01$). There was no significant difference in saltiness, which should be expected since weight loss, resulting mostly from loss of water, was similar.

Free fatty acid values were increased by the alternating temperature with the differences being significant at the 0.10 level for outside fat and the 0.01 level for seam fat.

Trial 2.—Results of trial 2 generally followed the same pattern as in trial 1. There was more difference in weight loss, however, as the 75-95° group showed a significantly greater ($P < 0.05$) loss after 4 months. Most of the hams had normal color and aroma with little difference between groups.

Table 1.--Summary of Results

Factors Studied	Aging Temperatures			
	Trial 1		Trial 2	
	65° F	65-95° F	75° F	75-95° F
Wt loss - % at:				
1 month	19.5	19.5	18.1	17.6
2 months	22.7	22.7	20.6	21.3
3 months	25.0	25.2	22.7	24.5[c]
4 months	27.4	27.2	24.4	27.0*
5 months	28.7	29.2		
Mean shear force values[a]				
Semimembranosus	43.8	19.6**	24.6	16.3*
Semitendinosus	37.2	16.5**	23.5	18.6*
Biceps femoris	42.7	21.9**	24.0	21.1
All muscles	41.3	19.3**	24.1	18.7**
Mean palatability scores[b]				
Flavor	6.2	6.2[c]	7.0	6.8
Saltiness	6.3	6.5	6.0	6.2
Tenderness	5.8	7.1**	6.6	7.0
Overall satisfaction	5.8	6.6**	6.9	6.8
Mean FFA values				
Outside fat	8.6	9.7[c]	9.5	10.4
Seam fat	3.6	6.1**	7.6	8.4

[a] Pounds force required to shear one-inch cores
[b] Based on 9-point hedonic scale
[c] $P < 0.10$
*$P < 0.05$
**$P < 0.01$

Warner-Bratzler shear results again showed the high temperature group to be more tender. The differences were significant ($P < 0.05$) for the semimembranosus and semitendinosus muscles and approached significance for the biceps femoris muscle. When values for all muscles were combined the difference was highly significant ($P < 0.01$) in favor of the hams in the high temperature group. Since the shear differences were not so great, however, as in trial 1, the palatability scores showed no significant difference, although the difference approached significance in respect to tenderness. Although the two trials cannot be directly compared as the samples were different, it was interesting to the authors to note the similarity of tenderness of the high temperature groups and the wide difference in tenderness for the low temperature groups. The average shear value for the 65° group of trial 1 was 41.3 which denotes tough ham while the average for the 75° group in trial 2 was 24.1. This difference could have been partly due to the natural condition of the ham and partly to the increase from 65 to 75° F.

EFFECTS OF SALT, MOISTURE AND AGING TIME ON THE VIABILITY OF TRICHINELLA SPIRALIS IN DRY-CURED HAMS

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The incidence of trichinosis in man has decreased steadily since the passage of the Federal Meat Inspection Act in 1906. A few cases are still reported, however. Commercially cured hams must be heat treated to destroy possible trichinae. Dry-cured hams, however, are not thus treated but must be subjected to rather harsh conditions of curing and smoking. These conditions are not conducive to the production of cured hams of the highest quality. Thus this project was undertaken to determine a combination of time and temperature and the percentage of salt and moisture that would render hams free from living trichinae and still produce a high quality product.

Procedure

Twenty-four weanling pigs were dosed with trichina larva, grown to market weight and slaughtered. Hams and shoulders were removed, examined for trichinae and found to be heavily infected. They were then dry cured for 2 days per pound, using 8% of fresh weight of a curing mixture containing approximately 75% salt. The hams were held at 36° F for one month, smoked and aged at 75° F to the end of the experiment.

Hams and shoulders were sampled by coring into the cushion of the ham and picnic part of the shoulder. This sampling was done on randomly selected hams after curing, after smoking, and each week during salt equalization and aging. After 4 weeks aging all remaining hams and shoulders were dissected and center samples taken. Trichinae were excysted by digesting lean samples in a pepsin-HCl solution. An aliquot of the digested material was taken and examined under a dissecting microscope for count and viability. Additional samples were fed to rats to check further for viability and another sample was analyzed for salt and moisture.

Results

Table 1 shows that there was a slow decrease in moisture and an increase in salt concentration with increased time lapse. There was no noticeable effect on the number of larvae during the curing, salt equalization and smoking periods as can be seen by the high counts per gram. A marked reduction in numbers of live trichinae were found at one week of aging and steadily decreased to 0 at 4 weeks. A marked difference was also seen in the condition of the trichinae recovered. Immediately after digestion, all the larvae from the hams through smoking were tightly coiled indicating the live condition. Rats fed samples containing larvae of this kind became infected, after 4 weeks aging no live or coiled larvae were found. At this time the average percent moisture was 66.5, while the average percent salt was 3.3, giving a water-salt ratio of 20:1 which is higher than in normal aged hams.

Table 2 shows similar results for shoulders except a marked reduction in numbers was found after smoking. This might have been due to a heavier salt and lower moisture concentration as the shoulders were thinner or to a longer exposure to salt. The water-salt ratio in lean of shoulders was 19:1 at one week of aging. Since this is lower than the 20:1 ratio in hams when all trichinae were dead it indicates that it is not salt concentration alone which causes the death of trichinae but perhaps a relationship between salt concentration and time.

Table 1.--Mean Values and Standard Deviations for Ham Samples

Period	Percent Water	SD	Percent Salt	SD[a]	Water / Salt	SD	Live Trichinae per Gram Muscle	SD
Out of Cure	70.5	1.0	0.7	0.3	116	3.4	180	86
1 week SE[b]	70.5	1.4	1.0	0.2	66	8.8	186	112
2 weeks SE	69.1	2.1	1.1	0.3	66	18.7	241	111
3 weeks SE	68.7	2.2	1.0	0.3	66	22.4	149	153
Before smoking	60.5	2.2	1.7	0.5	42	13.1	159	362
After smoking	68.4	1.5	2.1	0.7	36	12.2	140	103
1 week aging	70.3	0.5	2.1	0.1	33	0.6	50	35
2 weeks aging	67.7	2.0	2.5	0.6	28	5.7	34	35
3 weeks aging	67.0		2.9		23		23	
4 weeks aging	66.5	1.9	3.3	0.5	20	3.5	0	0

[a] Standard deviation

[b] Salt equalization

Table 2.--Mean Values and Standard Deviations for Shoulder Samples

Period	Percent Water	SD	Percent Salt	SD	Water / Salt	SD	Live Trichinae per Gram Muscle	SD
Out of Cure	70.8	1.1	1.3	0.5	61	22.5	226	170
1 week SE[a/]	69.8	1.3	1.9	0.8	42	16.8	215	126
2 weeks SE	68.8	0.6	2.8	2.0	26	8.1	152	122
3 weeks SE	68.4	2.1	2.6	0.8	28	7.1	114	62
Before smoking	68.4	1.6	2.6	0.7	27	10.3	110	80
After smoking	67.8	2.0	2.8	0.7	26	7.5	58	38
1 week aging	64.2	1.5	3.4	0.3	19	2.0	33	35
2 weeks aging	63.5	2.2	3.6	0.7	18	3.7	10	9
3 weeks aging	64.7	0.2	4.2	1.3	16	0.3	4	56
4 weeks aging	62.7	2.7	4.4	0.7	15	2.6	0	0

[a/] Salt equalization

Summary

Hams were rendered free of trichinae after dry curing for 2 days per pound, hanging for 1 month for salt equalization, smoking for 24 hours at 100° F and aging for 1 month at 75° F.

