Swine Research

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It is indeed a pleasure for me to write this foreword for the first University of Missouri Swine Research Report. This publication contains progress reports of some of the swine research being conducted at the University of Missouri. The goal of our research program is to design innovative and creative experiments that will help develop new information. The purpose of this report is to present the new findings from studies completed this year.

The problems and questions being asked in the swine industry are complex, this necessitates a team approach by the University and industry. We appreciate the support that has been given to our swine program. Listed on page iv. are those directly supporting our program this past year. We want to give a big "thank you" to these supporters.

We are very proud of our swine program at Missouri. We encourage you to visit our research farm. We enjoy showing people the facilities, and visiting about the work that is on-going and what is planned for the future. We hope the information contained in this report will be beneficial. If you have questions or if we can be of help to you, please let us know.

Sincerely,

Bob Moser

Bobby D. Moser
Department Chairman

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LIST OF COMPANIES AND ORGANIZATIONS WHICH HAVE SUPPORTED SWINE NUTRITION RESEARCH

For 1981 Swine Report

American Cyanamid Company, Princeton, New Jersey
American Hoechst Corporation, Somerville, New Jersey
Buckeye Cellulose Corporation, Memphis, Tennessee
Chem Metals, Baltimore, Maryland
Diamond V. Mills, Inc., Cedar Rapids, Iowa
Eli Lilly and Company, Indianapolis, Indiana
Hoffmann-La Roche, Inc., Nutley, New Jersey
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Mid-America Dairymen, Inc., Springfield, Missouri
Missouri Farmers Association, Inc., Columbia, Missouri
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National Pork Producers Council, Des Moines, Iowa
Nutra-Blend Corporation, Neosho, Missouri
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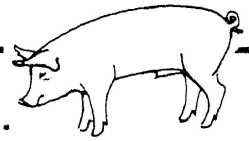
Rachelle Laboratories Inc., Long Beach, California
Ralston Purina Company, St. Louis, Missouri
Ray Foundation of Montana, Phoenix, Arizona
SmithKline Corporation, Philadelphia, Pennsylvania
Syntex, Inc., Springfield, Missouri
Sunline Brands Corporation, St. Louis, Missouri
The Upjohn Company, Kalamazoo, Michigan



NUTRITION OF ARTIFICIALLY-REARED BABY PIGLETS.
I. UTILIZATION OF DRIED SKIM MILK, CASEIN AND ISOLATED SOYBEAN PROTEIN

Trygve L. Veum and Javier P. Mateo

SUMMARY

Baby pigs were fed diets containing dried skim milk, casein (plus L-tryptophan and L-arginine) or isolated soybean protein (plus L-lysine, DL-methionine and L-tryptophan) as the source of protein (amino acids) from 1 to 29 days of age. The diets contained about 25% crude protein and 3.5 Mcal of ME/kg. Performance results indicate that the reference diet containing dried skim milk protein was superior to the diets containing either casein or isolated soybean protein from 1 to 15 days of age, while the diet containing casein was also superior to the diet containing isolated soybean protein during this period. However, performance of the piglets fed either dried skim milk, casein or isolated soybean protein was similar from 15 to 29 days of age. Digestibility, serum and subsequent performance data are presented.

INTRODUCTION

The lack of information on the ability of the baby pig to utilize economical protein sources other than milk proteins stimulated our interest in this area of research. Also, there appears to be a continuous trend toward earlier weaning at 2 to 3 weeks of age in more intensive confinement production systems. Thus, information obtained from artificial rearing will have practical application in formulating diets for these early weaned piglets. This experiment was conducted to compare the utilization of dried skim milk, casein and isolated soybean protein by baby pigs from 1 to 29 days of age.

EXPERIMENTAL PROCEDURE

Forty-five baby pigs were removed from their dams at 1 day of age and transferred to individual cages in the artificial rearing unit. The piglets were allotted by litter, sex and weight to one of three treatment groups. The dietary protein sources (table 1) consisted of dried skim milk, casein (plus L-tryptophan and L-arginine) or isolated soybean protein (plus L-lysine, DL-methionine and L-tryptophan). The diets were fed as a formula (1 part dry feed to 4 parts water) every 2 hr from 8:00 a.m. to 10:00 p.m. (8 times daily) for 14 days starting on day 1 of the experiment. The beginning level of formula dry matter was 4 g per feeding, which was gradually increased to 12 g commensurate with appetite. Starting on day 4, dry diet was also introduced to the baby pigs at the rate of 6 g per feeding and gradually increased to 12 g per feeding by day 15. Water was provided free choice.

All piglets received intramuscular injections of iron dextran (100 mg iron) at 2 and 12 days of age. Room temperature averaged 35 C the first week and was lowered 2 to 3 C each successive week. Blood samples were taken from the anterior vena cava from eight randomly selected piglets at 1 day of age and from all piglets at 29 days of age. A 5-day fecal and urine collection was conducted from days 11 to 15 of the experiment with four representative pigs per treatment.

At 15 days of age the pigs were transferred to larger cages, two pigs per cage, and full-fed the same diets for 2 additional weeks (15 to 29 days of age). Water was provided free choice.

At 29 days of age the pigs were transferred to nursery pens which contained self feeders and waterers. Each treatment group was allotted to one pen and all pigs were fed the same nursery diet (table 1) to evaluate subsequent performance to 64 days of age.

RESULTS

From 1 to 15 days of age, the average daily gain (ADG) and gain:feed ratio (G:F) were greater for the piglets fed the reference diet containing dried skim milk compared to the other two protein sources (table 2). Also, the ADG and G:F of piglets fed the diet containing casein were greater than that obtained with the piglets fed the diet containing isolated soybean protein.

However, from 15 to 29 days of age the ADG and G:F of the piglets fed the diet containing dried skim milk were only slightly greater than that obtained with the other two protein sources, which were similar in piglet performance.

The percentage of piglet deaths was 0, 11 and 33% on the dried skim milk, casein and isolated soy protein diets, respectively. The deaths were attributed to dehydration and starvation following diet refusal as confirmed by post-mortem examination.

The digestibilities for crude protein, ether extract (crude fat) and energy from 11 to 15 days of age (table 3) were similar for the diets containing casein or dried skim milk, which were greater than those obtained for the diets containing isolated soybean protein. The ash and dry matter digestibilities were also greater for the diets containing milk proteins, while the nitrogen free extract (carbohydrate) digestibilities were similar for all the protein sources.

The serum total glucose levels of the pigs fed the diets containing casein or isolated soybean protein at 29 days of age were similar (table 4), and greater than those obtained for the pigs fed the dried skim milk diet. The serum total protein levels of the two groups fed milk proteins were greater than those obtained for the group fed isolated soybean protein. The serum urea nitrogen levels were similar for all three treatment groups at 29 days of age.

Performance of the pigs from 29 to 64 days of age (table 5), when all the pigs were fed the same nursery diet, was similar. Thus, the baby pig diets with the different protein sources did not influence subsequent nursery performance.

TABLE 1. COMPOSITION OF DIETS[a]

Ingredients	Neonatal diets[b]: Dried skim milk	Casein	Isolated soy protein	Nursery diets
Glucose or lactose, %	-----	51.06	51.90	-----
Dried skim milk, %	86.37	-----	-----	5.00
48% soybean meal, %	5.53	-----	-----	26.00
Isolated soy protein, %	-----	-----	29.00	-----
Casein, %	-----	29.68	-----	-----
Corn oil, %	5.90	9.00	9.00	-----
Solka-floc, %[c]	-----	1.00	1.00	-----
Minerals, vitamins and amino acids, %[d]	2.20	9.26	9.10	2.10
Ground shelled corn, %	-----	-----	-----	29.40
Rolled oats, %	-----	-----	-----	10.00
Sucrose, %	-----	-----	-----	10.00
Dried whey, %	-----	-----	-----	15.00
Tallow, %	-----	-----	-----	2.50
Calculated composition:				
Crude protein, %	25.75	25.23	25.23	20.00
Mcal of ME/kg	3.55	3.50	3.50	2.78
Lysine, %	2.38	2.07	2.07	1.07
Sulfur amino acids, %	1.22	.83	.83	.52
Tryptophan, %	.40	.70	.70	.22

[a]Merck and Co., Syntex and Hoffmann-La Roche provided the L-lysine, DL-methionine and purified vitamins, respectively.

[b]The dried skim milk diet was a reference diet formulated with standard ingredients. The casein and isolated soy protein diets were semipurified.

[c]Source of dietary fiber.

[d]Minerals and vitamins provided to exceed National Research Council requirements.

TABLE 2. PERFORMANCE OF PIGLETS FED DRIED SKIM MILK. CASEIN OR ISOLATED SOYBEAN PROTEIN FROM 1 TO 29 DAYS OF AGE

Items	Dietary treatment: Dried skim milk	Casein	Isolated soy protein
Body weight, kg:			
1 day of age	1.27	1.23	1.23
29 days of age	6.38	5.61	4.84
Day 1 to 15			
Average daily gain, g	156^{a}	132^{b}	73^{c}
Gain:feed ratio	$.72^{a}$	$.63^{b}$	$.37^{c}$
Day 15 to 29			
Average daily gain, g	208	181	181
Gain:feed ratio	.57	.55	.54

^{a,b,c}Means with different superscripts are different (P<.05).

TABLE 3. EFFECT OF PROTEIN SOURCE ON DIET DIGESTIBILITY FROM 11 TO 15 DAYS OF AGE

Component	Dietary treatment: Dried skim milk	Casein	Isolated soy protein
Crude protein, %	95.8^{a}	96.0^{a}	88.4^{b}
Ether extract, %	95.7^{a}	85.8^{a}	70.9^{b}
Energy, %	96.4^{a}	93.5^{a}	88.6^{b}
Nitrogen free extract, %	98.5	97.8	97.5
Ash, %	87.9^{a}	74.2^{b}	66.0^{c}
Dry matter, %	96.6^{a}	94.2^{b}	89.9^{c}

^{a,b,c}Means in the same row with different superscripts are different (P<.05).

TABLE 4. EFFECT OF PROTEIN SOURCE ON SERUM PARAMETERS AT 29 DAYS OF AGE[a]

Items	Dietary treatment		
	Dried skim milk	Casein	Isolated soy protein
No. of pigs	9	17	12
	Total Glucose, mg/dl		
Day 29	87.8[b]	118.6[c]	123.7[c]
	Total Protein, g/dl		
Day 29	5.89[c]	5.59[c]	4.73[b]
	Urea Nitrogen, mg/dl		
Day 29	11.50	12.61	13.39

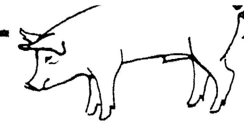
[a]Initial serum means from eight piglets at 1 day of age were as follows: glucose, 64.5 mg/dl; protein, 5.25 g/dl and urea nitrogen, 16.30 mg/dl.

[b,c]Means in the same row with different superscripts are different ($P<.05$).

TABLE 5. SUBSEQUENT PERFORMANCE FROM 29 TO 64 DAYS OF AGE[a]

Criteria	Previously-fed diets		
	Dried skim milk	Casein	Isolated soy protein
No. of pigs	9	16	12
Initial weight, kg	6.36	5.60	4.82
Average daily feed, kg	.61	.585	.565
Average daily gain, kg	.37	.32	.34
Gain:feed ratio	.61	.545	.60

[a]No difference ($P>.05$) between the performance criteria means.



NUTRITION OF ARTIFICIALLY-REARED BABY PIGLETS
II. UTILIZATION OF GLUCOSE vs LACTOSE

Trygve L. Veum and Javier P. Mateo

SUMMARY

Isonitrogenous (25.2% crude protein) and isocaloric (3.50 Mcal of ME/kg) diets containing either glucose or lactose were individually fed to baby pigs from 1 to 29 days of age. Lactose and glucose produced similar piglet performance, nutrient digestibility and serum levels of glucose, protein and urea nitrogen.

INTRODUCTION

With the continuing trend for weaning pigs at an earlier age, information on the ability of the baby pig to utilize different sugars as sources of dietary energy in early weaning diets becomes important. This experiment was conducted to compare the utilization of glucose and lactose by baby pigs from 1 to 29 days of age.

EXPERIMENTAL PROCEDURE

The baby piglets and the experimental methods and procedures were the same as described in paper I on the utilization of protein sources for artificially reared piglets from 1 to 29 days of age. Since there was no interaction between the sources of protein and the sources of sugar in the diets, the data on sugar sources is reported separately.

The dietary treatments consisted of glucose or lactose which were fed with either casein or isolated soy protein as the protein sources. The composition of these baby pig diets, as well as the nursery diet fed from 29 to 64 days of age, are shown in table 1 of paper I on the nutrition of artificially reared piglets.

RESULTS

Piglets fed the diets containing either glucose or lactose had similar average daily gains (ADG) and gain:feed ratios from days 1 to 15 and 15 to 29 days of age (table 1). Thus, there was no advantage to feed lactose compared with glucose during this growth period.

All nutrient digestibilities (table 2) were similar for the diets containing glucose of lactose. Piglets fed the diets containing glucose or lactose also had similar serum levels (table 3) of total glucose, total protein and urea nitrogen at 29 days of age.

The performance from 29 to 64 days of age in the nursery (table 4), when all the pigs were fed the same 20% crude protein diet, indicates that the carbohydrate sources fed from 1 to 29 days of age did not influence the subsequent nursery performance.

TABLE 1. PERFORMANCE OF PIGLETS FED DIETS CONTAINING GLUCOSE OR LACTOSE FROM 1 TO 29 DAYS OF AGE

Items	Dietary treatment	
	Glucose	Lactose
Body weight, kg:		
1 day of age	1.22	1.24
29 days of age	5.39	5.20
Day 1 to 15		
Average daily gain, g	107	110
Gain:feed ratio	.52	.54
Day 15 to 29		
Average daily gain, g	190	173
Gain:feed ratio	.59	.50

TABLE 2. EFFECT OF SUGAR SOURCE ON DIET DIGESTIBILITY FROM 11 TO 15 DAYS OF AGE[a]

Items	Dietary treatment	
	Glucose	Lactose
Crude protein, %	92.2	92.2
Ether extract, %	77.3	79.6
Energy, %	91.4	91.1
Nitrogen free extract, %	97.6	97.8
Ash, %	69.1	71.1
Dry matter, %	91.9	92.2

[a]No difference (P>.05) between treatment digestibility means.

TABLE 3. EFFECT OF SUGAR SOURCE ON SERUM PARAMETERS AT 29 DAYS OF AGE[a]

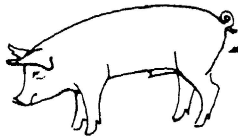
Items	Dietary treatment	
	Glucose	Lactose
No. of pigs	14	15
Total glucose, mg/dl		
Day 29	117.6	124.5
Total protein, g/dl		
Day 29	5.22	5.27
Urea nitrogen, mg/dl		
Day 29	12.72	13.12

[a]There were no differences (P>.05) between treatment serum parameter means.

TABLE 4. SUBSEQUENT PERFORMANCE FROM 29 TO 64 DAYS OF AGE[a]

Criteria	Previously-fed diets	
	Glucose	Lactose
No. of pigs	14	14
Initial weight, kg	5.37	5.16
Average daily feed, kg	.57	.58
Average daily gain, kg	.33	.32
Gain:feed ratio	.58	.56

[a]No difference (P>.05) between the performance criteria means.



NUTRITION OF ARTIFICIALLY-REARED BABY PIGLETS. III. UTILIZATION OF GLUCOSE, SUCROSE OR CORN STARCH BY 15-DAY OLD PIGS

Trygve L. Veum and Javier P. Mateo

SUMMARY

Glucose, sucrose and corn starch were evaluated as carbohydrate sources for pigs from 15 to 36 days of age. Average daily feed intake was greater for pigs fed the diets containing either glucose or sucrose compared to corn starch. The average daily gain of pigs fed the diet containing sucrose was greater than that of pigs fed the diet containing corn starch, while the group fed glucose was intermediate. However, the gain:feed ratios of pigs fed the three carbohydrate diets were similar, as were the crude protein, ether extract, energy and dry matter digestibilities. These results indicate that sucrose was utilized as well as glucose by baby pigs from 15 to 36 days of age while corn starch was inferior to glucose and sucrose.

INTRODUCTION

Previous work has shown that glucose and lactose are well utilized by the baby pig. In contrast, research conducted about 30 years ago indicated that the baby pig could not utilize sucrose or corn starch. However, the age at which the baby pig would develop a functional digestive enzyme system to utilize sucrose or corn starch has not been well defined. This experiment was conducted to evaluate sucrose and corn starch, compared with glucose, as carbohydrate sources for baby pigs reared artificially from 15 to 36 days of age with a preliminary adjustment period on the glucose diet from 1 to 14 days of age. Subsequent performance in the nursery was also evaluated.

EXPERIMENTAL PROCEDURE

Two trials involving a total of 54, 1-day-old piglets were used in this experiment. The piglets were individually fed the diet containing glucose (table 1) every 90 min according to appetite during a 14 day preliminary period in the automated artificial rearing unit. The diets were fortified with minerals and vitamins. On day 15 the piglets were allotted to three dietary treatments (table 1) based on weight, sex and litter, and transferred to larger cages with two pigs per cage. The diets were calculated to contain 23.5% crude protein and 3537 Mcal of ME/kilogram. From 15 to 36 days of age, each pair of pigs was full-fed and water was provided free choice. Scouring pigs were treated orally with neo-terramycin (1 cc) once daily for 3 days with restricted feed intake.

Blood samples were taken from the anterior vena cava of each piglet at 15, 22, 29 and 36 days of age to determine the serum levels of total glucose, total protein and urea nitrogen. A 5-day fecal collection period was conducted from 32 to 36 days of age for proximate analyses and gross energy determinations.

At 36 days of age, the pigs were transferred to a concrete floored nursery with each group assigned to one pen. All groups were fed the same 20% crude protein nursery diet (table 1 of paper I on artificially-reared pigs) to 64 days of age.

Data were tested by analysis of variance procedures utilizing the Statistical Analysis System.

RESULTS

The performance results from 15 to 36 days of age are shown in table 2. The average daily feed consumption was similar for pigs fed the diets containing glucose or sucrose, and greater than that for the pigs fed the diet containing corn starch. The average daily gain for pigs fed the diet containing sucrose was greater than that obtained for pigs fed the diet containing corn starch, while pigs fed the diet containing glucose were intermediate. The mean gain: feed ratio was similar for all three treatment groups.

There were no pig deaths during this experiment. Approximately 25% of the pigs scoured during the first week on test irrespective of the diet fed. Scouring pigs received an oral antibiotic (15 mg neomycin and 25 mg oxytetracycline) once daily for 3 days which stopped the scouring.

Apparent digestion coefficients from 32 to 36 days of age for crude protein, ether extract, energy and dry matter were similar for all three diets (table 3). Nitrogen free extract and ash digestibilities obtained for the sucrose diet were greater than those obtained for the glucose diet, while those for the corn starch diet were intermediate.

The serum parameters are shown in table 4. The mean serum total glucose level of pigs fed the diet containing glucose was greater than that obtained for the pigs fed the diets containing either sucrose or corn starch, which had similar total glucose levels. The mean serum total protein level of pigs fed the diet containing glucose was greater than that obtained for the pigs fed the diet containing corn starch, while the level obtained for the pigs fed the diet containing sucrose was intermediate. The mean serum urea nitrogen levels of pigs fed the diets containing glucose and sucrose were similar and greater than the level obtained from pigs fed the corn starch diet.