RELATION OF CERTAIN PROTEIN COMPONENTS AND FREE AMINO ACIDS TO QUALITY OF PORCINE MUSCLE FROM FIVE DIFFERENT WEIGHTS OF HOGS

W. Ronald Usborne, James D. Kemp and W. G. Moody

Much work has been done in recent years to determine the factors which affect pork quality and cutability. Previous work at this Station has shown that slaughter weight greatly influences cutability. This study was devised to determine the effect of slaughter weight on certain physical, chemical and organoleptic properties of raw and cooked pork from hogs of different weights.

Procedure

Four litters of five Hampshire half-brother barrows were grown and finished under the same environmental conditions and distributed among slaughter weight groups of 160±5, 190±5, 220±5, 250±5 and 280±5 pounds so that each litter was represented in each weight group. Live weights were adjusted for differences in fill. Complete carcass and cutout data were obtained. The color, firmness, marbling and texture were evaluated on a cross section of the longissimus dorsi; the anterior end of the same muscle was saved for chemical analyses.

The remainder of the right loin was cooked and longissimus dorsi samples were used for a palatability panel evaluation of flavor, juiciness, tenderness, and overall satisfaction; Warner-Bratzler shear tests; and for chemical analyses of the cooked product. The drippings from each cooked product were also subjected to chemical analyses. Raw and cooked samples were finely powdered while still in the frozen state by using a liquid nitrogen bath and a Waring blender. The percentage of water, protein, ether extract, and ash; the protein nitrogen components expressed in percents of total nitrogen and consisting of total fibrillar, soluble fibrillar, sarcoplasmic, non-protein, collagen, and residual connective tissue protein as determined by difference; and the free amino acids expressed as molar % were determined in these raw and cooked longissimus dorsi samples. Free amino acids were also determined on the drippings from cooking. Analysis of variance and simple and partial correlations were calculated for the various variables.

Results and Discussion

Lighter weight hogs had a more desirable raw meat quality with respect to color ($P < 0.05$), firmness ($P < 0.05$), and texture ($P < 0.01$) and also produced cooked roasts which had better flavor ($P < 0.05$), juiciness ($P < 0.01$), and overall satisfaction ($P < 0.05$). The percentage protein of the longissimus dorsi muscle increased linearly ($P < 0.01$) and the percentage collagen nitrogen decreased linearly ($P < 0.05$) as the live weight increased. There were no differences among weight groups in the percentages of total fibrillar protein nitrogen, soluble fibrillar protein nitrogen, non-protein nitrogen, and residual connective

tissue protein nitrogen. The percentage of sarcoplasmic protein nitrogen varied greatly among weight groups. The molar percentages of free theronine ($P < 0.05$), valine ($P < 0.01$), methionine ($P < 0.01$), isoleucine ($P < 0.01$), leucine ($P < 0.01$), phenylalanine ($P < 0.01$), and histidine ($P < 0.01$) increased linearly with increasing live weight while those of free alanine ($P < 0.05$) and glycine ($P < 0.01$) decreased.

In the cooked product, the percentages of soluble fibrillar protein nitrogen, sarcoplasmic protein nitrogen, nonprotein nitrogen and residual connective tissue protein decreased about 75%, 100%, 33%, and 43.5% respectively, while that of collagen nitrogen remained almost constant from the raw to the cooked state. The proportions of free aspartic acid, proline, glycine, and methionine were higher in raw pork, while those of free serine, glutamic acid, isoleucine, leucine, tyrosine, phenylalanine, lysine, and arginine were higher in cooked meat. The total free amino acids were higher in the drippings than in the raw and cooked pork. Flavor (0.48*), juiciness (0.79**), and overall satisfaction (0.72**) were negatively correlated with the percentage of protein. The percentage of sarcoplasmic protein nitrogen in the raw meat was correlated with firmness (0.58**), juiciness (0.51*) and overall satisfaction (0.45*). Tenderness of the cooked product was correlated with free serine (0.50*), glutamic acid (0.44*), leucine (0.56**), and phenylalanine (0.51*). Free glycine (0.70**) in raw pork and free glycine (0.52*) and proline (0.60**) in the cooked product along with several other free amino acids were correlated with the percentage of collagen nitrogen in raw and cooked pork. Various individual free amino acids in cooked pork were most frequently correlated with flavor, followed by juiciness and overall satisfaction. The higher quality pork had generally less total protein and more collagen nitrogen, smaller proportions of free threonine, valine, methionine, isoleucine, phenylalanine, and histidine, and greater proportions of glycine and alanine.

KEEPING QUALITY OF WHIPPING CREAM AND HALF-AND-HALF OBTAINED AT RETAIL OUTLETS

B. E. Langlois and H. E. Randolph

Samples of whipping cream and half-and-half representing 12 brands of 9 commercial plants were obtained from supermarket-type retail outlets in Lexington, Ky.

The samples were evaluated for flavor on the day purchased and after 4, 7, 10, and 14 days' storage at 45F. Samples scoring below 36.0 were considered to be unacceptable.

Standard plate counts and coliform counts were run on the samples on the day purchased and again after storage for 7 days at 45F.

Results

Results obtained with the half-and-half samples are given in Table 1.

Initial flavor scores of the samples on the day purchased ranged from 30.0 to 40.0, the average being 38.6. The age of the samples on the day purchased ranged from 2 to 14 days, the average being 6.0 days. The average purchase age ranged from a low of 3.3 days for Brand D to a high of 8.3 days for Brand E. Four percent of the samples were spoiled at the time of purchase. Approximately 42% of the samples had a shelf-life of greater than 10 days at 45F, with 15% being salable after 2 weeks. Nineteen percent of the samples had coliform counts which exceeded the legal standard plate count.