The pigs previously fed the three carbohydrate diets from 15 to 36 days of age performed equally well from 36 to 64 days of age when fed the same nursery diet (table 5). Thus, subsequent nursery performance was not influenced by previous neonatal diet.

TABLE 1. COMPOSITION OF BABY PIG DIETS

Ingredients	Baby Pig Diets[a]		
	Glucose	Sucrose	Corn starch
Glucose (%)	54.32	-----	-----
Sucrose (%)	-----	54.32	-----
Corn starch (%)	-----	-----	54.32
Isolated soy protein (%)	27.00	27.00	27.00
Corn oil (%)	9.00	9.00	9.00
Vitamin, mineral and antibiotic supplements[a]	8.00	8.00	8.00
Solka-floc (%)[b]	1.00	1.00	1.00
DL-methionine (%)	.50	.50	.50
L-tryptophan (%)	.18	.18	.18
Dietary composition (calculated analysis)			
Crude protein (%)	23.50	23.50	23.50
Metabolizable energy (kcal/kg)	3537.00	3537.00	3537.00
Lysine (%)	1.43	1.43	1.43
Sulfur amino acids (%)	1.18	1.18	1.18
Tryptophan (%)	.37	.37	.37

[a]Vitamins and minerals were provided to exceed National Research Council requirements. Neomycin sulfate was added at 400 mg/kg of complete diet.

[b]A source of dietary fiber.

TABLE 2. EFFECT OF CARBOHYDRATE SOURCE ON PERFORMANCE OF BABY PIGS FROM 15 TO 36 DAYS OF AGE

Item	Dietary Treatment		
	Glucose	Sucrose	Corn starch
Mean pig weight, kg:			
15 days of age	2.34	2.33	2.20
36 days of age	5.33	5.83	4.69
Average daily feed intake from			
15 to 36 days of age, g	293^{a}	282^{a}	214^{b}
Average daily gain from			
15 to 36 days of age, g	$142^{a,b}$	166^{a}	118^{b}
Gain:feed ratio from			
15 to 36 days of age	.49	.59	.55

^{a,b,c}Means within rows with different superscripts are different ($P<.05$).

TABLE 3. EFFECT OF CARBOHYDRATE SOURCE ON DIET DIGESTIBILITY FROM 32 TO 36 DAYS OF AGE

Criteria	Dietary Treatment		
	Glucose	Sucrose	Corn starch
Crude protein, %	81.7	79.0	84.0
Ether extract, %	94.1	95.4	93.7
Nitrogen free extract, %	96.8^{b}	97.3^{a}	$97.1^{a,b}$
Energy, %	89.4	89.7	90.7
Ash, %	52.7^{b}	61.0^{a}	$59.3^{a,b}$
Dry matter, %	89.3	89.7	90.2

^{a,b}Means in the same row with different superscripts are different ($P<.05$).

TABLE 4. EFFECT OF CARBOHYDRATE SOURCE ON SERUM PARAMETER MEANS[a]

Item	Dietary Treatment		
	Glucose	Sucrose	Corn starch
Serum total glucose, mg/dl	112.6[b]	102.3[c]	100.3[c]
Serum total protein, g/dl	4.74[b]	4.63[bc]	4.27[c]
Serum urea nitrogen, mg/dl	17.8[b]	17.3[b]	15.2[c]

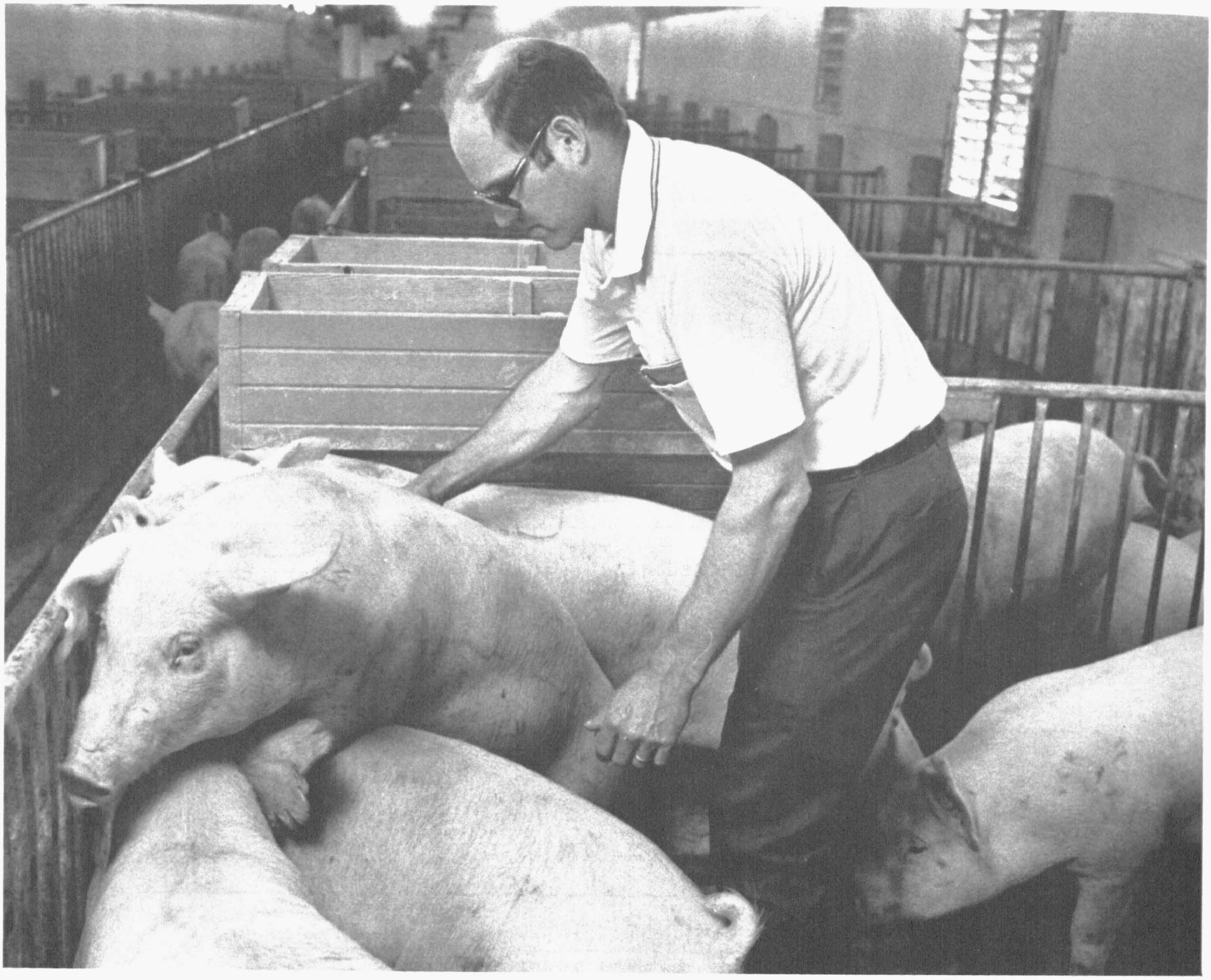
[a]Means of blood samples collected at 15, 22, 29 and 36 days of age.

[b,c]Means in the same row with different superscripts are different ($P<.05$).

TABLE 5. SUBSEQUENT PERFORMANCE OF BABY PIGS FROM 36 TO 64 DAYS OF AGE

Criteria	Diets Previously Fed From 15 to 36 Days of Age[a]		
	Glucose	Sucrose	Corn starch
Ending wt., kg	13.9	14.3	12.4
Avg daily gain, kg	.31	.30	.26
Avg daily feed, kg	.57	.58	.58
Gain:feed ratio	.54	.52	.46

[a]No differences ($P>.05$) between groups were obtained when all pigs were fed the same 20.0% crude protein diet from 36 to 64 days of age.

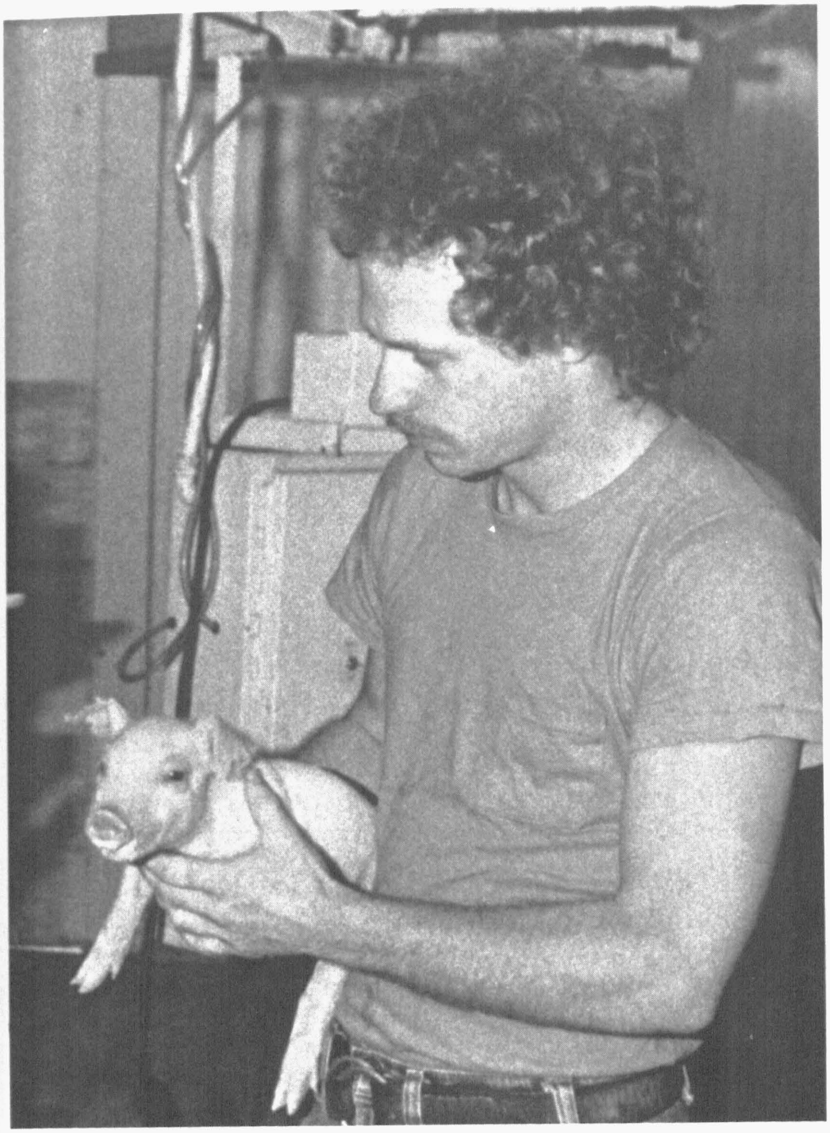


Trygve Veum, professor, leads studies of feed additives aimed at finding if they're economical and safe to use in swine rations.

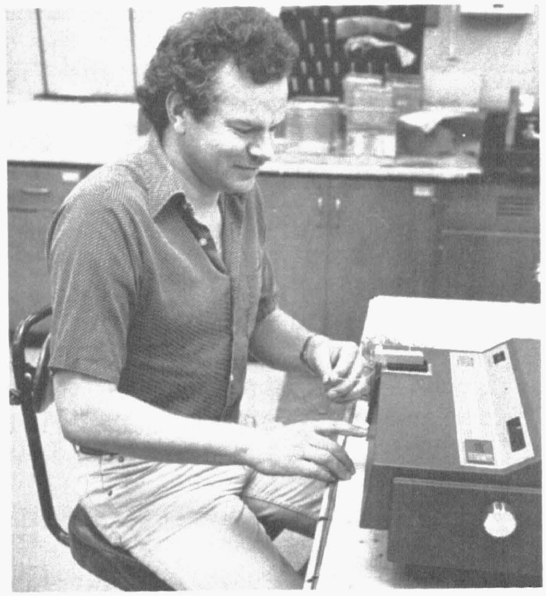
UMC Scientists Study nutrition In barn and lab

Dennis Jewell, research associate, uses a metabolic shaker to incubate liver cells to evaluate protein and energy metabolism.

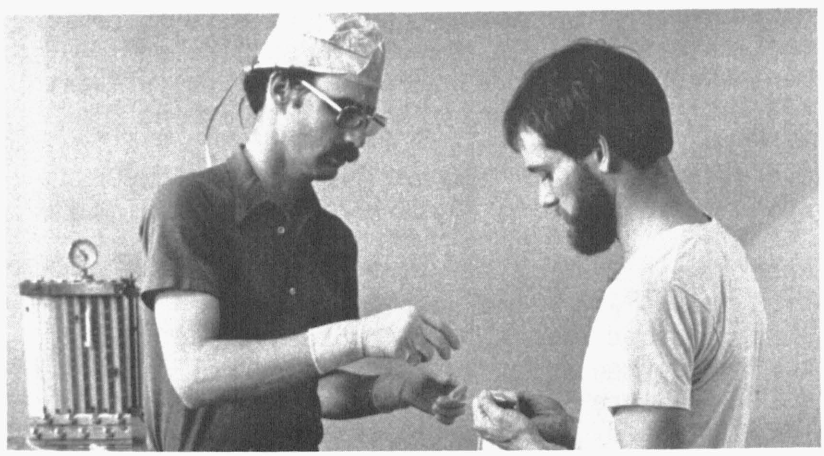
Studies examine effects of antibiotics, lysine, salt, fiber, and even egg whites in pig rations.



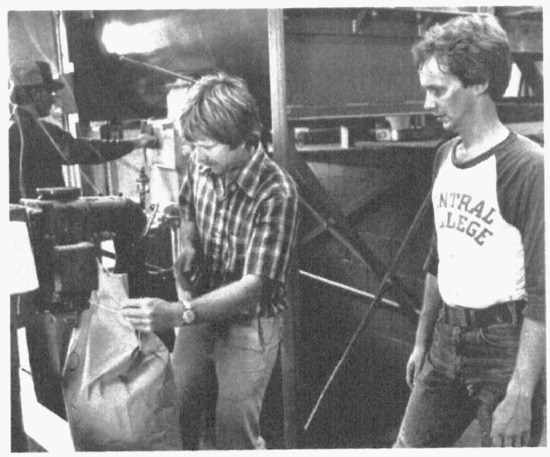
Kevin Watkins, graduate research assistant, works with pigs up to 21 days old using egg albumen as a protein source in the diet.



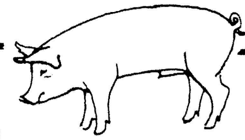
Jerzy Siwecki, post doctoral fellow, measures enzyme activity as an indication of protein synthesis in the liver of swine.



Ross Hamilton, L, Ph.D. candidate, and Brad Mathews, Master's candidate, conduct studies to determine if biotin, a water soluble vitamin, is required in the sow's diet.



Vern Pearson, L, Ph.D. candidate, and Bob Moore, Master's candidate, mix and bag experimental swine diets at the UMC feed mill.



THE BIOTIN STATUS OF YOUNG PIGS FED SEMIPURIFIED DIETS CONTAINING EGG ALBUMEN

C.R. Hamilton, D.E. Jewell, J.A. Siwecki and T.L. Veum

Introduction

Biotin, a water soluble B vitamin, is directly involved in the normal occurrence of carbohydrate and fat metabolism in the pig. Early research reports indicated the inclusion of supplemental biotin in practical swine diets to be an unnecessary practice. This conclusion was based on data indicating that the combination of naturally occurring biotin in feeds and biotin synthesized by the gut microflora was sufficient to meet the pig's needs. However, recent field and laboratory observations have demonstrated symptoms similar to those associated with biotin deficiencies; such as cracking and bleeding of the soles of the toes, hair loss, dermatoses, spasticity of the hind legs and general unsoundness in swine raised in confinement. With the recent rapid trend towards the production of swine in total confinement, the dietary addition of feed additives possessing antimicrobial properties and recent research data showing the availability of biotin in feed ingredients to be highly variable, a need for supplemental biotin could be necessary.

The purpose of this study was to evaluate the potential use of various plasma and tissue parameters as indicators of the biotin status of pigs fed semipurified diets formulated to provide a biotin status gradient.

Materials and Methods

Six groups of four littermate crossbred gilts averaging 11.1 kg were placed on test following weaning at four weeks of age. Gilts were stratified according to weight and ancestry before being randomly assigned to one of four treatment groups. Semipurified diets containing spray dried egg albumen (albumen) were formulated as shown in table 1. Albumen was either fed autoclaved (121°C for 1 hour) to denature the biotin binding protein, avidin, or nonautoclaved. The resulting treatments were: (1) nonautoclaved albumen with no added biotin; (2) treatment 1 plus 1.1 g/day sulfamethazine (to prevent microbial synthesis of biotin); (3) autoclaved albumen; and (4) treatment 3 plus .5 mg biotin/day.

Pigs were placed in stainless steel cages for the entire 42 day study. Water and feed were offered twice daily in a slurry mixture of 2.5:1 and intake was equalized among treatments.

Daily feed consumption and weekly pig weights were taken and recorded. Pigs were observed for deficiency symptoms and blood samples were taken via vena puncture just prior to weighing. Blood samples were processed and frozen pending analysis for pyruvic, lactic and free fatty acid levels as well as glucose and urea nitrogen levels. Gilts were sacrificed at the end of the trial by exanguination. Livers were weighed, sampled and assayed for pyruvate carboxylase activity (a biotin dependent gluconeogenic enzyme). Hepatic DNA, RNA and total protein levels were also determined.

Results

Pig performance and blood data are illustrated in table 2. Faster and more efficient pig gains resulted from feeding diets containing autoclaved versus nonautoclaved albumen. Two explanations are possible: (1) an increased availability of supplemental and microbial biotin resulting from deactivation of the avidin fraction, or (2) an improvement in protein quality caused by the heating process. Both of these explanations are related to the autoclaving process and the subsequent denaturing effects on certain proteins known to be present in egg albumen making an associative effect likely. However, comparisons of the blood urea nitrogen data support the latter explanation. Pigs fed the nonautoclaved diets had more urea nitrogen in the plasma than those receiving the autoclaved diets. These levels should be relative to amino acid degradation in the body.

Treatment means for all other blood data were not statistically different for the entire period. It should be noted that pigs in treatment 2 tended to have lower pyruvic and lactic acid levels as well as the highest free fatty acid levels. These effects could be related to biotin status and its effects on gluconeogenesis and fat metabolism.

The effects of biotin status on the hepatic parameters evaluated are presented in table 3. Pyruvate carboxylase activity in pigs fed the diets high in available biotin was greater than for those fed either of the nonautoclaved diets. These results should reflect the biotin status of the pig because of the dependency of pyruvate carboxylase activity on the presence of biotin.

Hepatic protein and nucleic acid levels are also presented in table 3. Total liver protein values were similar for pigs fed both diets containing nonautoclaved albumen and the autoclaved diet supplemented with biotin. However, total liver proteins from treatment 3 were greater than those from treatment 1. Analyses for liver DNA content tended to indicate a relationship between expected dietary biotin level and DNA level. As biotin level increased so did the DNA content as illustrated by the fact that pigs offered supplemental biotin had the greatest hepatic DNA content. Livers sampled from treatment 3 had more DNA per gram than those sampled from treatments 1 or 2. Comparisons between the two nonautoclaved treatments revealed that pigs fed sulfamethazine had 35% less hepatic DNA by weight, although these data were not statistically different. Mean liver RNA values were similar for all treatments.

As presented in table 3, pigs fed treatments 1 and 3 had similar protein: DNA and RNA:DNA ratios indicative of similar cell size and capacity for protein synthesis. Pigs supplemented with biotin had lower ratios than pigs fed either of the nonautoclaved diets but similar to those fed treatment 3. Liver tissue from the group fed sulfamethazine had the greatest protein synthetic capacity and cell size.

Pigs were visually examined for the presence of gross anatomical deficiency symptoms. Nonautoclaved albumen fed pigs exhibited symptoms similar to those reported by other workers. Sores about the feet, legs and eyes and the presence of a white film covering the tongue were observed in pigs from treatments 1 and 2 while pigs fed autoclaved diets appeared normal in these areas.

Conclusion

The treatment effects on pig performance and urea nitrogen levels in the plasma appear to have been due to either a difference in protein quality or an increase in biotin availability brought about by autoclaving of the spray dried egg albumen. This heat treatment may have deactivated proteins known to be present in this product such as trypsin inhibitor and avidin. Pyruvate carboxylase activity in liver tissue appears to be a good indicator of biotin status in pigs fed semipurified diets containing spray dried egg albumen. DNA levels as well as indicators of liver cell size and protein synthetic capacity could be of some use in predicting the biotin status of young gilts.

Table 1. Diet Composition

Ingredient	International reference no.	% of diet dry matter basis
Spray dried egg albumen[a]		23.71
Corn starch	4-02-889	55.14
Corn sugar	4-02-125	9.73
Corn oil	4-07-882	4.96
Mineral premix[b]		4.18
Vitamin premix[c]		2.29
Total		100.00

[a]Furnished by Kraft, Inc., Glenview, IL. Fed as either autoclaved or non-autoclaved.

[b]Mineral premix contained sources of all minerals needed by swine except sodium chloride (adequate amount supplied by egg albumen) formulated to exceed NRC requirements 1.5 times. Dicalcium phosphate used as a carrier.

[c]Vitamin premix contained sources of all vitamins needed by swine except biotin formulated to exceed NRC requirements by 1.5 times. Solka-floc (2 % of diet) used as carrier and source of fiber.

Table 2. Effects of Biotin Status on Pig Performance and Blood Parameters

Item	Treatment: 1 non-autoclaved	2 nonautoclaved + sulfa	3 autoclaved	4 autoclaved + biotin
No. of pigs[a]	6	5	6	6
Avg. initial wt., kg	11.06	11.06	11.06	11.21
Avg. daily gain, kg	.19[b]	.16[b]	.39[c]	.37[c]
Avg. gain:feed	.28[b]	.23[b]	.55[c]	.52[c]
Blood plasma data:				
pyruvic acid, mg/100 ml	1.48	1.17	1.46	1.43
lactic acid, mg/100 ml	57.39	49.79	60.48	61.4
glucose, mg/100 ml	78.98	81.18	83.20	85.92
urea nitrogen, mg/100 ml	19.61[b]	21.34[b]	7.62[c]	8.67[c]
free fatty acid, mg/100 ml	88.58	94.37	86.44	85.93

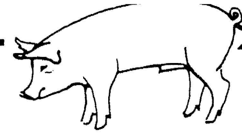
[a]One pig died of intestinal enteritis during the first week of the study.

[b,c]Means on the same row with different superscripts are different ($P<.05$).

Table 3. Effects of Biotin Status on Enzymatic Activity and Hepatic Parameters

Item	Treatment: 1 non-autoclaved	2 nonautoclaved + sulfa	3 autoclaved	4 autoclaved + biotin
Pyruvate carboxylase activity, μmoles $^{14}CO_2$ fixed/g liver/minute	.49[a]	.48[a]	2.40[b]	2.82[b]
Total liver protein, mg/g wet tissue	109.62[a]	119.59[a,b]	138.34[b]	131.8[a,b]
DNA, mg/g wet tissue	11.66[a]	7.55[a]	17.32[b]	25.17[c]
RNA, mg/g wet tissue	5.03	4.88	5.51	6.22
RNA/DNA	.47[a]	.71[b]	.33[a,c]	.24[c]
Protein/DNA	10.23[a]	18.61[b]	8.16[a,c]	5.33[c]

[a,b,c]Means on the same row with different superscripts are different ($P<.05$).



THE EFFECT OF FIBER FROM DIFFERENT SOURCES ON PERFORMANCE OF PIGS WEANED AT FOUR WEEKS OF AGE

Dennis E. Jewell and Trygve L. Veum

SUMMARY

Three experiments involving 426 pigs were conducted to evaluate the effect of ground oats, solka-floc, alfalfa meal, oat hulls or oat groats on the performance of pigs weaned at four weeks of age. In experiment 3, diets containing 20% ground oats, 1.5% solka-floc, 4.5% oat hulls, or 10.5% oat groats plus 4.5% oat hulls all increased average daily gain (ADG) when compared to the control group. Ground oats at 20% also increased the gain to feed ratio (G:F) when compared to the controls. In experiments 1 and 2, there were no significant ($P>.05$) differences in ADG of G:F Ratios when the diets contained 10 or 15% ground oats, 10.5% oat groats, 1 or 1.5% solka-floc, 3 or 4.5% oat hulls, and 3 or 4.5% oat hulls plus 7 ot 10.5% oat groats, respectively, when compared to the controls. Alfalfa meal at 10% of the diet reduced ADG and G:F ratios. Thus, adding fiber to the weanling pig diet produced inconsistent results, although 20% oats appeared to improve performance.

INTRODUCTION

Poor performance often accompanied by diarrhea can be a severe problem in early weaned pigs. This may be due to the change in diet, the change in environment, increases in hemolytic and non-hemolytic *E. coli* or other circumstances increasing the stress on the postweanling pigs. Previous workers have found that increasing the level of fiber in the diet had a beneficial effect on postweanling performance. However, in other experiments the effects of increasing the levels of dietary fiber were either inconsistent or not beneficial. Thus, these experiments were conducted to further evaluate the effects of both different sources and levels of fiber on postweanling performance of pigs weaned at 4 weeks and reared in an environmentally-regulated nursery with 100% concrete slats.

EXPERIMENTAL PROCEDURE

The diets for the experiments are shown in table 1. The basal diet was formulated to contain 18.1% crude protein 2.7% crude fiber and 3369 kcal digestible energy per kilogram. Fiber sources were substituted for corn in the experimental diets. Pigs were weighed and allotted directly to the experimental treatments. Pig weight and feed consumed were measured weekly throughout the 28-day studies.

In experiment 1, 180 pigs were allotted to five dietary treatments (table 1) by weight, sex and litter. Six pigs were placed in each 1.22 X 2.44 meter pen. In experiments 2 and 3, 126 and 84 pigs were allotted to nine and seven dietary treatments (table 1), respectively. In both experiments, four pigs were placed in each 1.22 X 1.22 meter pen.

RESULTS

In experiment 1, average daily gain (ADG) was depressed in the pigs fed the alfalfa meal when compared to the pigs fed the 10% oats, 1% solka-floc or the control diet (table 2). There were no differences (P>.05) in ADG or G:F due to the substitution of 10% oats, 1% solka-floc or 3% solka-floc for corn in the control diet (table 2).

The results of experiment 2 are shown in table 3. The control group was similar to the other groups in performance criteria. However, there was a greater ADG for the pigs fed 4.5% oat hulls compared with the pigs fed either 10% oats or 1.5% solka-floc.

In experiment 3, there was an increase in ADG when the pigs were fed diets containing 1.5% solka-floc, 20% oats, 4.5% oat hulls or 4.5% oat hulls plus 10.5% oat groats compared to the control group (table 4). The pigs fed diets containing 15% oats or 10.5% oat groats were intermediate between the two groups. The pigs fed 20% oats had an improved G:F ratio when compared to the controls. All other treatment groups were only slightly improved in G:F over the controls.

There was an increase in pig performance due to increased fiber in the diets in only one of these three experiments. It is possible that there was some change in the amount of stress that the animals were subjected to between the experiments. This might be reflected in the reduced ADG and G:F in the controls of experiment 3 when compared to the controls of experiment 1 or 2. It is obvious that there are many environmental factors that influence the performance of weanling pigs, and the diet is one of these factors. The type of nursery facility and the associated environment will undoubtedly have a positive or negative effect on pig performance which may interact with the level of nutrition and diet fed. Thus, additional work is planned to evaluated flat decks vs the conventional nursery used in these experiments (100% concrete slats) in relation to piglet response to dietary factors.

TABLE 1. PERCENTAGE COMPOSITIONS OF DIETS

Item	Diet / Experiment	1 / 1,2,3	2 / 1,2	3 / 1,2	4 / 1	5 / 1	6 / 2	7 / 2	8 / 2,3	9 / 2,3	10 / 2,3	11 / 2,3	12 / 3	13 / 3
Corn		54.56	44.56	53.56	51.56	44.56	51.56	44.56	39.56	53.06	50.06	39.56	44.06	34.56
Soybean meal solvent		26.80	26.80	26.80	26.80	26.80	26.80	26.80	26.80	26.80	26.80	26.80	26.80	26.80
Dried whey		10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Sugarcane sugar		5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Dicalcium phosphate		1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55
Limestone		.99	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99
Trace mineralized salt[a]		.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60	.60
Vitamin premix[a]		.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50	.50
Ground oats		-----	10.00	-----	-----	-----	-----	-----	15.00	-----	-----	-----	-----	20.00
Solka-floc		-----	-----	1.00	3.00	-----	-----	3.00	-----	1.50	-----	-----	-----	-----
Oat hulls		-----	-----	-----	-----	-----	3.00	-----	-----	-----	-----	4.50	-----	-----
Alfalfa meal		-----	-----	-----	-----	10.00	-----	-----	-----	-----	-----	-----	-----	-----
Oat groats		-----	-----	-----	-----	-----	-----	7.00	-----	-----	-----	10.50	10.50	-----
Calculated:														
Crude protein, %		18.10	18.40	18.10	17.90	19.00	18.00	18.60	18.50	18.00	18.00	18.80	18.80	18.70
Crude fiber, %		3.20	4.00	4.00	5.70	5.40	4.00	4.00	4.50	4.50	4.30	4.40	3.30	4.90
Kcal DE/kg		3369	3264	3334	3263	3275	3334	3305	3211	3316	3256	3274	3387	3158

[a]Provided in the complete diet: 0.50% NaCl; 0.1 ppm Se as $NaSeO_3$; 100 ppm Fe as $FeSO_4 \cdot H_2O$; 15 ppm Cu as CuO; 100 ppm Zn as ZnO; 50 ppm Mn as $MnSO_4$ and 0.9 ppm I as $Ca(IO_3)_2$.

[b]Provided per kg of diet: 1.9 mg vitamin A acetate; 13.8 µg vitamin D_3; 22 mg DL-α-tocopheryl acetate; 5.5 mg riboflavin; 27.5 mg D-pantothenic acid; 33 mg niacin; 410 mg choline as choline chloride; 33 µg vitamin B_{12}; 3.3 mg vitamin K as menadione sodium bisulfite; 2.2 mg thiamin; 1.1 mg folic acid; 1.1 mg vitamin B_6; 0.44 mg biotin and 55 mg ethoxyquin.

TABLE 2. PIG PERFORMANCE IN EXPERIMENT 1[a]

Variable	Control	10% Oats	1% Solka-floc	3% Solka-floc	10% Alfalfa meal
Initial weight, kg	7.60	7.68	7.20	7.41	7.58
Final weight, kg	14.04	14.10	13.98	13.51	13.30
Average daily gain, kg	.31[b]	.31[b]	.32[b]	.30[b,c]	.27[c]
Average daily feed, kg	.57	.59	.57	.53	.54
Gain:feed ratio	.54[b,c]	.53[b,c]	.56[b]	.55[b]	.50[c]

[a]Values are means of six replicates of six pigs each.

[b,c]Values on the same row with different superscripts differ ($P<.05$).

TABLE 3. PIG PERFORMANCE IN EXPERIMENT 2

Variable	Control	10% Oats	1% Solka-floc	3% Oat hulls	3% Oat hulls 7% Oat groats	15% Oats	1.5% Solka-floc	4.5% Oat hulls	4.5% Oat hulls 10.5% Oat groats
Initial wt., kg[a]	7.1	7.1	7.1	7.3	7.1	7.2	7.2	7.2	7.1
Average daily gain, kg[a]	$.30^{b,c}$	$.27^{c}$	$.28^{b,c}$	$.30^{b,c}$	$.29^{b,c}$	$.30^{b,c}$	$.26^{c}$	$.34^{b}$	$.31^{b,c}$
Final wt., kg[a]	15.5	14.7	14.9	15.7	15.1	15.5	14.6	16.6	15.9
Average daily feed, kg[a]	$.58^{b,c}$	$.53^{b,c}$	$.52^{b,c}$	$.56^{b,c}$	$.51^{c}$	$.57^{b,c}$	$.53^{b,c}$	$.62^{b}$	$.56^{b,c}$
Gain:feed ratio	.56	.51	.53	.53	.57	.52	.50	.54	.56

[a]Values are means of three replicates of six pigs each, self-fed for 28 days.

[b,c]Values on the same row with different superscripts are significantly (P<.05) different.

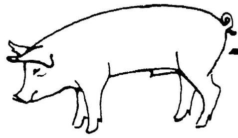
TABLE 4. PIG PERFORMANCE IN EXPERIMENT 3

Variable	Control	15% Oats	1.5% Solka-floc	4.5% Oat hulls	4.5% Oat hulls 10.5% Oat groats	10.5% Oat groats	20% Oats
Initial wt., kg[a]	6.8	6.8	6.7	6.8	6.7	6.8	6.8
Average daily gain, kg[a]	.27[b]	.31[b,c]	.35[c]	.35[c]	.35[c]	.33[b,c]	.37[c]
Final wt., kg[a]	13.5	15.5	16.6	15.6	16.5	16.1	17.2
Average daily feed, kg[a]	.60[b]	.64[b,c]	.72[b,c]	.73[c]	.74[c]	.71[b,c]	.74[c]
Gain:feed ratio[a]	.45[b]	.49[b,c]	.49[b,c]	.49[b,c]	.47[b,c]	.47[b,c]	.50[c]

[a]Values are means $\pm$ SEM of three replicates of four pigs on test for 28 days.

[b,c]Means on the same row with different superscripts are different ($P<.05$).

THE EFFECTS OF GROUND OATS OR SOYBEAN HULLS AND FEEDING REGIMENS ON PERFORMANCE OF PIGS WEANED AT FOUR WEEKS OF AGE



Dennis E. Jewell and Trygve L. Veum

SUMMARY

Five experiments involving 620 pigs were conducted to evaluate the effect of ground oats or soybean hulls when fed in different dietary regimens on average daily gain (ADG), average daily feed (ADF), gain to feed (G:F) ratios and the amount and severity of scouring. In experiment 1, diets containing 0, 33 and 66% oats were compared. In experiment 2, the same diets were compared after addition of lysine to equalize lysine in all diets. These diets were fed in different regimens which were also evaluated. In experiment 3, three diets were balanced for lysine, crude protein and metabolizable energy. The same regimes were followed as in experiment 2. In experiment 4, the same two high oat diets were retained from experiment 3 and two new diets were added with equal crude fiber supplied by soybean hulls. In experiment 5, the diets were calculated with soybean hulls used as if they contained no available energy or protein. There was no benefit due to feeding high fiber diets as measured by ADG or G:F ratios. In experiment 1 and 2 there was a decrease in the severity of scours ($P<.05$) due to increased oats in the diet. However, this decrease was not consistent through all the experiments.

INTRODUCTION

In continuing our investigation into the effects of increased dietary fiber we decided to control the differences due to changes in dietary protein and energy level. These experiments were conducted to evaluate the effects of dietary fiber when the diets were formulated to decrease the differences due to changes in protein and energy level.

EXPERIMENTAL PROCEDURES

The diets are shown in table 1. In all experiments pigs were allotted to treatments by weight, sex and litter. Four pigs were placed in each 1.22 X 1.22 meter pen. In experiment 1 the three treatments were fed diets 1, 2 and 3, respectively. In experiments 2-5 the diets were fed according to table 2. Pigs were weaned, weighed and allotted directly to the experimental treatments. Pig weight and feed consumed were measured weekly throughout the 56-day studies.

RESULTS

In experiment 1 there was no difference in ADG, ADF or G:F ratios due to the high oat diets. Although there was very little scours on any treatment, there was a decrease ($P<.05$) in the frequency and severity of scouring due to increased oats in the diet (table 3).

In experiment 2 there was no difference in ADG, ADF or G:F ratios in the pigs fed diets balanced for lysine content. There was a tendency toward increased ADG and G:F ratios in the pigs fed the high fiber diets. There was also a trend toward decreased scouring in the pigs fed the high fiber diets when compared to the controls (table 4).

In experiment 3 there was no difference between ADG, ADF or G:F ratios between treatments. There was a tendency for the high fiber fed pigs to have less scouring during the first 21 days of the experiment (table 5).

In experiment 4 there was no statistical difference between the treatments when compared to the controls. However, treatment 2 was greater than either 4 or 5 in ADG. There was a tendency for the pigs fed the high fiber diets to have more scouring than did the controls (table 6).

In experiment 5 the pigs fed the high fiber diets were not different than the controls. The pigs fed diet 2 were depressed in ADG and G:F ratios when compared to the controls and were significantly less ($P<.05$) than the pigs fed the high fiber from soybean hulls (treatment 6). There was a tendency for all the pigs fed the high fiber diets to have slightly higher scouring scores (table 7).

From these experiments it can be concluded that when the diets were balanced for protein and energy there was only a minimal effect on performance due to high fiber either from oats or soybean hulls in the diets of the four week old piglet.