Results obtained with the whipping cream samples are given in Table 2. Initial flavor scores of the samples on the day purchased ranged from 30.0 to 40.0, the average being 38.6. The age of the samples on the day purchased ranged from 2 to 17 days, the average being 7.1 days. The average purchase age ranged from a low of 5.1 days for Brand D to a high of 10.3 days for Brand H. Six percent of the whipping cream samples were spoiled at the time they

Table 1.--Keeping and Bacteriological Quality of Half-and-Half Obtained at Retail Outlets

Brand	Purchase Age	Initial Flavor	Days kept at 45F					Coliform Count >10/ml		Standard Plate Count>20 T/ml	
			0	0-<4	4-<7	7-<10	10-<14	>14	0 Days	7 Days	0 Days	7 Days
	Av	Av	Number of samples									
A	a/	38.9			1	1		2	0	0	0	3
B	7.7	37.9	1		1	4	1		2	5	3	7
C	6.7	37.8		1	1	2	2		0	0	1	5
D	3.3	39.2					3	4	0	1	0	4
E	8.3	35.9	2	3	2				6	7	6	7
F	5.5	39.7				1	3	2	0	1	0	5
G	4.6	39.2		1	2		1	1	0	2	0	3
H	6.0	39.6		2	4	1			2	6	4	7
I	6.4	38.9			3		3	1	0	0	0	5
J	6.4	38.7			1	1			1	1	1	3
K	4.1	39.5		1	4	2			3	4	1	7
L	7.0	38.8			1		4	1	0	1	1	6
	6.0	38.6	4%	11%	27%	16%	27%	15%	19%	38%	23%	84%

a/Code not available.

were purchased. Approximately 47% of the samples had a shelf-life greater than seven days, with 21% being usable after 14 days. The legal coliform count was exceeded by 27% of the samples at the time of purchase, while 41% had counts that exceeded the legal standard plate count.

Table 2.--Keeping and Bacteriological Quality of Whipping Cream Obtained at Retail Outlets

Brand	Purchase Age	Initial Flavor	Days kept at 45F					Coliform Count >10/ml		Standard Plate Count>20 T/ml	
			0	0-<4	4-<7	7-<10	10-<14	>14	0 Days	7 Days	0 Days	7 Days
	Av	Av	---------- Number of samples ----------									
A	a/	39.6	1			3			0	3	1	4
B	8.0	36.6	1	1	2	1	1		3	5	2	7
C	8.4	36.8		1	3				1	2	5	5
D	5.1	39.0		1	2	2		2	2	3	3	5
E	7.4	39.0		1	4	1	1		4	6	5	7
F	6.4	39.9						5	0	0	0	1
G	5.6	39.5			1	2	1	1	0	1	0	4
H	10.3	37.7	1	3	2			1	4	6	6	6
I	6.1	39.4		1	2	2		2	1	2	1	6
J	7.2	39.3			1	2	1	1	1	1	1	5
K	6.6	38.5		3	2	1		1	2	5	4	6
	7.1	38.6	6%	17%	29%	21%	6%	21%	27%	52%	42%	85%

a/ Code not available.

REDUCTIVE DECHLORINATION OF DDT BY ESCHERICHIA COLI

B. E. Langlois

The reductive dechlorination of DDT, containing various levels of the p,p' isomer by Escherichia coli was studied in skimmilk and various broths containing 1 ppm of the desired DDT.

The amount of dechlorination was determined after 0, 2, and 7 days incubation at 37°C by the use of election capture gas chromatography.

Controls containing only the medium and the various DDT's were run and analyzed along with the medium containing E. coli.

Results and Discussion

Neither the amount nor the structure of the DDT in the controls showed any detectable change after 7 days at 37°C.

Figure 1 compares chromatograms obtained after 0 and 7 days' growth of E. coli in trypticase soy broth containing 99.3% p,p'-DDT. The chromatograms are typical of those obtained from the different broths containing the various DDT's. The p,p' peak of all DDT's studied underwent reductive dechlorination by E. coli when grown in the various broths. In general, the p,p' peak was over 50% dechlorinated after 2 days and over 90% dechlorinated after 7 days. Neither the percentage of the p,p' isomer nor the type of broth appeared to affect the rate of reductive dechlorination by E. coli.

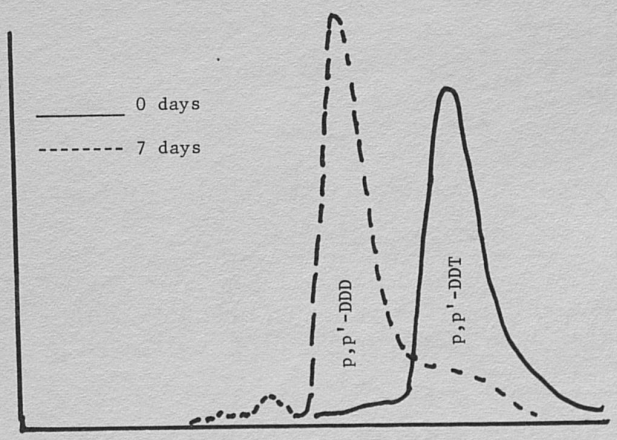

FIG. 1.—CHROMATOGRAMS OBTAINED AFTER GROWTH OF E. COLI IN TSB CONTAINING 99.3% P,P-DDT.

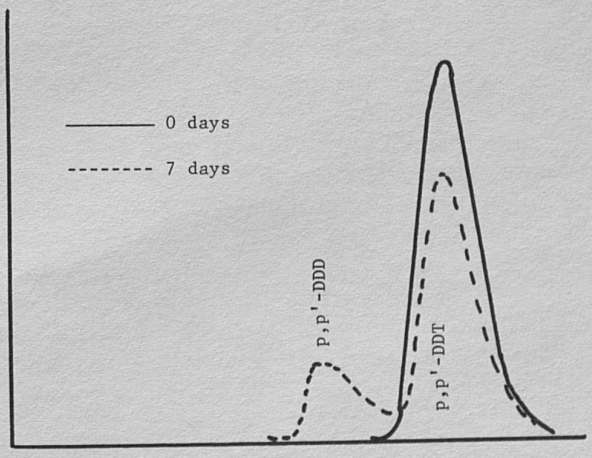

FIG. 2.—CHROMATOGRAMS OBTAINED AFTER GROWTH OF E. COLI IN SKIMMILK CONTAINING 99.3% P,P-DDT.

Figure 2 compares chromatograms obtained after 0 and 7 days' growth of E. coli in skimmilk containing 99.3% p,p'-DDT. The chromatograms are typical of those obtained from skimmilk containing the various DDT's. Unlike the results obtained with broth, there is very little change in the structure of the various DDT's in skimmilk. The p,p' peak of all the DDT's studied was not changed after 2 days and only the 99.3% p,p'-DDT showed a detectable change in the p,p' peak after 7 days. The skimmilk appeared to inhibit the reductive dechlorination mechanism of E. coli when used as a growth medium.

MANUFACTURING PRACTICES FOR CHOCOLATE-FLAVORED MILK AND DRINK IN THE UNITED STATES

B. E. Langlois and H. E. Randolph

Information concerning the processing, sales, and quality control practices of plants manufacturing chocolate-flavored (C-F) milk and drink is limited. Therefore, to obtain such information, a questionnaire was sent to 396 plants in 46 states. The questionnaire was returned by 271 (69.4%) plants.

This paper presents the results obtained from 250 plants, since 21 plants returning the questionnaire did not handle C-F milk or drink. Some of the principal results obtained from this survey are given in Table 1.

Processing

The majority (64.6%) of the plants reported that they processed and sold only a C-F milk containing over 3.25% milk fat. Fourteen percent of the plants sold both a C-F milk and a C-F skimmilk or drink.

Twenty percent of the plants reported that they produced less than 500 gallons of chocolate product a week. Less than 3% of the plants produced over 20,000 gallons a week. Chocolate-flavored milk and drink were processed five or more times a week by 45% of the plants. Every plant reported processing C-F product at least twice a week. Over 96% of the plants processed their own C-F products, and less than 17% did private labelling for other dealers.

Milk solids-not-fat in the form of low-heat NDM was added to the C-F product by about 12% of the plants. Eleven % of the plants reported the use of returned products in the production of their C-F product; however, this represented less than 5% of the milk used in each batch.

The answers to the questionnaire indicate a lack of uniformity in the temperatures and holding times used for the pasteurization of C-F milk and drink. HTST pasteurization was used by 80% of the plants, while 14% used vat pasteurization. Several plants indicated that they used both vat and HTST pasteurization. The distribution of pasteurization temperatures and holding time combinations obtained from the survey is given in Table 2. Nine different temperatures and two holding times were reported by the plants using vat pasteurization. The temperatures ranged from 145 to 185 F, with a holding time of either 20 or 30 minutes. The most common conditions used were 160, 165, or 170 F for 30 minutes.

Table 1.--Production Sales and Quality Control of Chocolate Flavored (C-F) Milk and Drink for Plants Responding to Survey

	% Affirmative Responses		% Affirmative Responses
Production of:			
C-F milk	64.4		
C-F low-fat milk	6.0		
C-F drink	7.2		
Both milk and low-fat milk	6.8		
Both milk and drink	14.0		
Addition of milk solids-not-fat	11.6		
Volume processed per week (gal)			
Less than 500	20.0		
500 to 1,000	13.2		
1,000 to 2,000	16.8	Percent of fluid sales represented by	
2,000 to 5,000	22.0	chocolate flavored milk or drink	
5,000 to 10,000	18.4	0 to 3 %	40.4
10,000 to 20,000	4.8	3 to 5%	26.0
Over 20,000	2.4	5 to 10%	18.4
		10 to 25%	9.2
Conducting routine shelf life test	66.0		
Temperature used		Percent of chocolate milk sales	
40 F or below	21.6	to schools	
40 to 45 F	31.6	0 to 3%	42.0
46 to 50 F	14.8	3 to 5%	3.6
Shelf life expected		5 to 10%	5.2
5 to 7 days	10.4	10 to 20%	4.8
8 to 10 days	30.4	20 to 30%	6.4
11 to 14 days	28.0	30 to 50%	12.0
Over 14 days	11.2	Over 50%	22.4

Table 2.--Distribution of Pasteurization Temperature and Holding Time Combinations Used by Plants Responding to the Survey

Pasteurization Temperature	Holding Time																						Total
	seconds													minutes									
F°	12	15	16	17	18	19	20	21	22	23	24	25	26	27	30	32	45	55	60	2	30		
145																					1		1
155																					2		2
157							1																1
160																					8		8
162			1	1																	1		3
165			2		1																8		11
166			1																				1
167			1																				1
168			3	1		1			1	1													7
169				2																			2
170	2	2	6	6	3		1	1			1						1				7		30
171			1	1	1																		3
172			1	1										1					1				4
173		1		1																			2
174			2																				2
175			18	7	7	4	3				1	3			2		1		1		2		49
176									1											1			2
177															1								1
178			1				1																2
180		1	8	5	5	1	3			1	1			1	1		1	1			1		30
181												1											1
182												1	1				1						3
183									1														1
185	1		5	3	2	1	2		1		1	1			1					1	2		21
186							1																1
187																1							1
190			4	2																			6
Total	3	4	54	30	19	7	12	1	4	2	4	6	1	2	5	1	4	1	2	2	32		196

The results obtained for HTST pasteurization were even more complex. Twenty-five different temperatures and 19 holding times were reported by the plants using HTST. The temperatures ranged from 157 to 190 F, and the holding times ranged from 12 to 60 seconds. Temperatures of 170, 175, 180 and 185 F were used by 14%, 29%, 18% and 11% of the plants, while holding times of 16, 17, 18 and 20 seconds were used by 33%, 19%, 12% and 7% of the plants.

Ingredients

Chocolate-flavored powders were used by 92% of the plants, and 88% of the plants purchased them complete except for sugar. Less than 3% of the plants used a different chocolate powder or syrup for producing C-F milk or drink for schools than they used for their non-school sales. The 250 plants purchased their C-F powder or syrup under 29 different brands. The plants surveyed purchased over 50 different types of chocolate products under the 29 brands. Of the 29 brands, three brands accounted for about 50% of the chocolate products purchased by the plants surveyed. Cane sugar was used by 79% of the plants, and 4% used beet sugar.

Sales

Chocolate-flavored products accounted for less than 5% of the total fluid milk sales for 66% of the plants, and in no case was the percentage greater than 25. The sale of C-F product to schools was less than 3% of the total C-F product sales for 42% of the plants; while 22% of the plants reported their sales to schools accounted for over 50% of their C-F product business.

Quality

A pickup of 8 days or less was used by 66% of the plants. The pickup time used for C-F products was the same as that used for homogenized milk by 84% of the plants.

Routine shelf-life tests were conducted by 66% of the plants, with approximately half the plants using a storage temperature of 45 F or less. Forty percent of the plants anticipated a shelf-life of 10 days or less at the temperatures they were using, while 57% of the plants anticipated the same shelf-life for C-F products as for homogenized milk.

Over 80% of the plants had not made a study of the reaction of the consumer to their product during the last year. A like number of plants reported that they had not received any consumer complaints on their C-F milk during the last year.

EFFECT OF FILTERING AND CLARIFYING MILK ON THE CATALASE AND THE WISCONSIN MASTITIS TEST RESULTS

H. E. Randolph and J. L. Bucy

The catalase test and the Wisconsin mastitis test (WMT) are two of the five screening procedures recommended by the U. S. Public Health Service for detection of abnormalities in the milk supply. There is a lack of information on factors which might influence the reliability of these tests. As a part of a comprehensive project, the effect of filtering and clarifying milk on the catalase and WMT test results was investigated.

Procedure

Thirty-five milk samples were collected from individual cows and bulk milk tanks. Three filter pads were used with different porosity. The control sample was taken before filtration and a comparison was made between test results.

Twelve samples of milk were collected before and after clarification at local commercial plants and the test results were compared.