TABLE 1. PERCENTAGE COMPOSITIONS OF DIETS

Item	Diet	1	2	3	4	5	6	7	8	9	10
	Experiment	1	1	1	2	2	2	3	3	3	4
Corn		60.00	33.00	--	65.16	32.60	--	65.13	31.40	--	64.78
Soybean meal (44%)		25.43	25.43	25.43	25.43	25.43	25.43	25.88	25.21	23.70	26.37
Ground oats		--	33.00	66.00	--	33.00	66.00	--	28.82	57.65	--
Fat		--	--	--	--	--	--	--	5.80	10.08	--
Soybean hulls		--	--	--	--	--	--	--	--	--	--
Dried whey delactosed		5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Dicalcium phosphate		1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57
Limestone		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Vitamin premix[a]		.50	.50	.50	.50	.50	.50	.50	.50	.50	.50
Trace mineralized salt[b]		.50	.50	.50	.50	.50	.50	.50	.50	.50	.50
Lysine premix[c]		--	--	--	.84	.40	--	.42	.20	--	.28
Calculated analysis:											
Crude Fiber, %		2.85	5.42	8.00	2.85	5.42	8.00	2.87	4.98	7.08	3.36
Crude Protein, %		18.31	19.17	20.43	18.31	19.17	20.43	18.17	18.25	18.19	18.18
Lysine, %		0.92	1.03	1.13	1.13	1.13	1.13	1.04	1.05	1.04	1.06
Kcal ME/kg		3245	2895	2407	3243	2880	2544	3101	3134	3104	3115

Item	Diet	11	12	13	14	15	16	17	18	19	20
	Experiment	4	4	4	4	5	5	5	5	5	5
Corn		38.98	57.82	--	47.14	64.70	51.90	39.00	53.85	13.43	42.86
Soybean meal (44%)		25.20	26.52	23.44	26.67	26.32	25.66	25.06	28.57	23.86	30.91
Ground oats		23.38	--	58.63	--	--	11.68	23.36	--	46.55	--
Fat		3.70	1.62	9.36	4.09	--	1.85	3.71	3.66	7.38	7.34
Soybean hulls		--	5.37	--	13.53	--	--	--	5.15	--	10.32
Dried whey delactosed		5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Dicalcium phosphate		1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57	1.57
Limestone		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Vitamin premix[a]		.50	.50	.50	.50	.50	.50	.50	.50	.50	.50
Trace mineralized salt[b]		.50	.50	.50	.50	.50	.50	.50	.50	.50	.50
Lysine premix[c]		.17	.10	--	--	.41	.34	.30	.20	.21	--
Calculated analysis:											
Crude Fiber, %		5.00	5.00	7.47	7.47	3.37	4.17	4.99	4.99	6.62	6.63
Crude Protein, %		18.19	18.18	18.19	18.20	18.14	18.13	18.14	18.14	18.14	18.15
Lysine, %		1.06	1.05	1.06	1.06	1.08	1.08	1.08	1.08	1.08	1.08
Kcal ME/kg		3116	3114	3119	3119	3113	3113	3113	3113	3113	3113

[a]Provided in the complete diet: 0.50% NaCl; 0.1 ppm Se as $NaSeO_3$; 100 ppm Fe as $FeSO_4 \cdot H_2O$; 15 ppm Cu as CuO; 100 ppm Zn as ZnO; 50 ppm Mn as $MnSO_4$ and 0.9 ppm I as $Ca(IO_3)_2$.

[b]Provided per kg of diet: 1.9 mg vitamin A acetate; 13.8 µg vitamin D_3; 22 mg DL-α- tocopheryl acetate; 5.5 mg riboflavin; 27.5 mg D-panthothenic acid; 33 mg niacin; 410 mg choline as choline chloride; 33 µg vitamin B_{12}; 3.3 mg vitamin K as menadione sodium bisulfite; 2.2 mg thiamin; 1.1 mg folic acid; 1.1 mg vitamin B_6; 0.44 mg biotin and 55 mg ethoxyquin.

[c]One part lysine HCl with 3 parts corn.

TABLE 2. FEEDING REGIMES ON EXPERIMENTS 2, 3, 4, 5

		Diet[a] Fed During Week					
Experiment	Treatment	1	2	3	4	5	6
2	1	4	4	4	4	4	4
2	2	5	4	4	4	4	4
2	3	5	5	4	4	4	4
2	4	5	6	4	4	4	4
2	5	6	5	5	4	4	4
3	1	7	7	7	7	7	7
3	2	8	7	7	7	7	7
3	3	8	8	7	7	7	7
3	4	8	9	8	7	7	7
3	5	9	8	8	7	7	7
4	1	10	10	10	10	10	10
4	2	11	11	10	10	10	10
4	3	12	12	10	10	10	10
4	4	13	13	11	11	10	10
4	5	14	14	12	12	10	10
5	1	15	15	15	15	15	15
5	2	16	16	15	15	15	15
5	3	17	17	15	15	15	15
5	1	18	18	15	15	15	15
5	5	19	19	17	17	15	15
5	6	20	20	18	18	15	15

[a]See table one.

TABLE 3. EFFECT OF HIGH LEVELS OF GROUND OATS ON PERFORMANCE AND INCIDENCE OF SCOURS OF PIGS ON EXPERIMENT 1

Items	Treatments		
	1	2	3
FIBER SOURCE			
Ground Oats, %	-----	33.00	66.00
PERFORMANCE[1]			
Body Weight, kg			
Initial	7.46	7.46	7.47
Final	22.88	21.78	22.84
Avg Daily Gain, kg	.37	.34	.37
Avg Daily Feed, kg	1.65	1.46	1.66
Gain:Feed	.22	.23	.22
SCOURING SCORES[2]			
1 to 7 Days	.53	.40	.40
7 to 14 Days	.59[b]	.47[bc]	.33[c]
14 to 21 Days	.29[b]	.14[bc]	.09[c]
Total (1 to 21 Days)	.47[b]	.34[bc]	.27[c]

[1]All values are means of 6 replicates of 4 pigs each with 7.46 kg initial weight and self-fed for 6 weeks.

[2]Mean total individual scores on a scale: 0 = normal, 1 = mild, 2 = moderate and 3 = watery.

[b,c]Means within row with different superscripts are different ($P<.05$).

TABLE 4. EFFECT OF HIGH LEVELS OF GROUND OATS AND FEEDING REGIMES ON PERFORMANCE AND INCIDENCE OF SCOURS OF PIGS ON EXPERIMENT 2

Criteria	Treatments				
	1	2	3	4	5
BODY WEIGHT, kg					
Initial	9.72	9.76	9.63	9.69	9.77
Final	27.06	27.71	27.64	27.59	27.94
PERFORMANCE[1]					
Avg Daily Gain, kg	.41	.42	.43	.43	.43
Avg Daily Feed, kg	.88	.88	.85	.86	.88
Gain:Feed	.47	.48	.50	.50	.49
SCOURING SCORES[2]					
1 to 7 Days	0.94	1.24	1.17	0.94	1.32
7 to 14 Days	1.61[b]	1.28[bcd]	1.05[cd]	1.42[bc]	0.95[d]
14 to 21 Days	1.81[b]	1.57[bc]	1.49[bc]	1.42[bc]	1.39[c]
Total (1 to 21 Days)	1.45	1.36	1.24	1.26	1.22

[1] All values are means of 7 replicates of 4 pigs each with 9.71 kg initial weight and self-fed for 6 weeks.

[2] Mean total individual scores on a scale: 0 = normal, 1 = mild, 2 = moderate and 3 = watery.

[b,c,d] Means within row with different superscripts are different ($P<.05$).

TABLE 5. EFFECT OF HIGH LEVELS OF GROUND OATS ON PERFORMANCE AND INCIDENCE OF SCOURS OF PIGS ON EXPERIMENT 3

Criteria	Treatments				
	1	2	3	4	5
BODY WEIGHT, kg					
Initial	9.59	9.64	9.68	9.62	9.84
Final	27.93	27.55	27.87	27.97	28.09
PERFORMANCE[1]					
Avg Daily Gain, kg	.44	.43	.43	.44	.43
Avg Daily Feed, kg	.90	.88	.96	.92	.98
Gain:Feed	.48	.48	.45	.47	.44
SCOURING SCORES[2]					
1 to 7 Days	1.44	1.13	1.46	1.29	0.51
7 to 14 Days	1.86[b]	1.27[c]	1.81[b]	1.26[c]	1.89[b]
14 to 21 Days	1.29	0.82	1.08	0.80	1.14
Total (1 to 21 Days)	1.53	1.07	1.45	1.12	1.52

[1]All values are means of 5 replicates of 4 pigs each with 9.67 kg initial weight and self-fed for 6 weeks.

[2]Mean total individual scores on a scale: 0 = normal, 1 = mild, 2 = moderate and 3 = watery.

[b,c]Means within row with different superscripts are different ($P<.05$).

TABLE 6. EFFECT OF DIETARY FIBER SOURCE ON PERFORMANCE OF PIGS ON EXPERIMENT 4

Criteria	Treatments[a]				
	1	2	3	4	5
BODY WEIGHT, kg					
Initial[a]	8.23	8.30	8.33	8.35	8.34
Final[a]	25.68	26.14	25.54	24.07	24.03
PERFORMANCE					
Avg Daily Gain,[a] kg	.41[bc]	.42[b]	.41[bc]	.37[c]	.37[c]
Avg Daily Feed,[d] kg	.85	.90	.85	.78	.81
Gain:Feed[d]	.49	.48	.48	.48	.46
SCOURING SCORES[e]					
4 to 5 Weeks	1.23	1.35	1.18	1.43	1.67
5 to 6 Weeks	1.87	2.03	1.85	1.96	2.04
6 to 7 Weeks	1.68	1.87	1.93	1.80	1.80
Total 4 to 7 Weeks	1.60	1.75	1.67	1.73	1.84

[a]Means are presented. On ADG, initial and final weights, 28 pigs were used as individuals in the analysis.

[b,c]Means in the same row with different superscripts are different ($P<.05$).

[d]Means from 7 pens of 4 pigs each.

[e]Means of scores from individual pigs: 0 = normal, 1 = mild, 2 = moderate and 3 = watery.

TABLE 7. EFFECT OF DIETARY FIBER SOURCE ON PERFORMANCE OF PIGS ON EXPERIMENT 5

Criteria	Diets[a]					
	1	2	3	4	5	6
BODY WEIGHT, kg						
Initial[f]	7.64	7.71	7.72	7.83	7.74	7.73
Final[f]	23.46^{cd}	22.39^{d}	24.75^{bc}	24.48^{bc}	24.39^{bc}	25.41^{b}
PERFORMANCE						
Avg Daily Gain[f], kg	$.37^{bc}$	$.34^{c}$	$.40^{bc}$	$.37^{bc}$	$.36^{bc}$	$.41^{b}$
Avg Daily Feed[g], kg	.77	.78	.88	.86	.79	.88
Gain:Feed[g]	.48	.44	.45	.44	.45	.47
SCOURING SCORES[h]						
4 to 5 weeks	1.01^{c}	1.34^{c}	0.97^{c}	1.85^{b}	1.32^{c}	1.87^{b}
5 to 6 weeks	0.65^{c}	0.99^{bc}	1.02^{bc}	1.26^{b}	0.90^{bc}	0.96^{bc}
7 to 8 weeks	0.50^{bc}	0.37^{cd}	0.19^{d}	0.70^{b}	0.44^{c}	0.61^{bc}
Total (4 to 8 weeks)	0.72^{e}	0.99^{cd}	0.72^{e}	1.27^{b}	0.89^{de}	1.15^{bc}

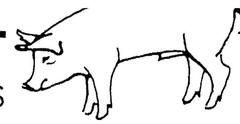
[a]All values are means.

[b,c,d,e]Means in the same column but with different superscripts are different (P .05).

[f]Individual pig basis.

[g]Pen basis.

[h]Means of total scores from individual pigs using the following scale: 0 = normal; 1 = mild; 2 = moderate; and 3 = watery.



VIRGINIAMYCIN, PROTEIN AND ENERGY RELATIONSHIPS IN DIETS FOR PIGS DURING THE STARTER, GROWER AND FINISHING PHASES

Trygve L. Veum and Dennis E. Jewell

SUMMARY

Virginiamycin (27.5 ppm) improved pig performance during the starter phase with a lower response during the grower phase and overall (starter through finishing). Virginiamycin improved performance on the low protein diet during the finishing phase and increased loin eye muscle area on the low protein sequence. A crude protein level of 20% produced greater daily gains during the starter phase than 18% crude protein. The high protein sequence also produced a larger loin eye muscle area. The high energy sequence (added fat) improved performance during the grower and finishing phases and overall.

INTRODUCTION

Virginiamycin, produced by Streptomyces Virginiae, has been shown to be effective in increasing average daily gain and gain:feed ratio of growing pigs. European reports also indicate that virginiamycin improves performance from the starter phase through the finishing phase, with the greatest response obtained during the starter and grower periods. The following experiment was conducted with pigs from weaning to market weight to evaluate the effect of virginiamycin on improved energy and nitrogen utilization as measured by pig performance, carcass measurements, and energy and nitrogen balance.

EXPERIMENTAL PROCEDURE

Two hundred forty-eight crossbred pigs weaned at four weeks of age were utilized in two trials. The pigs were housed in the same environmentally-regulated facilities in both trials which contained 100% concrete slats, self-feeders and nipple waterers. All pigs were stratified by weight and assigned to treatments based on body weight, sex and litter. There were four pigs per pen (three pigs in one replication) during the starter phase. The pigs were relocated and two pens (replications) with similar pig weights were combined at the initiation of the growing phase so that there were eight pigs per pen (seven pigs in one replication) during the growing and finishing phases.

Different diets were formulated for the starter (7.4 to 22.3 kg, six weeks), grower (22.3 to 46.7 kg, five weeks) and finisher (46.7 to 92.1 kg, eight weeks) phases (tables 1, 2 and 3, respectively). The experimental design was a 2 X 2 X 2 factorial with either "low" or "high" energy levels, "low" or "high" protein levels and 0 or 27.5 ppm virginiamycin. Protein and lysine levels were increased about 2 and .1% and/or energy about .35 kcal of metabolizable energy (ME)/g by replacing cornstarch with either protein ingredients or fat, respectively. Protein quality was standardized by using the same ratio of protein ingredients in all diets within phases.

At the end of the finishing period, backfat thickness and loin eye muscle area were estimated for all pigs with a sonaray machine. Also at the end of the finishing period, six pigs (three pigs per trial) from each of the four treatments fed either the low protein and high energy sequence or the high protein and low energy sequence, with 0 or 27.5 ppm virginiamycin, were kept on their respective diets and placed in metabolism cages. After a five day adjustment period, total fecal and urine collections were obtained from individual pigs for five days. Urine was collected daily in flasks containing 25 ml of 6 N HCl and 15 ml of toluene. Ten percent of the urine was saved each day and frozen. Feces and urine were analyzed for nitrogen and dry matter and energy determinations were made by the use of a Parr adiabetic oxygen bomb calorimeter.

Data were subjected to an anlysis of variance. The data for both trials were combined for summarization since there were no trial X treatment interactions.

RESULTS

There were no interactions between virginiamycin, protein level and energy level (the three main effects) for most of the parameters evaluated. Thus, only main effect results are presented except where interactions require further explanation.

The main effect performance results for the starter phase are shown in table 4. Virginiamycin increased average daily gain (ADG) and gain:feed ratio (G:F). The 20% protein diets also produced a greater ADG than the 18% protein diets, while G:F was similar for both protein levels. The higher energy level (added fat) slightly improved performance. Average daily feed intake (ADF) was similar within each main effect.

During the growing phase (table 5), virginiamycin continued to improve ADG and ADF. Performance of the pigs in the high protein sequence was similar to that of the pigs in the low protein sequence. The higher energy level (added fat) improved ADG and G:F. The ADF was slightly increased and decreased by virginiamycin and the high energy levels, respectively.

During the finishing phase (table 6), either virginiamycin or the high protein sequence did not improve ADF or ADG. However, the high energy level (added fat) improved ADG and G:F ratio. The ADF was slightly increased by the high protein sequence, and slightly decreased by high energy.

An interaction was obtained between protein and virginiamycin for ADG during the finishing phase (table 7). Virginiamycin improved the ADG (with a trend for greater ADF) of pigs fed the low protein sequence, but not pigs fed the high protein sequence.

The overall effect on performance from the starter through the finishing phases is shown in table 8. The overall aDG was improved by virginiamycin, the high protein sequence and the high energy sequence. The G:F was improved only for the high energy sequence. The overall effect on ADF was a slight increase for the virginiamycin and the high protein sequences and a slight decrease for the high energy sequences.

Backfat thickness and loin eye muscle area were not influenced by main effects (table 9), except for an increased backfat thickness with the higher levels of energy (added fat). The interaction between protein and virginiamycin for loin eye muscle area (table 10) suggests that the high protein sequence increased muscle area in the absence of virginiamycin, while virginiamycin increased muscle area only at the low protein sequence.

The apparent nitrogen digestibility and biological value, net protein utilization, and energy digestibility and retention (table 11) were similar among the four treatments fed either the low protein and high energy sequence or the high protein and low energy sequence, with 0 or 27.5 mg/kg virginiamycin.

TABLE 1. STARTER DIETS

Ingredient	Diet[a]			
	Control	Control + fat	Control + protein + fat	Control + protein - fat
Ground corn, %	40.00	40.00	40.00	40.00
44% soybean meal, %	28.00	28.00	31.17	31.17
Delactosed whey, %	10.00	10.00	11.13	11.13
Cornstarch, %	19.00	11.00	1.29	1.29
Fat, %[b]	-----	8.00	8.98	8.98
Minerals & vitamins, %[c]	3.00	3.00	2.90	2.90
Crude protein, %	18.10	18.10	20.10	20.10
Lysine, %	1.02	1.02	1.13	1.13
Mcal of ME/kg	3.15	3.51	3.51	3.15
% Lys/Mcal ME/kg	.32	.29	.32	.36

[a]All diets were fed with or without 27.5 ppm virginiamycin provided by the Smith Kline Corporation, Philadelphia, Pennsylvania.

[b]Hydrolyzed animal and vegetable fat provided by the Buckeye Cellulose Corporation, Memphis, Tennessee.

[c]Minerals and vitamins provided to exceed National Research Council requirements.

TABLE 2. GROWER DIETS

Ingredients	Diet[a] Control	Control + fat	Control + protein + fat	Control + protein - fat
Ground corn, %	54.60	54.60	60.67	60.67
44% soybean meal, %	24.40	24.40	27.11	27.11
Cornstarch, %	18.00	10.00	.51	8.51
Fat, %[b]	-----	8.00	8.81	.81
Minerals & vitamins, %[c]	3.00	3.00	2.90	2.90
Crude protein, %	16.03	16.03	17.82	17.82
Lysine, %	.81	.81	.90	.90
Mcal of ME/kg	3.21	3.57	3.57	3.21
% Lys/Mcal ME/kg	.25	.23	.25	.28

[a,b,c]See table 1 for description of footnotes.

TABLE 3. FINISHING DIETS

Ingredients	Diet[a] Control	Control + fat	Control + protein + fat	Control + protein - fat
Ground corn, %	60.00	60.00	66.61	66.61
44% soybean meal, %	19.00	19.00	21.09	21.09
Cornstarch, %	18.00	10.00	.67	8.67
Fat, %[b]	-----	8.00	8.73	.73
Minerals & vitamins, %[c]	3.00	3.00	2.90	2.90
Crude protein, %	14.04	14.04	15.59	15.59
Lysine, %	.66	.66	.73	.73
Mcal of ME/kg	3.24	3.60	3.60	3.24
% Lys/Mcal ME/kg	.20	.18	.20	.23

[a,b,c]See table 1 for description of footnotes.

TABLE 4. PERFORMANCE MAIN EFFECTS FOR THE STARTER PHASE[a]

	Virginiamycin		Protein Level		Energy, Mcal ME/kg	
	0	27.5 ppm	18%	20%	3.15	3.51
Average daily feed, kg	.67	.67	.65	.69	.68	.66
Average daily gain, kg	.33[b]	.36[c]	.33[b]	.36[c]	.34	.35
Gain:feed ratio	.49[b]	.53[c]	.51	.51	.50	.52

[a]The experimental units are pens of 3 or 4 pigs. There were no interactions between main effects.