Results and Discussion

Filtration, using three different commercial filter pads, caused no significant change in the results of either test.

Clarification caused a pronounced reduction in results of both tests (Table 1). The average reduction for the 12 milk samples was 35% for the catalase test and 50% for the WMT. Based on these trials, extreme caution should be used in interpreting results of these tests when the possibility of prior clarification exists.

Table 1.--Effect of Clarification on the Catalase and Wisconsin Mastitis Test Results[a/]

	Before Clarification	After Clarification
Catalase Test	------- % Oxygen produced --------	
Range	18.8-56.6	14.4-34.4
Average	32.0	20.7
Standard deviation	9.97	4.97
Average % reduction	-----	34.7
Wisconsin Mastitis Test	---------- WMT values ----------	
Range	3.0-15.9	2.0-8.7
Average	11.0	5.5
Standard deviation	3.72	1.92
Average % deduction	-----	50.0

a/Results represent trials with 12 different milk samples.

EFFECT OF CHEMICAL SANITIZERS ON THE WISCONSIN MASTITIS TEST

R. L. Richter and H. E. Randolph

Methods for detecting abnormal or mastitic milk have been receiving more attention recently because of the new Grade A pasteurized milk ordinance that becomes effective on or before July 1, 1967. Several tests have been recommended by the USPHS, and the Wisconsin Mastitis test is one of the recommended tests. A substantial amount of work has been done comparing the results of the Wisconsin Mastitis test with the actual leucocyte count, but little work has been done to determine factors that might affect the reliability of this test. This experiment was designed to determine whether chemical sanitizers could cause a reduction in the Wisconsin Mastitis test.

Procedure

Milk samples showing positive reactions to the California Mastitis Test were obtained from the University of Kentucky dairy herd. Chlorine, iodophor, quaternary ammonium compounds, and orthophosphoric acid sanitizers were investigated. Five milk samples were used for each sanitizer. The concentrations of sanitizers studied were 0, 5, 10, 25 and 50 ppm. The 0 ppm concentration had distilled water added to the milk to produce the same dilution factor as the milk samples containing the sanitizers. The samples were tested immediately after the addition of the sanitizer and again after holding at 4.5°C for 5, 24, and 48 hours from the time the sanitizer was added.

Results and Discussion

The chlorine and acid sanitizers had no effect on the Wisconsin Mastitis Test at any of the concentrations tested. The quaternary ammonium compounds and the iodophors had a marked effect at concentrations of 25 and 50 ppm. Normal milk samples would not be expected to contain concentrations at such a high level, but under abnormal conditions it is possible to have these concentrations in a sample. These results indicate that the reliability of the Wisconsin Mastitis Test results could be influenced by quaternary ammonium and iodophor sanitizers.

Table 1.--Wisconsin Mastitis Test Values as Affected by Chemical Sanitizers[a/]

Time Tested[b/]	Parts per Million of Sanitizer				
	0	5	10	25	50
(hours)	WMT value				
Iodophor[c/]					
0	20.1	19.3	18.2	15.2**	10.4**
5	16.7	15.5	15.2	13.7**	11.4**
24	15.3	14.8	14.9	10.4**	6.0**
48	11.9	11.5	10.3	7.1**	3.5**
Iodophor[d/]					
0	19.7	19.3	17.9	16.5**	15.2**
5	19.6	19.7	19.2	15.9**	10.2**
24	16.0	16.7	15.7	11.4**	7.6**
48	11.8	12.5	11.5	7.7**	3.2**
QAC[e/]					
0	23.2	23.1	23.0	22.8	22.6
5	21.3	21.1	20.6	20.5	18.7**
24	19.1	18.8	19.1	17.2	13.0**
48	14.4	14.7	14.2	12.1*	9.3**
QAC[f/]					
0	19.6	19.8	19.7	19.5	18.9
5	18.7	19.2	18.3	17.7**	17.8**
24	16.7	15.5	15.3**	14.8**	14.2**
48	13.2	13.0	12.6	12.4	11.5**

* Significant at 5% level ** Significant at 1% level

[a/] Results with each sanitizer represents trials with different samples of milk.

[b/] Storage at 4.5°C after the addition of the sanitizer.

[c/] Phosphoric acid, nonyl phenoxy polyethoxy ethanol-iodine complex, polyethoxy polypropoxy polyethoxy ethanol-iodine complex.

[d/] Polyethoxy polypropoxy ethanol-iodine complex, nonyl phenylether of polyethylene glycol-iodine complex.

[e/] Alkyl dimethyl benzyl ammonium chloride, alkyl dimethyl ethylbenzyl ammonium chloride.

[f/] Alkyl dimethyl benzyl ammonium chloride.

EFFECT OF STORAGE TIME ON THE WISCONSIN MASTITIS TEST

R. L. Richter and H. E. Randolph

The increased use of the Wisconsin Mastitis Test as a screening test for abnormal or mastitic milk in the Grade A pasteurized milk market has caused a need to establish the reliability of this test. It has been shown that some chemical sanitizers have a significant a significant effect on the Wisconsin Mastitis Test at concentrations of 25 ppm or greater. Knowledge of the effect of chemical sanitizers initiated this study of the effect of holding time on the Wisconsin Mastitis Test.

Procedure

A total of 34 milk samples that gave a positive reaction to the California Mastitis Test were obtained from the University of Kentucky dairy herd. After the samples had been collected they were taken to the laboratory where the Wisconsin Mastitis Test was performed. The samples were then cooled immediately to 4.5°C and held at that temperature for 4, 24, and 48 hours. Every sample was tested in duplicate at the end of each holding period.

Results

The results of this study indicate that the Wisconsin Mastitis Test reaction decreases during storage. After the samples were held for 4, 24, and 48 hours the average reductions in the Wisconsin Mastitis reading from the control (0 hr) were 3.09%, 14.49%, and 32.81% respectively. The rate of decrease in reaction appears to be first order in nature. Similar results were observed at storage temperature of 1.7°, 7.0°, and 10.0°C.

Table 1.--Effect of Storage Time on Wisconsin Mastitis Test

	Holding Time, Hours			
	0	4	24	48
Mean	21.67	21.0	18.53	14.56
Range	13.5-30.0	13.0-29.5	10.5-30.0	6.0-26.0
Std dev	3.959	2.209	4.456	4.695
Av % reduction from 0 hr	--	3.09	14.49	32.81

a/ Results of 34 samples tested

EFFECT OF HEAT-SHOCK ON THE WISCONSIN MASTITIS TEST

R. L. Richter and H. E. Randolph

The Wisconsin Mastitis Test (WMT) is based on the reaction of the reagent used in the test with the DNA of leucocytes from injured udders. DNA is composed of proteins and proteins are susceptible to heat. This fact and the possibility that milk can presumably receive heat treatments caused this study to be initiated.