[b,c]Main effect means with different superscripts are different ($P<.05$).

TABLE 5. PERFORMANCE MAIN EFFECTS FOR THE GROWER PHASE[a]

	Virginiamycin		Protein Level		Energy, Mcal ME/kg	
	0	27.5 ppm	16%	18%	3.21	3.56
Average daily feed, kg	1.67[b]	1.77[c]	1.72	1.71	1.75	1.69
Average daily gain, kg	.66[d]	.72[e]	.69	.70	.68[d]	.71[e]
Gain:feed ratio	.40	.40	.40	.41	.39[d]	.41[e]

[a]Experimental units are pens of 7 or 8 pigs. There were no interactions between main effects.

[b,c]Main effect means with different superscripts are different ($P<.10$).

[d,e]Main effect means with different superscripts are different ($P<.05$).

TABLE 6. PERFORMANCE MAIN EFFECTS FOR THE FINISHING PHASE[a]

	Virginiamycin		Protein Level		Energy, Mcal ME/kg	
	0	27.5 ppm	14%	16%	3.24	3.60
Average daily feed, kg	2.21	2.23	2.19	2.26	2.25	2.19
Average daily gain, kg[d]	.81	.81	.80	.82	.78[b]	.84[c]
Gain:feed ratio	.36	.36	.36	.36	.34[b]	.38[c]

[a]Experimental units are pens of 7 or 8 pigs.

[b,c]Main effect means with different superscripts are different ($P<.05$).

[d]Interaction between protein and virginiamycin ($P<.05$).

TABLE 7. PROTEIN X VIRGINIAMYCIN INTERACTION DURING FINISHING

	Without Virginiamycin		27.5 ppm Virginiamycin	
	14% protein	16% protein	14% protein	16% protein
Average daily feed, kg	2.16	2.26	2.21	2.26
Average daily gain, kg[a]	.78[b]	.84[d]	.82[c,d]	.80[b,c]
Gain:feed ratio	.36	.37	.37	.35

[a]Protein X virginiamycin interaction ($P<.05$).

[b,c,d]Means with different superscripts are different ($P<.05$).

TABLE 8. OVERALL PERFORMANCE MAIN EFFECTS FROM THE STARTER THROUGH THE FINISHER PHASES[a]

Overall	Virginiamycin 0	Virginiamycin 27.5 ppm	Protein Sequence Low	Protein Sequence High	Energy, Mcal ME/kg Low Levels	Energy, Mcal ME/kg High Levels
Average daily feed, kg	1.58	1.62	1.58	1.62	1.62	1.58
Average daily gain, kg	.62[b]	.64[c]	.62[b]	.64[c]	.62[b]	.65[c]
Gain:feed ratio	.39	.40	.39	.40	.38[b]	.41[c]

[a]The experimental units are pens of 7 or 8 pigs.

[b,c]Main effect means with different superscripts are different ($P<.05$).

TABLE 9. CARCASS MEASUREMENTS FOR MAIN EFFECTS[a]

	Virginiamycin 0	Virginiamycin 27.5 ppm	Protein Sequence Low	Protein Sequence High	Energy, Mcal ME/kg Low Levels	Energy, Mcal ME/kg High Levels
Backfat, cm	2.67	2.69	2.64	2.69	2.62[b]	2.74[c]
Loin eye muscle area (cm^2)	28.39	27.61	27.87	28.13	27.61	28.32

[a]Means of 232 individual pigs. Protein X virginiamycin interaction ($P<.05$) for loin eye muscle area.

[b,c]Means with different superscripts are different ($P<.05$).

TABLE 10. PROTEIN X VIRGINIAMYCIN INTERACTION FOR LOIN EYE MUSCLE AREA

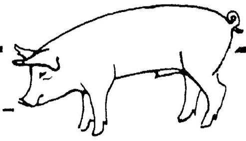
	Without Virginiamycin		27.5 ppm Virginiamycin	
	Low protein sequence	High protein sequence	Low protein sequence	High protein sequence
Loin eye muscle area (cm^2)	26.90[a]	28.32[b]	28.77[b]	27.87[b]

[a,b]Means with different superscripts are different (P<.05).

TABLE 11. THE EFFECTS OF VIRGINIAMYCIN AND LYSINE:ENERGY RATIO ON DIGESTIBLE AND METABOLIZABLE ENERGY AND NITROGEN BALANCE[a]

Finishing diet	Control + fat	Control + protein	Control + fat	Control + protein
Virginiamycin	0	0	27.5 ppm	27.5 ppm
% Lysine/Mcal ME/kg	.183	.226	.183	.226
Apparent nitrogen digestibility, %	88.2	89.7	88.6	89.8
Apparent biological value, %	64.8	57.2	56.5	59.5
Apparent net protein utilization, %	56.9	51.3	50.1	53.2
Apparent energy digestibility, %	84.3	87.0	84.1	86.8
Apparent energy retention, %	82.6	84.6	82.5	84.8

[a]Values are means from six pigs per treatment.



THE EFFECT OF VIRGINIAMYCIN IN LOWER ENERGY - HIGHER FIBER DIETS FOR PIGS DURING THE STARTER, GROWER AND FINISHING PHASES

Trygve L. Veum and Dennis E. Jewell

SUMMARY

Virginiamycin improved the daily gains and reduced the incidence of scouring during the starter phase. Virginiamycin also increased the daily feed consumption of pigs consuming the diets containing soybean hulls during the starter phase. Virginiamycin slightly improved the overall daily gain from the starter through the finishing phases, and slightly increased the loin eye muscle area. The substitution of 5% soybean hulls into the diet increased the daily feed intake and daily gain during the starter period, with a similar trend overall from the starter through the finishing phases.

INTRODUCTION

Energy efficiency has become more critical in swine production as our basic energy resources have drastically increased in price, both in the United States and world wide. One way to increase the efficiency of production is to decrease the amount of feed energy required to produce a pound of pork. The following experiment was conducted with pigs from weaning to market weight to evaluate the effect of virginiamycin on improved energy and nitrogen utilization in lower energy - higher fiber diets as evaluated by performance and energy and nitrogen balance.

EXPERIMENTAL PROCEDURE

One hundred forty-four crossbred pigs weaned at four weeks of age were stratified by weight and assigned to treatments based on body weight, sex and litter. The pigs were housed in the same confinement facilities as described for the previous experiment with virginiamycin, with four pigs per pen in the starter phase and eight pigs per pen in the grower and finishing phases.

Different diets were formulated for the starter (8.7 to 23.5 kg, five weeks), grower (23.5 to 49.1 kg, six weeks), and finishing (49.1 to 92.0 kg, eight weeks) phases (tables 1, 2 and 3, respectively). The experimental design was a 2 X 3 factorial with 0 or 27.5 ppm virginiamycin and with 0, 5 or 10% soybean hulls which replaced cornstarch. Thus, soybean hulls reduced the metabolizable energy (ME) in Kcal/kg by 0, 6 or 12%, respectively. Protein quality was standardized within phases by using the same ratio of protein ingredients in all the diets. The data was analyzed as described for the previous experiment with virginiamycin.

RESULTS

Results for the starter phase (table 4) suggest that 5% soybean hulls increased average daily feed (ADF) and average daily gain (ADG) while 10% soybean hulls did not improve performance over the group without soybean hulls. Virginiamycin increased ADG over all levels of soybean hulls and gain:feed ratio (G:F) only in the diet without soybean hulls. Virginiamycin also increased ADF of the 5 and 10% soybean hull groups.

The scouring score from days 1 to 21 of the experiment (table 4) indicates that soybean hulls did not influence the incidence of scouring. However, virginiamycin reduced the incidence of scouring from 14 to 21 days, which resulted in a slight reduction overall from 1 to 21 days.

During the grower phase (table 6), soybean hulls increased ADF, but the response was greater with 5 than with 10% hulls. Soybean hulls tended to reduce feed efficiency expressed as G:F. All treatments were similar in ADG. Virginiamycin did not improve pig performance during the grower phase.

During the finishing phase (table 7), both levels of soybean hulls tended to increase ADF, while ADG was similar among all treatments. Feed efficiency was poorer for the diets containing soybean hulls compared to the diets without soybean hulls. Virginiamycin did not improve pig performance during the finishing phase.

The overall performance from starter through the finishing phases (table 8) indicates that soybean hulls increased ADF and reduced feed efficiency (G:F). Virginiamycin also increased the overall ADG.

The carcass measurements (table 9) obtained at the end of the experiment found that backfat thickness was not influenced by any of the treatments. However, there was a trend for a larger loin eye muscle area in pigs fed the diets containing virginiamycin and soybean hulls.

TABLE 1. COMPOSITION OF STARTER DIETS[a]

Ingredients	Soybean hulls, %		
	0	5	10
Ground corn, %	53.17	53.17	53.17
44% soybean meal, %	28.38	28.38	28.38
Delactosed whey, %	5.00	5.00	5.00
Cornstarch, %	10.00	5.00	---
Soybean hulls, %	---	5.00	10.00
Minerals & vitamins, %[b]	3.45	3.45	3.45
Crude fiber, %	3.26	4.91	6.57
Crude protein, %	18.00	18.00	18.00
Lysine, %	1.03	1.03	1.03
Mcal of ME/kg	3.15	2.97	2.78
% Lys/Mcal ME/kg	.33	.35	.37

[a]All diets fed with or without 27.5 ppm virginiamycin provided by the Smith Kline Corporation, Philadelphia, Pennsylvania.

[b]Minerals and vitamins provided to exceed National Research Council requirements.

TABLE 2. COMPOSITION OF GROWER DIETS[a]

Ingredients	Soybean hulls, % 0	5	10
Ground corn, %	62.81	62.81	62.81
44% soybean meal, %	23.80	23.80	23.80
Cornstarch, %	10.00	5.00	-----
Soybean hulls, %	-----	5.00	10.00
Minerals and vitamins, %[b]	3.39	3.39	3.39
Crude fiber, %	3.12	4.77	6.42
Crude protein, %	16.00	16.00	16.00
Lysine, %	.85	.85	.85
Mcal of ME/kg	3.19	3.01	2.82
% Lys/Mcal ME/kg	.27	.28	.30

[a,b]See table 1 for description of footnotes.

TABLE 3. COMPOSITION OF FINISHER DIETS[a]

Ingredients	Soybean hulls, % 0	5	10
Ground corn, %	68.71	68.71	68.71
44% soybean meal, %	18.07	18.07	18.07
Cornstarch, %	10.00	5.00	-----
Soybean hulls, %	-----	5.00	10.00
Minerals & vitamins, %[b]	3.22	3.22	3.22
Crude fiber, %	2.83	4.48	6.13
Crude protein, %	14.00	14.00	14.00
Lysine, %	.70	.70	.70
Mcal of ME/kg	3.21	3.03	2.84
% Lys/Mcal ME/kg	.22	.23	.23

[a,b]See table 1 for description of footnotes.

TABLE 4. PERFORMANCE FOR THE STARTER PHASE[a]

	Without Virginiamycin			27.5 ppm Virginiamycin		
	Soybean hulls, %			Soybean hulls, %		
	0	5	10	0	5	10
Average daily feed, kg[b]	.77[e]	.86[d,e]	.78[d,e]	.78[e]	.94[d]	.86[d]
Average daily gain, kg[c]	.38[e]	.43[d,e]	.39[d,e]	.42[d,e]	.46[d]	.44[d,e]
Gain:feed ratio	.50	.50	.50	.56	.48	.50

[a]The experimental units are pens of 3 or 4 pigs.

[b]Quadratic effect due to soybean hulls, ($P<.05$).

[c]Main effect difference due to virginiamycin ($P<.05$) and a quadratic effect due to soybean hulls ($P<.10$).

[d,e]Means with different superscripts are different ($P<.05$).

TABLE 5. SCOURING SCORE DURING THE FIRST 21 DAYS

	Without Virginiamycin			27.5 ppm Virginiamycin		
	Soybean hulls, %			Soybean hulls, %		
Days on experiment	0	5	10	0	5	10
	Scouring score[a]			Scouring score[a]		
1 to 7	1.35	1.46	1.21	1.03	1.14	1.26
7 to 14	2.05	1.99	1.97	1.97	2.00	1.96
14 to 21[b]	1.17	1.26	1.24	1.07	1.12	1.07
1 to 21[c] (mean)	1.52	1.57	1.48	1.35	1.42	1.43

[a]All pigs were scored daily and given scores from 0 to 3, with 0 = normal and 3 = severe scouring.

[b]Main effect difference due to virginiamycin ($P<.05$).

[c]Main effect difference due to virginiamycin ($P<.10$).

TABLE 6. PERFORMANCE FOR THE GROWER PHASE[a]

	Without Virginiamycin			27.5 ppm Virginiamycin		
	Soybean hulls, %			Soybean hulls, %		
	0	5	10	0	5	10
Average daily feed, kg[b]	1.43[d,e]	1.57[d,e]	1.58[d,e]	1.30[e]	1.64[d]	1.50[d,e]
Average daily gain, kg	.59	.62	.61	.62	.62	.59
Gain:feed ratio[c]	.42[d,e]	.40[d,e]	.39[e]	.48[d]	.38[d,e]	.40[d,e]

[a]Experimental units are pens of 7 or 8 pigs.

[b]Linear and quadratic effect due to soybean hulls (P<.10).

[c]Linear effect due to soybean hulls (P<.05).

[d,e]Means with different superscripts are different (P<.05).

TABLE 7. PERFORMANCE FOR THE FINISHING PHASE[a]

	Without Virginiamycin			27.5 ppm Virginiamycin		
	Soybean hulls, %			Soybean hulls, %		
	0	5	10	0	5	10
Average daily feed, kg[b]	2.39[d,e]	2.61[d,e]	2.68[d]	2.20[e]	2.67[d]	2.57[d,e]
Average daily gain, kg	.76	.75	.78	.78	.81	.78
Gain:feed ratio[c]	.32[d,e]	.29[e]	.29[e]	.36[d]	.30[d,e]	.30[d,e]

[a]Experimental units are pens of 7 or 8 pigs.

[b,c]Linear effect due to soybean hulls (P<.05).

[d,e]Means with different superscripts are different (P<.05).

TABLE 8. OVERALL PERFORMANCE FROM THE STARTER THROUGH THE FINISHING PHASES[a]

	Without Virginiamycin			27.5 ppm Virginiamycin		
	Soybean hulls, %			Soybean hulls, %		
	0	5	10	0	5	10
Average daily feed, kg[b]	1.66[e,f]	1.82[e,f]	1.83[e,f]	1.54[e]	1.89[f]	1.78[e]
Average daily gain, kg[c]	.61[e]	.63[e,f]	.62[e,f]	.62[e,f]	.66[f]	.63[e,]
Gain:feed ratio[d]	.37	.35	.34	.41	.35	.36

[a]The experimental units are pens of 7 or 8 pigs.

[b]Linear effect due to soybean hulls ($P<.05$), quadratic effect due to soybean hulls ($P<.10$).

[c]Main effect difference due to virginiamycin ($P<.10$), quadratic effect due to soybean hulls ($P<.10$).

[d]Linear effect due to soybean hulls ($P<.05$).

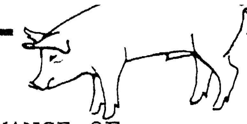
[e,f]Means with different superscripts are different.

TABLE 9. CARCASS MEASUREMENTS[a]

	Without Virginiamycin			27.5 ppm Virginiamycin		
	Soybean hulls, %			Soybean hulls, %		
	0	5	10	0	5	10
Backfat (cm)	2.89	2.98	3.04	2.93	3.16	2.98
Loin eye muscle area (cm^2)[b]	29.68	29.19	29.46	29.52	31.49	30.91

[a]Means of 129 individual pigs.

[b]Main effect difference due to virginiamycin ($P<.10$).



EFFECT OF DIETARY LACTOBACILLUS ON GROWTH AND PERFORMANCE OF PIGS FED A LOW PROTEIN-LOW LYSINE DIET

R.J. Moore, D.E. Jewell and T.L. Veum

SUMMARY

A 70 day feeding trial involving 80 crossbred pigs (initial weight=27 kg) was conducted to evaluate a dietary Lactobacillus culture in sparing dietary lysine. Growth and feed efficiency were used as criteria for evaluation. During a 14 day starter period, growth and feed efficiency were inferior in pigs fed diets with 68 kg of soybean meal (SBM) removed per ton and replaced with corn, or corn and a lactobacillus culture (LP). Pigs fed diets with 34 kg SBM removed per ton and supplemented with corn and LP had performance equal to the control pigs. Diets with 34 kg SBM removed and replaced with only corn had poorer ADG and G:F. There was no effect of LP after 14 days of the experiment. These data suggest that LP may be beneficial in diets for young pigs which are marginal in lysine composition or contain a poorly available form of lysine.

INTRODUCTION

The majority of swine diets used in today's swine production systems are based upon corn and soybean meal being the primary nutrient sources. Soybean meal is the most expensive portion of the diet, and is added to supply an adequate level of crude protein level in the diet, as well as to improve the balance of essential amino acids. Lysine is the first limiting amino acid in this type of diet. Thus, if a less expensive source of lysine could be added to the diet in the place of soybean meal, protein requirements could be met with less expense and without sacrifices in pig growth and feed effieciency. Recent advances in microbial genetics and selection have led to the isolation of lysine-secreting mutant strains of the bacteria *Lactobacillus plantarum*. A number of products are commercially available which contain LP, and this experiment was designed as a pilot study to look at their effectiveness in the diets of growing pigs.

EXPERIMENTAL PROCEDURE

Eighty (80) crossbred pigs (initial weight=27 kg) were used in a feeding trial to evaluate dietary LP as a lysine source for swine. The pigs were allotted by weight, litter and sex to five dietary treatments of 2 pens of 8 pigs each. Treatments were: (1) control diet balanced for lysine, (2) control diet with 34 kg of SBM removed per ton and replaced with corn, (3) control diet with 68 kg of SBM removed per ton, (4) Diet 2 supplemented with 150 gm per ton of LP culture, and (5) Diet 3 supplemented with 300 gm of LP culture per ton. Diets were self-fed for a 14 day starter period. For days 15 to 70, the crude protein level and lysine levels in the diets were lowered 1.1% and 0.07%, respectively. Feed consumption and weight gain were determined weekly.

RESULTS

During both feeding periods, those pigs fed the diets with 68 kg of SBM removed had inferior average daily gain (ADG) and gain:feed (G:F) ratios (table 2 and 3) compared to the other groups of pigs. Thus, LP doesn't appear to be effective in diets where substantial deficits in lysine exist.

During the 14 day starter period (table 2), pigs fed the diet with 34 kg of SBM removed and supplemented with LP had ADG and G:F ratios similar to the pigs fed the control diet, while the pigs fed the diet with 34 kg of SBM removed and supplemented with only corn had lower ADG and G:F. Although the LP supplemented pigs consumed more lysine than did the unsupplemented group, this amount of lysine was not sufficient to account for the increased pig performance observed, and the response noted appears to be due to the LP culture.

During the subsequent 56 day grower period (table 3), the pigs fed either of the diets with 34 kg of SBM removed had lower ADG and G:F ratios compared to the control pigs. Thus, any beneficial effect due to LP does not appear to carry over into pigs of an older age.