Experimental Procedure

Five samples of mastitic milk obtained from the University of Kentucky dairy herd were used in each heat treatment of 110°, 120°, 130°, and 140° F. The milk samples were heated for 0, 1, 2, 4, 6, 8, 10, 15, and 20 minutes at each temperature. To develop the proper temperature, 10 ml of each sample was transferred to 16 x 125 mm screw-top test tubes and placed in a water bath of the desired temperature. Four minutes were required for the milk samples to reach the desired temperature.

This period of forewarming is not included in the holding time. At the end of each holding period the samples were placed in an ice water bath and allowed to cool. The WMT was performed in duplicate on each sample for each holding time when the samples were cool.

Results

Heat treatment decreased the Wisconsin Mastitis test values. The effect increased with the severity of the heat treatment. After the milk samples were held for one minute at 110°, 120°, 130°, and 140°F, the reduction in the WMT values was 23.8, 58, 64.2, and 78.2% respectively. As the holding time increased, the WMT values decreased. At the completion of the 10-minute holding period at the previously mentioned temperatures the reductions were 33.7, 74.5, 86.5, and 90.4%. These reductions increased to 39.5, 79.2, 85, and 95.6% of the original Wisconsin Mastitis Test value at the end of the 20-minute heat treatment.

These results indicate that temperatures ranging from comparatively mild heat treatments to temperatures near the phosphatase inactivation point can affect the WMT severely. Care must be exercised in interpreting WMT results when the possibility of prior heat treatment exists.

Table 1.--Effect of Heat Treatment on the Wisconsin Mastitis Test

Holding Time, Minutes	°F			
	110	120	130	140
	WMT Value			
0 (Control)	24.3	21.2	26.0	23.0
1	18.5	8.9	9.3	5.0
2	17.9	9.4	7.2	4.5
4	17.5	9.3	5.8	4.2
6	17.5	8.9	5.7	3.5
8	17.8	9.3	4.9	3.5
10	16.1	5.4	3.5	2.2
15	15.7	5.2	3.2	2.0
20	14.7	4.4	3.9	1.0

FACTORS WHICH MAY INFLUENCE THE RESULTS OF THE CATALASE TEST FOR ABNORMAL MILK

J. L. Bucy, H. E. Randolph, and T. R. Freeman

The catalase test has been widely used as a screening procedure for detection of abnormalities in the milk supply. It is one of five tests recommended for this purpose by the U. S. Public Health Service. Although considerable work has been done on the effect of techniques and storage of the milk, there is a definite lack of information on factors which might influence the reliability of the catalase test results. The influence of various concentrations of five commercial chlorine sanitizers, six other chemical sanitizers, three metals, two antibiotics, and three storage temperatures and times on the catalase test results was investigated.

Of the factors investigated, only the chlorine sanitizers significantly altered the results of the catalase test; therefore, only this aspect of the study will be considered in this report.

Procedure

Milk samples were obtained from individual cows, individual herds, and bulk tank milk delivered to the Lexington market. Dilute solutions of the sanitizers were prepared so that a constant volume (5 ml) could be added to 95 ml milk to give concentrations of 5, 10, 15, 20, 25, and 50 ppm active ingredient in the milk. Five ml distilled water was added to the control. The temperature of the milk was adjusted to room temperature before testing. The catalase activity of the sample, immediately after addition of the sanitizers and after holding at 4.5°C for 5 and 24 hours, was determined by the inverted tube method. Graduated centrifuge tubes with one-hole rubber stoppers fitted with straight glass tubing were used. The tubes were completely filled with water after 9 ml milk containing the sanitizer and 1 ml of 3% hydrogen peroxide was added. The tubes were inverted and incubated at room temperature for 3 hours and the ml of 0_2 produced was read directly from the graduated tubes and calculated as percentages.

Table 1.--Catalase Readings as Affected by Chlorine Sanitizers[a/]

Sanitizer and Concentration	Tested Immediately	After 5 Hr at 4.5°C	After 24 Hr at 4.5°C
PPM	% Oxygen Produced, Average		
Calcium hypochlorite			
0	43.5	38.8	41.4
5	37.1	36.3	36.8
10	35.3	33.0	35.6
15	35.3	32.6	34.3
20	34.0	31.2	29.5
25	33.1	30.0	30.1
50	31.9	18.1	18.6
Sodium hypochlorite			
0	41.1	38.8	41.4
5	34.6	32.7	34.7
10	31.7	30.3	29.9
15	30.8	25.8	26.8
20	29.7	25.0	22.1
25	28.8	22.6	22.3
50	24.1	16.0	13.3
Dichloro(s) triazinetrione			
0	45.7	48.6	51.5
5	43.5	45.5	47.1
10	41.1	43.9	44.8
15	40.6	40.8	43.0
20	38.0	39.3	41.9
25	37.5	37.8	39.1
50	31.3	30.2	29.1
Dichloroisocyanuric acid			
0	47.9	45.3	51.3
5	42.4	37.7	44.4
10	39.8	34.0	40.6
15	38.6	30.6	35.7
20	36.8	28.6	36.4
25	35.0	25.3	33.9
50	31.5	18.2	23.5
1,3 dichloro 5,5 dimethylhydantoin			
0	42.6	43.7	42.2
5	38.4	36.6	34.9
10	34.2	31.5	29.9
15	31.1	28.2	27.5
20	30.2	26.2	24.2
25	28.6	23.1	22.4
50	24.6	17.3	15.1

[a/] Results for each sanitizer represent trials with five different samples of milk.

Results and Discussion

The catalase activity of the milk samples ranged from 4% to 80% oxygen produced. The effect of the various concentrations of the different sanitizers used in terms of percent oxygen produced is shown in Table 1. All of these sanitizers caused a marked reduction in the percentages of oxygen produced in the catalase test. The effect increased with increasing concentrations of chlorine and was more pronounced when the samples were tested after holding at 4.5°C for 5 and 24 hours following addition of the sanitizer.

Although seemingly there are some variations in magnitude of the effect of the different sanitizers on the test results, the basic pattern is very similar for all the sanitizers. It is believed that these differences shown here are not due to variations in the inhibiting properties of the sanitizers; rather, it seems more likely that these apparent differences are due to variations in the milk samples.

The foregoing results indicate that the reliability of the catalase test results could be greatly decreased as a result of contamination with chlorine sanitizers on the farm or in collection of the samples.

FREEZING POINT OF MILK PRODUCED IN KENTUCKY

T. R. Freeman and J. L. Bucy

Since about 1925 the freezing point of milk has been used for detecting and measuring the adulteration of milk by the addition of water. In recent years freezing point observations reported by health department, dairy industry, and land grant college personnel have caused serious doubts to be raised regarding standards which have been generally accepted as reliable.

To obtain information that would assist in establishing a reliable freezing point standard, a survey has been made of the freezing point of known-pure samples of milk produced in Kentucky.

Over a period of two years 24-hour composite herd samples were collected from five soil areas of Kentucky having widely differing characteristics. This involved 507 samples from 45 herds varying in size from 2 to 105 animals, and averaging 21. Samples were collected from night and morning milkings and were held in ice until analyzed at the laboratory in Lexington. The time interval between sampling and freezing point determination was always less than 48 hours.

Average freezing point values obtained from the five soil areas (Purchase, Western Coal Fields, Knobs, Hills of the Bluegrass, Inner Bluegrass) were -0.540, -0.542, -0.541, -0.540, and -0.540°C, respectively. The ranges in freezing points for these five regions were -0.526 to -0.558, -0.524 to -0.559, -0.512 to -0.554, -0.518 to -0.567, and -0.511 to -0.567. The unweighted average freezing point for all samples was -0.5402°C.

Sixty-nine percent of all samples fell within the range -0.550 to -0.536°C, 69% within the range -0.545 to -0.531, and 84% within the range -0.550 to -0.531°C. A definite seasonal trend was observed, the highest average freezing point (-0.537°C) occurring in June and the lowest (-0.545) in January, representing 44 and 41 herd samples, respectively.

SOUR CREAM WITHOUT BACTERIAL CULTURES

T. R. Freeman and J. L. Bucy

A so-called "chemical coagulation" method for producing commercial sour cream is being promoted by at least two dairy supply companies. While the coagulants sold by the two companies differ slightly with regard to the mechanism of acid production, neither uses a bacterial culture or a "starter." Both companies claim that the "chemical coagulation" method produces a more uniform product and that labor costs are reduced by eliminating the need for culture propagation.

In cultured sour cream the flavor is produced by the culture or "starter." In the "chemical coagulation" or non-culture method, flavor is obtained by adding synthetic flavor concentrates. Experiments were conducted using such flavor concentrates obtained from 14 proprietary sources. The flavor of the resulting sour creams was slightly more desirable than the control, which contained only the acidulant, but these artificially flavored products were definitely inferior in flavor quality to sour creams prepared with the use of bacterial cultures.

Two flavor concentrates especially formulated and prepared for this purpose in the Food Science and Technology Department at Oregon State University have been obtained through the courtesy of Dr. R. C. Lindsay. These have also been used in the preparation of experimental batches of sour cream. Although this work has not been completed, there appears to be a strong indication that these flavor concentrates also produce sour cream with somewhat "unnatural," less pleasing flavor than is routinely obtained by the conventional, culture method.

QUALITY CONTROL PROGRAMS OF MILK MARKETING COOPERATIVES IN THE UNITED STATES

T. R. Freeman and H. E. Randolph

For effective results, some segment of the dairy industry must assume definite responsibility for the raw milk quality control program. For a number of years the milk producer cooperative dominated the scene. In recent years, however, there has been a definite trend toward a stronger dairy plant field program. The implication is that processor-distributors have not been entirely happy with the quality of the raw milk delivered to their plants. It was believed that many cooperative managers would welcome some sort of "standard of comparison" that would aid them in evaluating their own quality control programs.

Questionnaires were mailed to 123 of the major cooperatives, representing all sections of the United States. Replies were received from 63.

There was no relationship between size of organization and number of fieldmen per 100 members or per million pounds of milk produced. Proportion of fieldman time spent on milk quality problems varied from 15 to 100%. Nineteen of the cooperatives indicated that their fieldmen gave 25% or more time to procurement, and 13 cooperatives reported 25% or more time devoted to herd management problems.

Opinion was equally divided as to whether raw milk quality problems should be the responsibility of the cooperative, or jointly of the plant, the cooperative, and the regulatory agency. Seventy-two percent indicated that their quality standards were the same as recommended by USPHS (1953). The predominant comment from the remaining 28% was to the effect that their standards were more stringent than those of USPHS.

The number, kind, and frequency of quality tests used varied greatly. Monthly testing (as compared with twice-monthly, quarterly, and twice-yearly) was the most popular time schedule. Of 18 types of tests reported in use, tests for inhibitors and for total bacterial numbers were the most widely used.

FACTORS RELATING TO THE SERVING OF ICE CREAM AS DESSERT WITH THE TYPE A SCHOOL LUNCH

H. E. Randolph, A. W. Rudnick, Jr., and
C. E. Bevins[1/]

This study was undertaken to determine the frequency ice cream was served as a dessert in schools in Kentucky. Furthermore, reasons were sought to explain the frequency or infrequency of such service.

Procedure

A rather comprehensive questionnaire covering the years 1964-65 and 1965-66 was sent to 605 schools throughout the state. There were 533 replies, some of which, of course, were not complete. The State Department of Education cooperated fully in the study and added to the data such items as enrollment, average daily attendance, and other details for the two years covered by the questionnaire.

Table 1 gives an indication of the character of the sample obtained. On the average, the individual school population was not large, was classed as rural rather than urban, was supervised by a man, and the children spent about 25¢ per day for the school lunch. As could be expected, the largest number of schools represented were of the elementary type or grades 1-6 or 1-8. There were 276 and 280 in these combined categories, or slightly over half of the schools replying for the two years. This then sets the picture for the study.

Results and Discussion

The first ice cream question was whether ice cream was served at any time during each of the past two school years (1964-65) (1965-66). In 1964-65, 77.6% stated ice cream had been served, but this dropped to 72.0% the following year. When asked how frequently it was served, 43% reported "infrequently" for both years. The next most common frequency was twice a month (21.4 and 23.7% respectively). Numbers serving ice cream at various frequencies can be seen as part of Table 2. Only 14 schools served ice cream regularly for both years.

[1/]Kentucky State Department of Education, Frankfort.

Table 1.--Characteristics of Schools Answering Questionnaire[a/]

	1964-65			1965-66		
Mass Characteristics	Range	Mean	S.D.	Range	Mean	S.D.
Student enrollment, No.	45-3725	624	427	37-3749	625	419
Average daily attendance, No.	45-2499	574	386	77-2568	584	389
Average daily National School Lunch participation, No.	38-1885	392	252	32-1923	403	253
Average student participation in NSL (%)	9-99	72	20	10-99	73	20
Average cost of lunch (cents)	10-47	24.9	3.8	10-49	24.8	4.1
Special Characteristics	Percent[b/]			Percent[b/]		
Urban	31.9			32.0		
Rural	63.6			63.7		
Female principal	18.4			17.0		
Male principal	77.6			79.5		
Academic Characteristics	Number of schools			Number of schools		
Elementary (1-6)	102			105		
Elementary (1-8)	174			175		
Junior high (7-9)	23			20		
High school (10-12)	9			10		
High school (9-12)	48			49		
Complete school (1-12)	129			128		
Junior-senior high (7-12)	24			24		
Other[c/]	17			17		

[a/] Report of 533 returns from 605 inquiries sent out.

[b/] Percentages do not equal 100% because some respondents failed to answer questionnaire.