This pilot study gives some indication of the effectiveness of LP in the diet of growing pigs. However, it alos raises some questions which need to be more adequately answered when considering whether to include LP in the diet as a lysine source. Some general conclusions are:

1. LP <u>may</u> be effective in younger pig diets which are marginal in lysine content or where the lysine availability is questionable.

2. It does not appear to be of value in the diets of older pigs (i.e. those heavier than 35 kg bodyweight).

3. Based on our work and that of others, the stability of the organisms in the diet may be a problem. Also, the viability of the microbes in commercial products is variable and will effect the response obtained.

As the techniques associated with these organisms improves in the future, this approach to lysine nutrition may prove beneficial.

TABLE 1

DIET COMPOSITION DURING STARTER PERIOD (DAYS 1-14)

Ingredient	Dietary Treatment				
	Control	C-34 kg SBM	C-68 kg SBM	C-34 kg SBM+LP	C-68 kg SBM +LP
	(%)	(%)	(%)	(%)	(%)
Ground corn	79.02	82.71	86.40	82.46	86.15
Soybean meal	17.50	13.75	10.00	13.75	10.00
Dicalcium Phosphate	1.43	1.51	1.58	1.51	1.58
Ground Limestone	0.80	0.78	0.76	0.78	0.76
Vitamin premix	0.75	0.75	0.75	0.75	0.75
Trace mineralized salt	0.50	0.50	0.50	0.50	0.50
Bacteria premix (<u>Lactobacillus plantarum</u>)	----	----	----	0.25	0.25
	Nutrient Composition				
Crude Protein, (%)	14.87	13.56	12.26	13.56	12.26
Lysine, (%)	0.66	0.58	0.50	0.58	0.50
Methionine/cystine, (%)	0.50	0.48	0.45	0.48	0.45
Tryptophan, (%)	0.15	0.13	0.11	0.13	0.11

TABLE 2

PERFORMANCE DURING STARTER PERIOD (DAYS 1-14)[1]

Criteria	Dietary Treatment				
	Control	C-34 kg SBM	C-68 kg SBM	C-34 kg SBM+LP	C-68 kg SBM+LP
Daily gain (kg)	0.61^{a}	0.55^{ab}	0.50^{bc}	0.62^{a}	0.45^{c}
Daily feed (kg)	1.51	1.48	1.50	1.54	1.49
Gain:feed	0.40^{a}	0.38^{ab}	0.33^{bc}	0.40^{a}	0.30^{c}
Daily lysine (gm)	9.98	8.60	7.52	8.95	7.46

[1]Means with different superscripts are different (P<.05).

TABLE 3

PERFORMANCE DURING GROWER PERIOD (DAYS 15-70)[1]

		Dietary Treatment			
Criteria	Control	C-34 kg SBM	C-68 kg SBM	C-34 kg SBM+LP	C-68 kg SBM+LP
Daily gain (kg)	0.82[a]	0.70[ab]	0.61[b]	0.70[ab]	0.63[b]
Daily feed (kg)	2.51	2.51	2.27	2.47	2.34
Gain:Feed	0.33[a]	0.28[ab]	0.27[b]	0.28[ab]	0.27[b]
Daily lysine (gm)	14.77	12.77	9.74	12.56	10.04

[1]Means with different superscripts are different ($P<.05$).

EFFECT OF DIETARY YEAST CULTURE AND PHOSPHORUS LEVEL ON THE UTILIZATION OF PHYTATE PHOSPHORUS BY THE RAT. I. PERFORMANCE, SERUM AND BONE PARAMETERS

R.J. Moore and T.L. Veum

SUMMARY

A 28 day balance experiment was conducted with 48 male growing rats to investigate the effects of live yeast culture (LYC) and phosphorus (P) level in the diet on the availability of plant origin phosphorus. Rats were allotted to one of four treatment groups: (1) marginal P (0.34%) without LYC, (2) marginal P with LYC (2%), (3) adequate P (0.40%) without LYC, and (4) adequate P with LYC (2%). No significant effects on growth were seen. The LYC slightly decreased average daily feed (ADF) and average daily gain (ADG), and this appears to be due to poor palatability. Serum P was higher in the rats fed diets 3+4, and LYC increased serum P in rats fed diet 2 vs. diet 1, while it decreased serum P in rats fed diet 4 vs. diet 3. Serum alkaline phosphatase (AP) was higher in the rats fed diets 1+2 vs. 3+4. Femur mineralization was greater in the rats fed the adequate P diets compared to those fed the marginal P diets. LYC caused slight improvements in femur ash, Ca and P at both P levels. These data indicate that phytate P is not available to the rat and that LYC may improve plant P availability. In this respect, the rat offers a suitable model for applied studies in swine concerning phosphorus availability.

INTRODUCTION

Cereal grains and oilseed meals are major sources of P in the diets of swine. However, as much as 60 to 80% of this P has a low bioavailability since it is found in an organic form called phytate. If the phytate P could be made more digestible, it would reduce the amount of inorganic P supplements meeded, and result in a cost saving to the producer. A problem with investigating enzymatic methods for enhancing phytate availability in swine is the time and expense involved with swine metabolism trials. Thus, this experiment was performed to answer two questions: 1) Does the rat have similar responses to phytate in the diet as the pig, and 2) Can the rat be used as a model to study microbial phytase activity present in yeasts.

EXPERIMENTAL PROCEDURE

A 28 day experiment using 48 male growing rats was done to look at phytate digestibility. Diets used have been described in the summary section above and given in table 1. Rats were individually caged and allowed access to feed and water _ad libitum_. Growth and feed consumption were monitored for 21 days. At day 21, 6 rats from each treatment group were placed in metabolism cages for a 7-day balance study. Total fecal and urine collections were made for each rat daily and pooled for the entire collection period. Feed and feces were analyzed for nitrogen, Ca and P, and phytate P. Urine was analyzed for nitrogen, Ca and P. On day 28, rats were sacrificed and the femur and serum were collected for Ca, P and enzyme analysis.

RESULTS

Growth was not significantly effected by dietary P or LYC. However, LYC slightly decreased the ADF and ADG. This apparent palatability effect is similar to results which our laboratory has seen in growing pigs fed this LYC product.

Femur mineralization improved with the addition of P and LYC. This would indicate that the LYC was improving the utilization of dietary P. Whether this is due to increased phytate digestibility or better utilization of the total dietary P is not apparent from the data.

Serum P was higher in the rats fed the high P diets, which would indicate that the rats on the marginal P diets were marginally deficient in P. That LYC increased serum P in the marginal P rats would support the suggestion that it was increasing P availability, however, since it decreased serum P in rats fed the adequate P diets, this conclusion is not totally valid.

On the basis of this data, the rat offers a satisfactory model for applied nutrition studies of P availability in diets which contain plant origin phosphorus.

TABLE 1. COMPOSITION OF DIETS

Ingredient	Dietary Treatment			
	1	2	3	4
Ground corn, %	74.41	72.41	74.26	72.24
44% soybean meal, %	15.08	15.08	15.08	15.08
Corn oil, %	7.50	7.50	7.50	7.50
Ground limestone, %	1.15	1.15	0.94	0.92
Dicalcium phosphate, %	----	----	0.38	0.40
Yeast culture, %	----	2.00	----	2.00
Amino acid premix, %	0.76	0.76	0.76	0.76
Vitamin premix, %	0.60	0.60	0.60	0.60
Trace mineral-salt premix, %	0.50	0.50	0.50	0.50
Crude protein, %	15.88	15.25	14.63	15.13
Calcium, %	0.58	0.60	0.62	0.64
Phosphorus, %	0.34	0.34	0.38	0.40
Phytate P, %	0.17	0.17	0.18	0.18
Molar Ca:P ratio	1.32	1.36	1.41	1.24

TABLE 2. EFFECT OF DIET ON RAT PERFORMANCE

Criteria	Dietary Treatment 1	2	3	4
Average daily gain (gm)	6.24	6.18	6.64	6.30
Average daily feed (gm)	17.07	16.83	17.77	17.13
Gain:feed ratio	0.36	0.37	0.37	0.37

TABLE 3. EFFECT OF DIET ON FEMUR MINERALIZATION

Criteria	Dietary Treatment 1	2	3	4
Femur Weight, gm	0.40	0.42	0.41	0.41
Ash, % [1]	57.24	57.28	58.28	58.92
Calcium, %	20.49	20.65	20.79	21.12
Phosphorus, % [1]	10.52	10.67	10.88	10.98
Ca:P ratio	1.95	1.94	1.91	1.92

[1] Rats fed diets 3+4 had higher ash and phosphorus (P .05) levels than rats fed diets 1+2.

TABLE 4. EFFECT OF DIET ON SERUM PARAMETERS

Criteria	Dietary Treatment 1	2	3	4
Calcium (mg/dl)	10.81	9.21	10.36	10.52
Phosphorus (mg/dl) [1,2]	5.07	5.85	6.82	5.63
Alkaline phosphatase (IU/liter)	111.30	115.90	102.50	108.60

[1] Rats fed the adequate P diets had higher serum P levels than did those fed the marginal P diets (P .05).

[2] Yeast culture increased (P .05) serum phosphorus in the rats fed the marginal phosphorus diets but decreased it in rats fed the adequate phosphorus diets.

EFFECT OF DIETARY LIVE YEAST CULTURE AND PHOSPHORUS LEVEL ON THE UTILIZATION OF PHYTATE PHOSPHORUS BY THE RAT. II. DIGESTION AND UTILIZATION OF NUTRIENTS

R.J. Moore and T.L. Veum

SUMMARY

A 7-day metabolism trial with 24 male growing rats was done to determine the extent of digestion of dietary phosphorus (P) from plant feedstuffs and the biological value of dietary P from the diet. Dietary treatments have been described in a previous paper. Rats fed the marginal P diets digested more phytate, but retention of Ca and P indicate that phytate derived P is of poor biological value, and may act as an anti-calcifying agent. Protein digestibility is enhanced by increased phytate digestion, but biological value and net protein utilization were not affected.

INTRODUCTION

As previously described, phytate-P isn't readily available to the rat or pig. Theoretically, phytate-P which is made available to the animal should be able to be used for metabolic functions such as bone mineralization, etc. However, little data is available assessing its biological value to the rat or pig. Thus, this part of our study dealt with the absorption and utilization of the Ca and P in a grain-oilseed meal diet. In addition, since phytate interacts with protein in oilseeds, this experiment also looked at the effect of phytate digestibility on protein utilization.

EXPERIMENTAL PROCEDURE

The experimental methods for this experiment and the diets used have been described in a companion paper, and the reader is referred to that paper for a brief description of the experimental design.

RESULTS

The digestibility of dietary Ca, P and phytate is shown in table 1. Total phosphorus digestibility was higher in rats fed the marginal P diets compared to those fed the adequate P diets. These rats also had lower urine P and higher urine Ca excretion rates. These three responses are typical of rats in a P deprived state. However, phytate digestibility was also higher in the marginal P fed rats. This adaptive response has not been seen before and is indicative that the rat may be able to increase intestinal enzyme levels to increase P absorption.

The rats on all diets absorbed equal amounts of Ca and P from the gut, thus the Ca:P ratio of absorbed minerals were adequate for normal metabolism. However, because of the increased urine Ca excretion and reduced urine P in rats fed the marginal P diets, these rats had a lower ratio of Ca:P for these minerals retained. A possible reason for this is that a greater percentage of total P absorbed in these rats was of phytate origin, and this P may not have been in a form which the rat could use for metabolic purposes. The LYC slightly increased the ratio of Ca:P retained, thus it may be contributing to better utilization of the phytate-P or total plant P in the diet. With respect to P nutrition, it is apparent that more precise characterization of the form of phytate derived P is needed before we can say that hydrolyzed phytate-P is of value for non-ruminants.

Protein digestibility (table 2) increased in the diets where phytate digestibilities were higher. This is probably due to disassociation of the phytate-protein complex. Thus, by increasing the hydrolysis of phytate, it should be possible to increase the efficiency of protein utilization. Protein apparent biological value and net protein utilization were not improved, and this was probably due to the high protein quality of the diet. Yet, in diets of low protein quality, this may offer a means of increasing the efficiency of protein utilization in non-ruminants.

TABLE 1. EFFECT OF DIET ON NUTRIENT UTILIZATION

	Dietary Treatment			
Criteria	1	2	3	4
Phosphorus digestibility(%)[1]	58.41	57.91	51.32	45.72
P absorbed (mg)	32.27	29.40	24.59	30.69
Urine P (mg)[2]	0.28	0.24	1.40	1.54
P retained (mg)	31.99	29.16	33.19	29.15
Phytate digestibility(%)[1]	72.00	72.01	45.73	42.39
Phytate-P absorbed (mg)[3]	18.64	16.33	12.80	12.03
% total P absorbed from phytate[1]	57.97	59.01	36.84	38.26
Ca absorbed (mg)	52.74	50.01	56.01	50.36
Urine Ca (mg)[1]	7.79	6.24	2.68	2.25
Ca retained (mg)	44.95	43.77	53.33	48.11
Ratio of Ca:P absorbed	1.62	1.67	1.62	1.68
Ratio of Ca:P retained[2]	1.40	1.48	1.61	1.69

[1]Marginal phosphorus groups were higher ($P<.01$) than were adequate phosphorus groups.

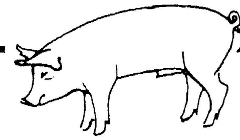
[2]Adequate phosphorus groups were higher ($P<.01$) than were marginal phosphorus groups.

[3]Marginal phosphorus groups were higher ($P<.05$) than were adequate phosphorus groups.

TABLE 2. EFFECT OF DIET ON PROTEIN UTILIZATION

Criteria	Dietary Treatment			
Digestibility(%)[1]	85.68	85.68	84.15	83.94
Nitrogen balance (gm/day)	0.25	0.21	0.24	0.22
Net protein utilization (%)	60.73	57.10	57.41	56.02
Apparent biological value (%)	70.89	66.43	68.22	66.66

[1]Rats fed the adequate phosphorus diets had lower ($P<.05$) protein digestibilities than did those fed the marginal phosphorus diets.



ANTIMICROBIAL AGENTS IN THE FINISHING PIG DIET

Trygve L. Veum, Thomas H. Davison,
Laverne Dowell and Lyndle R. Vanskike

SUMMARY

Diets containing 4.4 ppm flavomycin, 22 ppm lincomycin, 11 ppm oleandomycin, 11 ppm virginiamycin or no drug (control diet) were fed to finishing pigs in total confinement. Daily feed consumption, average daily gain and gain:feed ratios for the four groups fed the different antimicrobial agents and the control group (no drug) were all similar in this experiment.

INTRODUCTION

The effectiveness of antibiotics and other synthetic antimicrobial agents as feed additives for the weanling and growing pig, when evaluated by performance, is well documented. However, the effectiveness of these feed additives for the finishing pig is more controversial, particularly when the pigs are healthy and stress is minimized by above average management.

EXPERIMENTAL PROCEDURE

A total of 160 crossbred barrows and gilts averaging 46 kg were allotted by litter, sex and weight to five dietary treatments; which were a basal corn-soybean meal 14% crude protein control diet (C) without any drug (table 1), C + 4.4 ppm flavomycin, C + 22 ppm lincomycin, C + 11 ppm oleandomycin and C + 11 ppm virginiamycin. The pigs were housed in an environmentally-regulated facility with 100% concrete slats. Each 2.1 X 2.9 m pen contained eight pigs, a self-feeder and a nipple waterer. The feeding period was 8 weeks with a final average pig weight of 95 kg.

RESULTS

The average daily feed consumption, average daily gain and gain:feed ratio were similar among all the treatment groups, including the control group (no drug), as shown in table 2. The performance of all the treatment groups exceeded that listed as expected for pigs of this age group by the National Research Council (1979). Thus, the good performance produced by the control group was not improved by the addition of any one of the feed additives used in this experiment.

TABLE 1. COMPOSITION OF FINISHING CONTROL DIET[a]

Ingredients	Diet
Ground corn, %	81.81
44% soybean meal, %	15.07
Dicalcium phosphate, %	1.17
Ground limestone, %	1.05
Trace minerals plus salt[b]	.50
Vitamin premix[b]	.40
Crude protein, %	14.0
Lysine, %	.63
Calcium, %	.70
Phosphorus, %	.55
Mcal of ME/kg	3.13

[a]Individual feed additive premixes were prepared to provide either 4.4 ppm flavomycin, 22 ppm lincomycin, 11 ppm oleandomycin or 11 ppm virginiamycin in the complete feed. The feed additives were provided by American Hoechst Corporation, The Upjohn Company, Pfizer, Inc. and The SmithKline Corporation, respectively.

[b]Minerals and vitamins were provided to exceed National Research Council requirements.

TABLE 2. FINISHING PIG PERFORMANCE[a]

Criteria	Dietary treatment group				
	Control (no drug)	4.4 ppm flavomycin	22 ppm lincomycin	11 ppm oleandomycin	11 ppm virginiamycin
Average daily feed, kg	2.90	2.85	2.88	2.88	2.84
Average daily gain, kg	.88	.85	.89	.90	.87
Gain:feed ratio	.30	.30	.31	.31	.30

[a]A 56-day feeding period with average initial and final weights of 46 and 95 kg, respectively. There were no differences (P <.05) between treatments in the performance criteria measured.

USE OF BACITRACIN METHYLENE DISALICYLATE DURING FINISHING[1]

George Wm. Jesse and Gene Grellner

SUMMARY

The addition of 30 grams of bactracin methylene disalicylate (BMD) to a corn-soy diet did not affect performance of barrows and gilts in three different growing-finishing trials.

INTRODUCTION

During the summer of 1980 three hundred and four crossbred barrows and gilts were utilized during three separate trials to determine the effect of bactracin methylene disalicylate (BMD) on the performance of confinement raised pigs finished in a totally-enclosed building. The primary purpose of this study was not to assess the manufacturer's claim of a 7.1% improvement in average daily gain (ADG) and a 6.8% improvement in feed efficiency (F/G) but rather to determine whether or not BMD would be a beneficial addition to the University of Missouri growing-finishing (G-F) program.

PROCEDURES

All pigs were full fed a corn-soy diet (meal form) formulated to meet NRC recommendations. The BMD treatment consisted of the control diets plus 30 grams of bacitracin methylene disalicylate (.6 lb. of BMD-50) per ton. Pigs in trials 1 and 3 were fed a 16% C.P. diet during the first two weeks regardless of their initial weight followed by a 14% and finally a 13% diet. Trial 2 pigs were started on a 14% diet.

The experimental design for all three trials is shown in table 1. All pigs were assigned to replicate by weight. The eighty barrows and gilts used in trial 1 were assigned in approximately equal numbers to pen and replicate. In trial 2 eighty barrows were assigned to replicates 1, 2, 3, 4 and 5 and 48 gilts to replicates 6, 7 and 8. Average beginning weight was nearly identical to the trial 1 pigs (82.4 vs. 83.9 lbs. for trials 1 and 2, respectively). The 96 barrows used in trial 3 had an average initial weight of 116.1 lbs. Average beginning and final weight by replicate for all three trials are given in table 2. Since the barrows from all three trials were scheduled to be used in a subsequent study, ending weight was intended to be between 180 and 200 lbs. A few pens were weighed off test before 180 lbs. and some after 200 lbs.; however, in each case a complete replicate (two pens) was terminated.