[c/] Schools with grades 1-7, 6-12 and 2-7.

Table 2.--Relationship of Frequency of Serving Ice Cream to Participation in the National School Lunch Program and to Price of Meal

Frequency of Service	Number Serving	Percent Participation in NSLP[a]		Cost of School Lunch - cents	
		Mean	SD	Mean	SD
1964-1965					
Twice or more/week	14	85	11	29.0	8.1
Once/week	74	77	17	25.4	4.0
Twice/month	86	80	13	24.7	3.4
Once/month	60	78	16	25.7	3.6
Infrequently	177	74	18	24.3	3.4
Did not serve	122	58	26	25.2	4.1
1965-1966					
Twice or more/week	14	88	11	28.0	8.9
Once/week	65	79	18	25.3	3.8
Twice/month	88	80	16	24.7	4.4
Once/month	52	77	15	25.8	3.7
Infrequently	162	75	19	24.5	3.6
Did not serve	152	65	24	24.8	4.3

[a] National School Lunch Program.

An effort was made to learn if there was any relationship between frequency of ice cream service and participation in the National School Lunch Program. Frequency of service and cost of meal relationships also were sought. The most outstanding feature of these data, shown in Table 2, is that when ice cream was served most frequently there was a high average participation in the NSLP despite the fact that the average meal costs more. Where ice cream was served infrequently or not at all, the NSLP participation was the lowest. The data show that non-service did not reduce meal cost at all.

When asked to give reasons why ice cream was not used or was not used more frequently, by far the greatest number said, "It costs too much." There were 51 such replies for '64-65 and 66 for '65-66. The next most common reason concerned lack of adequate refrigeration and storage space. There were 29 such replies the first year and 33 for the second year. A categorization of the replies is given in Table 3. There were a few answers dealing with strictly local problems that are not listed herein. For the most part these answers are those of the respondent. As is seen from Table 3, there are policy concerns, nutritional "problems", and miscellaneous problems as well.

There was a very important area that was conspicuous by its infrequency or omission. In both years only one respondent complained about poor ice cream quality or poor delivery service.

Lack of knowledge of nutrition unfortunately was evident. Statements, such as "not enough nutritional value in ice cream," "served milk instead of ice cream so children would have more calcium," "served chocolate milk instead of ice cream," while not frequent, occurred more than once as can be seen by Table 3.

Table 3. --Selected Reasons Given by Respondents for Not Serving Ice Cream with School Lunch*

Reasons and Comments	Number 1964-65	1965-66
Pertaining to costs	55	72
Manager felt it was too expensive	1	2
Costs too much	51	66
No money available	1	2
Children will not accept small units; large units too expensive	1.	1
Too many "free" eaters to buy and give away	1	1
Service difficulties	49	53
Sanitary reasons	1	1
No (or not enough) refrigeration facilities	17	19
Not enough storage space	12	14
More trouble to serve	8	4
Difficulty of delivery	1	5
No facilities for serving ice cream	2	2
Time consuming	1	1
Ice cream not readily available	5	5
Inadequate personnel	2	2
Nutritional reasons	9	6
Other desserts provide more food value	1	1
Usually serve fruit to meet U.S.D.A. requirements	2	1
Did not realize ice cream was an acceptable dessert	2	1
Not enough nutritional value in ice cream	2	2
Serving milk to provide calcium	2	1
Policy problems	4	4
It decreases participation in whole lunch	1	1
Possibility of administrative problems	1	1
Does not think state will allow it	1	1
Not permitted by policy	1	1
Miscellaneous	12	12
Children prefer hot baked dessert	1	1
Not purchased by school lunch authorities	10	10
Poor quality ice cream	1	1

*Wording for the most part is that of the respondents.

The respondents were asked if they preferred to serve ice cream with a particular type of meal. Of those answering, 65% said they did and listed their meal type preference, as shown on Table 4. Ice cream obviously was thought of by the majority as part of a regular plate lunch, but they also believed it can supplement soup and sandwiches.

Table 4.--Type of Meal with Which it is Preferred that Ice Cream be Served

Type of lunch	Number Answering	% Answering
Regular plate	142	48
Soup-sandwich	95	32
Sandwich-milk	24	8
Other	35	11

Several suggested advantages of serving ice cream were listed in the questionnaire and are shown on Table 5. Many of the respondents checked several of these, but it must be noted that 75% believed that because the children liked ice cream this was a marked advantage. Although it was pointed out earlier that some were not aware of the nutritional qualities of ice cream, these appear to be a minority. As seen from this table, over half of the respondents recognized this quality of ice cream. About half of those answering believed that ice cream helps increase school lunch participation—a belief supported by evidence presented earlier in this paper. Quality and convenience were the general advantages listed as "other" in this table. One respondent used ice cream as a "come on" to sell the lunch when there was a food on the menu the children did not like.

When asked to check suggested disadvantages of serving ice cream, the respondents answered as shown in Table 6. Again cost was the chief disadvantage with lack of refrigeration second. Listed as "other" disadvantages was fear children would eat only the ice cream and not the full meal; difficulty in handling; and strangely, "serving ice cream is always welcomed by the children."

The respondents were asked to give suggestions for making ice cream more popular in school lunch use. As could be expected from the material presented here, "reduce cost" was the chief suggestion with 106 conveying that idea. The next most common suggestion was to make more "flavors and kinds" available. Actually some 65 categories of suggestions were made from "get government subsidy as for milk" to "sell the lunch room supervisor on the idea."

From this survey, it generally appears that people in decision-making areas of the school lunch programs have a favorable impression of ice cream. They are worried, however, about the cost of the product. It also is evident that refrigeration capacity may be a major obstacle in some areas. While ice cream served frequently apparently increases the cost of the lunch, at the same time frequent serving is associated with an increase in the percent participation in the program.

Table 5.--Advantages of Serving Ice Cream

Advantages	Number Answering[a/]	% Answering[b/]
Children like ice cream	400	75
Ice cream is easy to serve	235	44
No pre-preparation when ice cream is served	199	37
Ice cream helps in balancing nutritional quality	294	55
Serving ice cream decreases cost of lunch	8	1
Serving ice cream increases participation	274	51
Other	17	4

a/ Number answering exceeds number of returned questionnaires because many checked several advantages.

b/ Percentage based on number of answers as related to number of questionnaires returned.

Table 6.--Disadvantages of Serving Ice Cream

Disadvantages	Number Answering[a/]	% Answering[b/]
Ice cream difficult to serve	62	11
Ice cream taxes refrigeration and storage space	159	30
Ice cream is not readily available	54	10
Ice cream increases cost of lunch	335	63
Children do not like ice cream	4	<1
Serving ice cream decreases participation in lunch	11	2
Other	29	5

a/ Number answering exceeds number of returned questionnaires because many checked several disadvantages.

b/ Percentage based on number of answers as related to number of questionnaires returned.

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