The finishing facility was environmentally controlled and included a totally slotted floor with a below the slat flushing system. Each pen was 7' x 10' and included one four-hole self-feeder and one nipple watered.

[1] BMD provided by A.L. Laboratories, Inc.

The data were analyzed by analysis of variance according to SAS with pen treated as the experimental unit with respect to feeded efficiency.

RESULTS AND DISCUSSION

Average daily gain and feed efficiency were not affected by the addition of BMD to a corn-soy diet as shown in tables 2, 3 and 4. Secondly, performance in all three trials was quite uniform for those pigs fed to approximately 200 lbs. Hence, these results imply that the addition of BMD to the University of Missouri G-F diets will not benefit confinement fed pigs during the summer. Whether or not these same results would occur during the winter is not known.

TABLE 1. EXPERIMENTAL DESIGN

Trial[a]	No. reps.[c]	Diet[a]			
		Control		BMD	
		No. barrows	No. gilts	No. barrows	No. gilts
1	5	24	16	19	21
2	8	40	24	40	24
3	6	48		48	

[a]The control diet was corn-soy. The BMD diet was the control plus 30 g. of BMD.

[b]Trials began on August 5, September 25 and November 18, 1980, respectively.

[c]Each replicate of trial 1 included barrows and gilts. Trial 2 replicates 1-5 were barrows and 6-8 gilts.

TABLE 2. AVERAGE INITIAL AND FINAL WEIGHT BY REPLICATE

Trial	Replicate	Initial wt., lbs.	Final wt., lbs.			
			42 days	49 days	56 days	70 days
1	1	96.8		191.6		
	2	86.1		174.3		
	3	81.9				208.0
	4	76.9				196.6
	5	70.6				191.0
2	1	106.6		200.1		
	2	94.8		192.0		
	3	88.2			195.5	
	4	83.3			190.7	
	5	66.1			164.2	
	6	86.7			180.6	
	7	78.3			170.5	
	8	65.1			159.1	
3	1	135.3	218.9			
	2	126.1	208.3			
	3	120.3	202.3			
	4	113.3	201.4			
	5	106.8	191.6			
	6	94.8	176.1			

TABLE 3. PERFORMANCE - TRIAL 1.

Item	Diet	
	Control	BMD
Initial wt., lbs.	82.5	82.4
Final wt., lbs.:		
49 days	184.4	181.5
70 days	199.1	198.0
ADG (49 days), lbs.	1.91[a]	1.83[a]
F/G (49 days)	3.00[a]	3.00[a]
ADG (70 days), lbs.	1.75[a]	1.74[a]
F/G (70 days)	3.30[a]	3.20[a]

[a]Means in the same line not having a superscript in common are different (P<.05).

TABLE 4. PERFORMANCE - TRIAL 2

Item	Diet	
	Control	BMD
Initial wt., lbs.	84.0	83.8
Final wt., lbs.:		
49 days	194.8	197.7
56 days	176.1	178.1
ADG (49 days), lbs.	1.93[a]	1.97[a]
F/G (49 days)	3.35[a]	3.32[a]
ADG (56 days), lbs.	1.74[a]	1.79[a]
F/G (56 days)	3.19[a]	3.10[a]

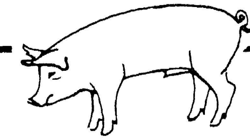
[a]Means in the same line not having a superscript in common are different (P<.05).

TABLE 5. PERFORMANCE - TRIAL 3[a]

Item	Diet	
	Control	BMD
Initial wt., lbs.	115.4	116.8
Final wt., lbs.	199.8	199.8
ADG, lbs.	2.01[b]	1.97[b]
F/G	3.47[b]	3.48[b]

[a]42 day trial.

[b]Means in the same line not having a superscript in common are different (P<.05).



EFFECT OF CALCIUM CHLORIDE AND SODIUM TRIPOLYPHOSPHATE ON FEED INTAKE REGULATION OF SELF-FED GILTS

V.J. Pearson, D.E. Jewell and T.L. Veum

SUMMARY

An evaluation of mineralized salts, calcium chloride and sodium tripolyphosphate, was undertaken to determine their influence on feed regulation of breeding age gilts and their effects on the gilts reproductive performance. Three treatments were used: (A) a typical corn-soybean diet containing 13% crude protein with .75% calcium and .60% phosphorus, (B) diet A diluted with 2.9% calcium chloride and 2.2% sodium tripolyphosphate and (C) diet A diluted with 3.5% calcium chloride and 2.6% sodium tripolyphosphate. Diet A was hand fed at 2.26 kg daily while diets B and C were self-fed. All gilts were heat checked twice daily during the 12 week feeding period. Breeding was initiated on week 6 utilizing artificial insemination. The gilts were slaughtered at day 40 of gestation to obtain their reproductive tracts, kidneys and right front foot. Average daily feed consumption was 2.26, 2.93 and 2.72 for gilts on diets A, B and C, respectively. Average daily gain for the pigs on diets A, B and C were 2.26, 3.08 and 2.90 kg, respectively, while the gain to feed ratio was .19, .19 and .17 kg. The addition of 3.55% and 2.61% sodium tripolyphosphate was effective in restricting daily feed intake and weight gains of self-fed gilts from prebreeding to day 40 of gestation without producing any detrimental physiological effects.

INTRODUCTION

It is known that restrictive feeding of sows and gilts during pregestation and gestation improves reproductive efficiency. It was reported that the combination of calcium chloride and sodium monophosphate appeared to restrict feed intake of gestating sows. This finding was substantiated by previous work at Missouri which indicated that a combination of calcium chloride and sodium tripolyphosphate was effective in controlling feed intake and weight gain in self-fed replacement gilts.

PROCEDURE

Seventy-five gilts, weighing an average of 112 kg, were allotted to three dietary treatments for the twelve week feeding period (table 1).

The animals were housed in modified open-front shelters. The gilts on diet A were hand-fed (2.26 kg) daily while B and C were fed using self-feeders. Each pen was equipped with an automatic waterer. All gilts were heat checked twice daily from weeks 1 to 12. Breeding was initiated on week 6 utilizing artificial insemination.

Blood samples were collected by vena cava puncture on days 0, 14, 28 and 42 of the experiment and analysis was performed for chloride, inorganic phosphorus, sodium and calcium.

The gilts were slaughtered on day 40 of gestation. The reproductive tract of each gilt was removed and the number of live embryos and corpora lutea were recorded. The kidneys were removed and a section of kidney was sectioned and stained to demonstrate calcification. The right front leg of each gilt was removed and the metacarpal bones were taken, dried and fat extracted whereupon calcium, phosphorus and ash were determined. The fracture strength of the bone was also determined.

RESULTS

Average daily feed intake (ADFI) was greater for groups B and C than group A (table 2). However, diet C containing 3.5% calcium chloride ($CaCl_2$) and 2.6% sodium tripolyphosphate (STPP) restricted the ADFI of the gilts more adequately than diet B which had $CaCl_2$ and STPP levels of 2.9% and 2.2%, respectively.

No detrimental physiological or skeletal effects were observed in the two groups of gilts fed the mineral salts compared to the group hand fed the basal diet based on the criteria utilized. The criteria included micro-histology of the kidney for calcification; breaking strength of the meta-carpal bone; percentage ash, calcium and phosphorus of the metacarpal bone; and serum levels of calcium and phosphorus (tables 3, 4 and 5).

Reproductive performance was also similar among the three groups to day 40 of gestation based on conception rate and number of corpora lutea and live embryos on day 40 of gestation.

The greater water consumption and urination associated with the feeding of these mineral salts may be undesirable on solid concrete floors, especially in cold climates where bedding is utilized in open front shelters. Also the dietary level of zinc may need to be increased to 100 or 150 ppm to avoid a possible zinc deficiency aggravated by the high levels of calcium in the diets.

TABLE 1. COMPOSITION OF THE DIETS

Ingredients	Internat'l Ref. No.	Dietary treatments A %	B %	C %
Ground yellow corn	(4-02-935)	83.54	79.31	78.39
44% soybean meal	(5-04-604)	13.00	12.34	12.20
Dicalcium phosphate	(6-01-080)	1.55	1.48	1.46
Calcium carbonate	(6-02-632)	0.91	0.86	0.85
Trace mineral salt[a]		0.50	0.48	0.47
Vitamin supplement (50B)[b]		0.50	0.48	0.47
Calcium chloride (anhydrous)[c]			2.88	3.55
Sodium tripolyphosphate[d]			2.17	2.61
Total		100.00	100.00	100.00
Calculated Analysis:				
Crude protein, %		13.07	12.41	12.27
Crude fat, %		3.28	3.11	3.08
Crude fiber, %		2.28	2.36	2.62
Calcium[c], %		.75	.71	.70
Phosphorus[c], %		.60	.57	.56
Net energy, kcal/kg		3179.4	3019.4	2983.5

[a]Mineral premix supplies the following per kilogram in diet A: 10 mg selenium as sodium selenite, 100 mg iron as ferrous sulfate, 15 mg copper as cuprous oxide, 100 mg zinc as zinc oxide, 50 mg manganese as manganese sulfate, .95 mg iodine as calcium iodate. Sodium chloride supplied at .4%.

[b]Vitamin premix supplies the following per kilogram in diet A: 5500 USP units vitamin A as vitamin A acetate, 550 USP units vitamin D as d-activated animal sterol, 22 IU units vitamin E as dl-alpha-tocopheryl acetate, 5.5 mg riboflavin, 27.5 mg pantothenic acid, 33 mg niacin, 770 mg choline chloride, .033 mg vitamin B12, 2.2 mg vitamin D as menadione sodium bisulfite complex, 2.2 mg thiamine as thiamine hydrochloride, 2.2 mg pyridoxine as pyridoxine hydrochloride, .55 mg biotin, and 1.1 mg folic acid.

[c]Commercial product containing 36% calcium.

[d]Commercial product containing 31% sodium and 25% phosphorus.

TABLE 2. DAILY FEED INTAKE, DAILY GAIN AND GAIN:FEED RATIO OF GILTS GIVEN DIFFERENT LEVELS OF MINERAL SALTS

Response criterion	Experimental Treatments A	B	C
No. of pigs	25	25	25
Avg initial weight, kg	107.76	108.53	108.87
Avg final weight, kg	143.55	155.89	148.52
Avg daily feed intake, kg	2.26[a]	3.08[b]	2.90[b]
Avg daily gain, kg	.43[a]	.56[b]	.47[a]
Gain:feed ratio	.19[a]	.18[a]	.16[b]
Corrected ADF[c]	2.26[a]	2.93[b]	2.72[b]
Corrected G:F ratio[c]	.19[a]	.19[a]	.17[b]

[a,b]Means in the same row with different superscripts are different ($P<.05$).

[c]Corrected for the dilution factor of the mineral salts calcium chloride and sodium tripolyphosphate.

TABLE 3. EFFECT OF CALCIUM CHLORIDE AND SODIUM TRIPOLYPHOSPHATE ON METACARPAL FRACTURE STRENGTH AND MINERAL ANALYSIS[a]

Response criterion	Experimental Treatments A	B	C
Fracture strength (kg/cm^2)[b]	57.06	58.65	55.42
Ash, %	63.62	63.96	63.62
Calcium, %	24.20	24.41	24.25
Phosphorus, %	10.94	11.04	11.02

[a]Means reported on a fat-free basis.

[b]Instron Table Moded, Serial No. 1567, Instron Engineering Corp., 2500 Washington St., Canton Massachusetts.

TABLE 4. EFFECT OF CALCIUM CHLORIDE AND SODIUM TRIPOLYPHOSPHATE ON LIVE EMBRYOS AND CORPORA LUTEA

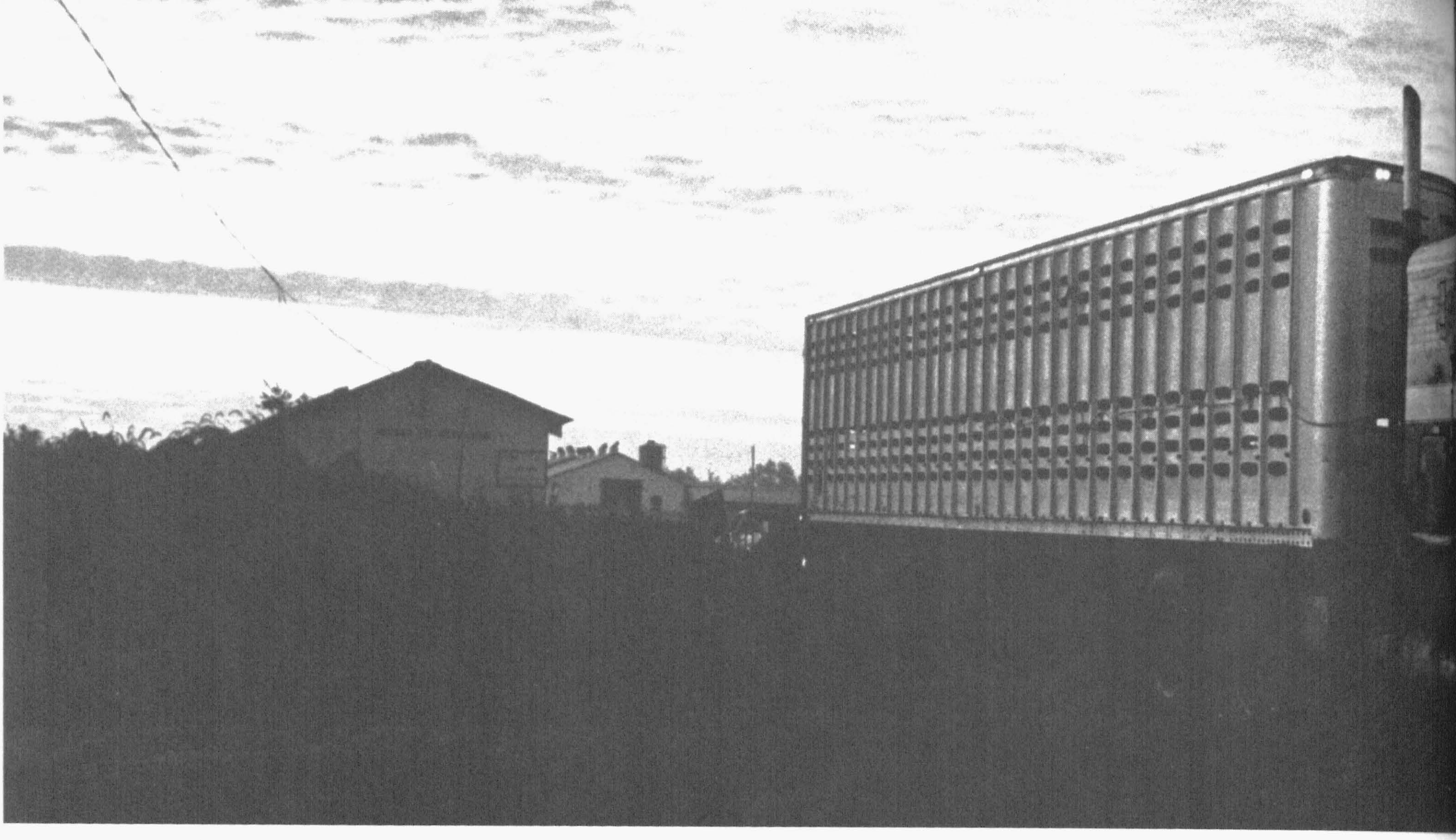
Response criterion	Experimental Treatments A	B	C
Live embryos	10.0 $\pm$ 4.39[a]	10.7 $\pm$ 3.87	9.9 $\pm$ 2.33
Number of lutea	11.8 $\pm$ 2.86	12.6 $\pm$ 3.23	12.0 $\pm$ 3.26

[a]Means $\pm$ standard errors are presented.

TABLE 5. SERUM CALCIUM, PHOSPHORUS AND CHLORIDE LEVELS COMPARED TO MINERAL SALT LEVELS

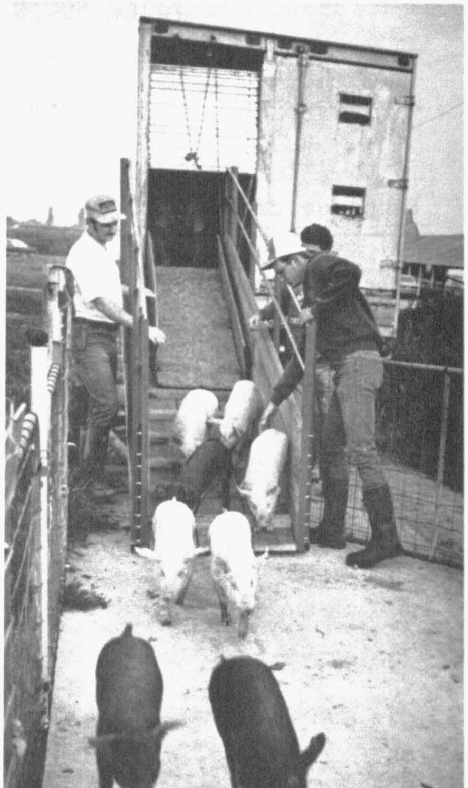
Response criterion	Experimental Treatments A	B	C
Calcium, ppm	93.74 $\pm$ 1.66[a]	93.15 $\pm$ 1.66	93.86 $\pm$ 1.93
Phosphorus, mg/100 mg	6.98 $\pm$ .16	7.21 $\pm$ .18	7.03 $\pm$ .21
Chloride, meq/liter	99.62 $\pm$ .37	103.20 $\pm$ .59	102.61 $\pm$ .53
Sodium, meq/liter	141.04 $\pm$ 1.95	142.67 $\pm$ .36	142.84 $\pm$ .41

[a]Means $\pm$ standard errors.



Travel time and weight loss of feeder pigs in transit give researchers a starting point for testing alternative management techniques during the growing-finishing period.

Special equipment recorded the air temperatures in the pig cargo area of the transport during the haul.

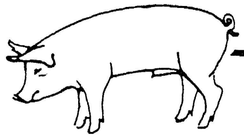


Pigs come off the truck after an overnight journey to the research station.

Feeder Pigs Go on the Road Again

UMC Scientists Study Stress Of Moving Pigs

Herman Mayes, L, agricultural engineering research associate, and George Jesse, assistant professor, confer on allotting pigs to management treatments.



WEIGHT LOSS OF FEEDER PIGS DURING HANDLING, MARKETING AND TRANSPORTING

Herman F. Mayes and George W. Jesse

SUMMARY

Field studies with feeder pigs indicate that the shrinkage will exceed 6.0% of the body weight during handling, marketing, and transporting. Individual animal shrinkage may exceed 12%

The total time a feeder pigs is fasted (no feed or water available) is a better indicator in accessing the magnitude of shrinkage than is time in transit.

These field studies are consistent with available data from laboratory studies on the shrinkage of feeder pigs. Weight regain for the feeder pigs in the field studies was slower than for the feeder pigs in the laboratory studies.

INTRODUCTION

The production and marketing of feeder pigs is a vital segment of the total swine industry in the State of Missouri and other areas of the United States. The total number of feeder pigs produced in Missouri is estimated to be from 2.25 to 2.50 million head with over 1.3 million head exported from the State in the calendar year 1979. The objective of this paper is to report some of the results to date from field studies designed to determine shrinkage during handling, marketing and transporting.

REVIEW OF LITERATURE

The rate of shrinkage and total shrinkage of feeder pigs during handling, marketing and transporting is unknown. Little, if any, scientific information is available in the literature.

Brooker (1976) states that some buyers report shrinkage to be 15% for a 20.4 kg feeder pig being transported 12 hours by truck. Hahn (1978) reported the weight loss of 34.9 kg pigs with feed and water withheld for 24 hrs under controlled environmental conditions to be from 7.7 to 9.0%. Bailey (1978) noted a weight loss of 5.5 to 6.2% over a 24-hour period for pigs averaging 31.8 kg being held in a test to simulate air transport of pigs. Losses over a 48-hour period ranged from 11 to 12.5%.

In a controlled study, Bowland and Standish (1966) found that when feed and water were withheld for 24 hours on a 93 kg hog, a shrink of 5.7% occurred. Other studies on slaughter hogs relate shrinkage to time in transit or distance traveled. Stout and Cox (1959) reported that the highest shrinkage occurs early in the transit period and does not increase in proportion with the hours in transit.

Michael R. Hails (1978) stated that "Loss in weight during transport occurs through sweating, respiration, and excretion of faeces and urine. Excretory loss has little or no economic significance and occurs most readily in pigs, less so in sheep, and still less readily in cattle. Loss in weight during transport is therefore a complex phenomenon, involving different types of loss, and is affected by several factors including age and weight of animal, nutritional state and type of animal, type and time of last feed before transport, loading and type of transport, length of transport, season, etc."

PROCEDURE

These shrinkage studies were a part of an overall project dealing with the care and management of feeder pigs after their arrival at a finishing facility. Source of pigs included those raised in confinement at the University of Missouri's Swine Reseach Complex (SRC) and one or more of the cooperating feeder pigs markets located within the State of Missouri. Studies conducted in May 1978, and in January 1979, used pigs from the SRC.

All pigs from the SRC were transported to a cooperating feeder pig market where they were handled, sorted, and penned in the same manner as all pigs that were marketed through the market. They remained in the market facility without feed and water for approximately 24 hours which conrresponded to the average time for all of the feeder pigs in the market. Next, they were transported a distance of 322 and 376.8 km, respectively, in returning to the feeder pig test facility at another University of Missouri swine farm. They were isolated from other hogs on the farm to reduce the possibility of disease transmission.

Pigs purchased through the cooperating feeder pig markets were marketed during a regularly scheduled sale date. Purchase weights generally ranged from 20.4 to 24.9 kg. They were handled and processed at the market according to normal operating procedure for that specific market.

Purchased pigs were transported by a commercial livestock trucker that normally transports feeder pigs. Trucks used were regular straight trucks equipped with two decks. In one of the studies the pigs were transported in a double decked, gooseneck trailer. The distance pigs were transported varied from 241.5 to 563.6 km with the later studies having transpor distances of 483.1 to 563.6 km. This distance was based on an analysis of the shipment of feeder pigs from Missouri and is considered to be an average distance.

Pigs were eartagged when they were offloaded at the feeder pig test facility if they had not been eartagged at the producers' farms or at the market. All pigs were weighed individually after being eartagged and assigned to various dietary regimes. Individual weights were obtained 2, 3, 7, or 14 days after being placed on feed and water. In the tests conducted in 1980 and 1981, weights were taken on day 3 and 14.

In the test conducted in October 1980 and January 1981, arrangements were made through the cooperating feeder pig markets to weigh a portion of the feeder pigs at the producers' farms. These pigs were eartagged and processing at the market was according to the market's normal operationg procedure. In addition to the weights taken at the producer's farm, weights were secured just prior to leaving the market, at the beginning of the transport phase. Approximately 20% of the pigs purchased were weighed individually just prior to leaving the market. Group weights on all pigs were obtained upon arrival and just prior to leaving the feeder pig barn.

RESULTS AND DISCUSSION

Data on shrinkage, average individual weights, transport distance, and weights at 2, 3, 7, or 14 days are given in Table 1. The values given represent the shrinkage between the initial weight of the feeder pigs at the market and the weight taken at the University of Missouri feeder pig facility after transportation. This shrinkage does not represent all of the shrinkage that occurs to the feeder pig in moving from the production farm to a finishing facility, but rather the loss the feeder pig experiences from the time it is weighed at the feeder pig market until it arrives at a finishing facility.

Shrinkage between the market and the finishing facility ranged from 0.82 to 3.40 kg; the larger value of 3.40 kg occurred on some heavy feeders weighing 37.8 kg when they arrived at the market.

Shrinkage data in Table 2 are for the tests conducted in July and October, 1980, and in January 1981. In these studies weights were taken on all pigs upon arrival at the market, at the market prior to transport, at the University of Missouri feeder pig facility, and on some of the pigs at the farm of origin.

The data for each of these studies were analyzed using an analysis of variance procedure and Duncan's multiple range test. This analysis indicated significant differences between the market arrival weight and the arrival weight at the University of Missouri feeder pig facility in all three tests. Significant differences also occurred between some of the other weights in part of the tests. The overall means for the weights taken at the farm of origin, upon arrival at the market, prior to being loaded for transport and upon arrival at the University of Missouri feeder pig facility were significantly different from each other. Weights taken after 3 days of feed and water were also different ($P < .05$).

The percent change in weight of feeder pigs over the time period for marketing, transporting and 3 days of feed and water is shown in Figure 1. The results from laboratory studies conducted by Hahn et al. (1978) in which feeder pigs had feed and water withheld for 48 hrs is also shown. Results from these tests in which weights were taken at the farm, at various intervals and upon receipt at the feeder pig research facility are plotted. Two of the three studies showed a decrease in weight almost identical with the laboratory data. The October study did not have the decrease in weight in the first 25 hrs but after 40 hrs had reached a 0.8% decrease.

The increase in weight after the pigs had been put on feed and water is also shown in Figure 1. The two field studies had a slower recovery rate than the laboratory study. This may be the result of several factors. In the laboratory studies the pigs were not moved when feed and water was restored after a 48 hr fasting period and the same feed was used as had been used prior to the fasting period. In the field studies pigs from two or more producers were mixed when the feeding trials began plus the diet was most likely different from what the pigs had been receiving prior to being sold.

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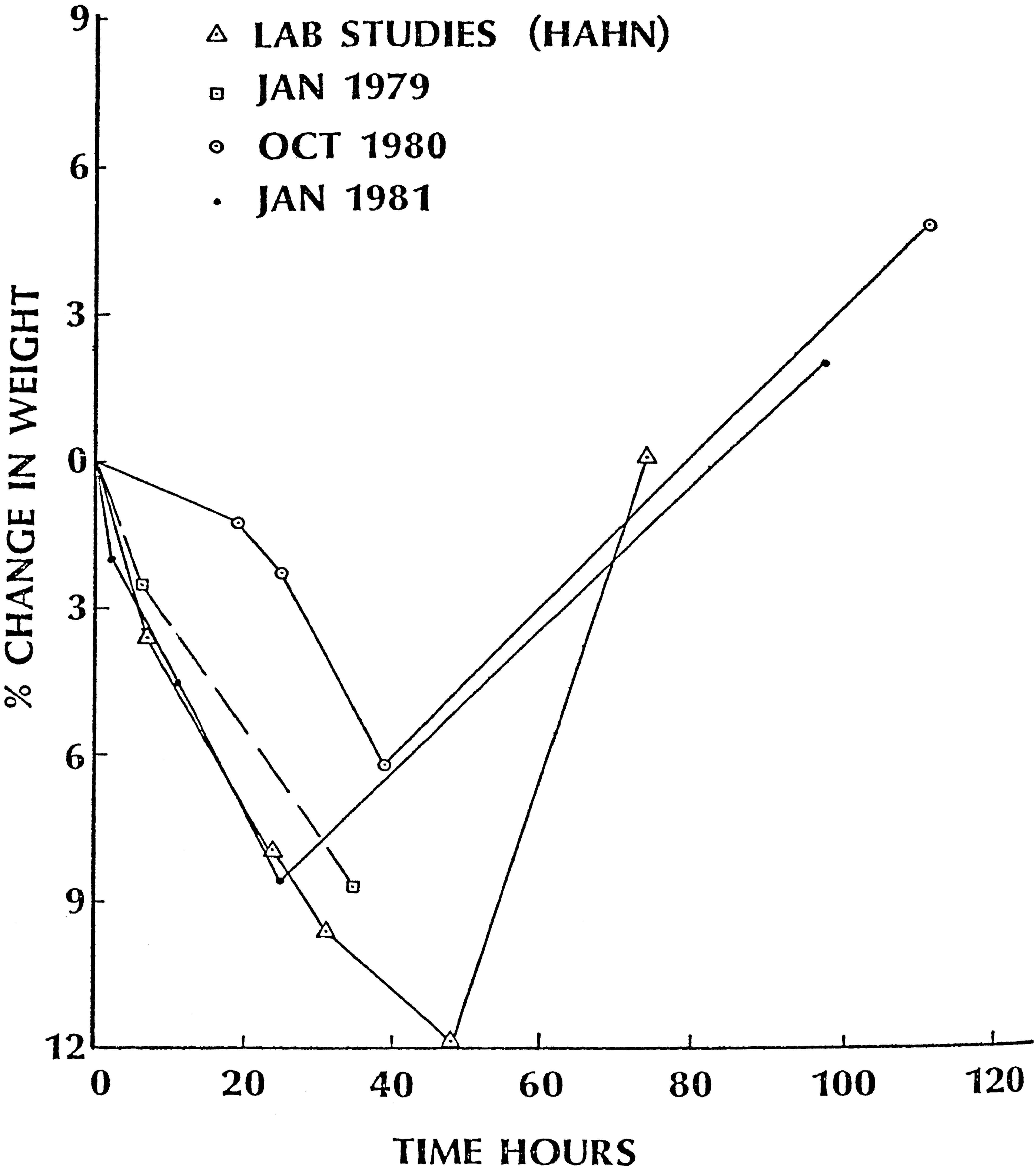

FIG. 1. CHANGE IN WEIGHT OF FEEDER PIGS VERSUS TIME.

TABLE 1. SUMMARY OF WEIGHTS AND SHRINKAGE OF FEEDER PIGS ON TESTS CONDUCTED IN 1978 AND 1979

	Number of Head	Weights, kg Initial Farm	Market Feeder Pig	UMC Swine Farm	Shrinkage kg	%	Transport Distance km	Weights, kg 2 day	3 day	7 day	14 day
May 1978 Pigs from UMC	25		23.2	22.4	0.8	3.5	376.8				26.5
	25		28.5	27.6	0.9	3.3	376.8				32.2
January 1979 Pigs from UMC	50	38.8	37.8	35.4	3.4	8.8*	322				41.4
April 1979	122		24.9	23.1	1.8	7.1	310.8				28.4
November 1979	120		24.4	22.4	2.0	8.2	362.3	24.3		26.9	

*These values represent shrinkage from producer farm to UMC Swine Farm, while other values for shrinkage are market to UMC Swine Farm.

TABLE 2. SUMMARY OF WEIGHTS AND SHRINKAGE OF FEEDER PIGS ON TESTS CONDUCTED IN 1980 AND 1981

	Number of Head	Weights, kg					Transport Distance km	Shrinkage, kg			
		Initial Farm	Market	Prior to Loading	UMC Swine Arrival	Farm Day 3		Farm to Market	In the Market	During trans-port	Farm to UMC Swine Farm
July 1980	90		21.5	20.8	19.6	22.5	483.1		0.7	1.2	
	90		23.9	23.0	21.8	25.8	483.1		0.9	1.2	
Mean			22.7^{a}	21.9^{b}	20.7^{b}	24.2^{c}					
October 1980											
	95	22.0	21.7	21.5	20.6	23.0	563.6	0.3	0.2	0.9	1.4 (6.4%)
	97		20.8	20.4	19.6	22.0	563.6		0.4	0.8	
	97		21.3	20.9	20.1	22.5	563.6		0.4	0.8	
Mean		22.0^{a}	21.3^{b}	20.9^{c}	20.1^{d}	22.5^{e}					
January 1981	48	24.5	24.0	23.4	22.4	24.9	563.6	0.5	0.6	1.0	2.1 (8.6%)
	201		24.8	23.9	22.9	25.8	563.6		0.9	1.0	
Mean		24.5^{ab}	24.4^{ab}	23.7^{bc}	22.6^{c}	25.4^{a}					
Overall Mean		23.2^{a}	22.6^{b}	22.0^{c}	21.0^{d}	23.8^{e}					

a,b,c,d,e Values with different superscripts in each column are significantly different ($P < 0.05$).

EFFECT OF THE FEEDER PIG MARKETING ROUTINE ON PERFORMANCE DURING THE GROWING-FINISHING PERIOD[1]

Dallas D. Hockman, George Wm. Jesse and Herman F. Mayes

SUMMARY

Two trials were conducted to determine whether or not the routine experiences of a feeder pig (i.e. transporting, mixing, etc.) affect overall performance during the growing-finishing period.

Average daily gain for pigs fed to a 220-230 lb. end weight was not affected by treatment (control vs. travel pigs) during either trial (Trial I - 1.46 vs. 1.47 lb.; Trial II - 1.72 vs. 1.80 lb.). However a more revealing picture of the pig's response to stress was noted by comparing ADG by 14 day periods. In both trials the travel pigs were slower starting and required a period of time to reach the performance level of those pigs that stayed home (Trial I - 8-10 weeks; Trial II - 2-4 weeks). These data suggest that the older, heavier feeder pig is not affected as much by the feeder pig routine as the younger, lighter weight pig.

INTRODUCTION

Many pigs in Missouri and the Midwest are finished on farms other than those on which they were farrowed. These pigs, called feeder pigs, may represent as many as one-third of the slaughter hogs marketed.

The marketing routine feeder pigs experience often results in a "lag period" at the purchaser's farm. During this period pigs may consume small quantities of feed, gain little weight, have a rough hair coat and often suffer from diarrhea. An exact dollar value for these losses is difficult to determine since most are unseen contributors to morbidity rather than mortality. A conservative estimate of $.50 per feeder pig would amount to .75 to 1.25 million dollars for Missouri alone.

The primary objective of this experiment was to determine whether or not routine experiences of a feeder pig affect performance during the growing-finishing (G-F) period.

PROCEDURES

During the summer of 1978 and the winter of 1979 two hundred and twenty-five university raised pigs were used during two separate trials to measure the effect of feeder pig stress on performance. Each trial included the movement of pigs through an MFA Tel-o-Auction where they

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[1]Initiative for this project came from the feeder pig committee of the Missouri Pork Producers Association. Financial assistance was provided by the University of Missouri Office of Rural Development.

experienced the normal processing routine for that market.

Trial I

Trial I included two sources of pigs as shown in table 1. Seventy-five were three-way cross (Hampshire, Yorkshire and Duroc) barrows from the university confinement facility (SRC) and fifty were barrows and gilts (purebred and two-way cross) from the university pasture facility (PF). These were randomly assigned within source to one of three treatments which included: 1) control; 2) travel pigs; and 3) SRC control. Although treatment 3 was not a necessary component of this experiment it was included to enable a comparison of performance in confinement with performance at the pasture facility. In addition, it provided some insight regarding the effect of a two-mile haul from the SRC to the PF. Unfortunately, any differences in performance will be confounded with source and facility or source and a two-mile relocation.

The SRC pigs were transported to the PF on May 3 and weighed immediately after arrival. The PF pigs were also weighed at this time. The following day the treatment 2 (travel) pigs were transported to an MFA Tel-o-Auction at Westphalia, Missouri where they experienced the normal processing routine for that market; eartagging, vaccinating, sorting, weighing and mixing. At this time the two sources of pigs PF and SRC, were comingled. After 18 hours at the market the pigs were trucked 235 miles and then returned to the PF. Total time on the truck was 11 hours.

Upon arrival at the PF the pigs were placed in an open-front barn. The water was not medicated; the diet was a 16% corn-soybean meal with 5 lbs. (250 grams) of ASP-250 per ton. On May 7, after giving the travel pigs two days to recover, the control pigs were vaccinated for erysipelas and all pigs were wormed with tramisol. They were then moved to outside grass lots at the PF on May 8. This move was due to limited labor and available space. Within three days most of the pigs were coughing and scouring; hence, they were moved back inside for treatment. Terramycin was added to the drinking water for 7 days.

Weights were taken at two week intervals throughout the trial. Feed records were kept to determine the total amount of feed consumed. The trial lasted 126 days with the average end weight being 230 lbs. Carcass data were collected on a representative number. Backfat, loin eye, length and carcass weight were the measurements recorded.

Trial II

As shown in table 2, one hundred SRC barrows were used in a second trial which began on January 30, 1979. These pigs, randomly assigned to either a control or travel group, averaged approximately 88 lbs. The pigs were transported from the SRC to the PF on January 30 and then sorted, tagged and weighed. That afternoon the pigs were trucked to the MFA feeder pig barn at Westphalia even though weather conditions were very bad with the temperature being 18^{o}F. The control pigs staying at the PF were allowed feed and water at 3:00 p.m., January 30.

After 23 hours at the market the travel pigs were trucked 350 miles and returned to the PF at 7:45 p.m., January 31. All pigs were weighed and randomly assigned to 10'x 20' pens in an open front barn immediately following arrival of the travel pigs.

The travel pigs were given access to feed and water at 8:30 p.m. on January 31 after being off feed and water for 34½ hours. During the first seven days both treatment groups received terramycin in the water and 20 lbs. (500 grams) of ASP-250 in the feed. Both groups were wormed with tramisol or February 7. After seven days the pigs were taken off water medication and ASP-250 was reduced to 5 lbs. per ton. These pigs were also fed to approximately 230 lbs.

RESULTS AND DISCUSSION

Trial I

As shown in table 3, those pigs that experienced the normal feeder pig marketing routine (travel pigs) gained equally as well as the controls when taken to a 230 lb. slaughter weight (1.46 vs. 1.47 lbs.). The confinement fed pigs on the otherhand gained significantly faster ($P<.05$) than either group of outside pigs (1.60 lbs.). Overall performance was not affected by source of pigs (SRC vs. PF) as indicated in table 4. Although ADG of all pigs was lower than expected, one should keep in mind that the test was conducted during the summer. In addition, all pigs were sick during the first two weeks due to flu symptoms.

A somewhat revealing picture of the pig's response to stress can be seen by comparing ADG by 14 day periods (table 5). For example, there was a significant difference ($P<.05$) between period one and two for all three treatments. This difference is possibly due to an adjustment to new pigs and facilities. The travel pigs required 8-10 weeks to reach the performance level of those pigs that stayed at home (control) as reflected by a superior ADG for period 5 (1.84 vs. 1.21 lbs.). Unlike the undulating biweekly ADG of the control pigs, the travel pigs exhibited a continual increase in daily gain through period 5 (10 weeks). This may reflect a compensatory response to their previous treatment. The first significant decline in ADG of the SRC control pigs occurred during the fifth two week period. This might possibly be due to hot weather at the time.

Table 6 indicates the confinement raised travel pigs (SRC) required a much longer period of time to recover from the effects of the marketing routine than the pasture facility (PF) pigs (8-10 vs. 2-4 weeks). The PF travel pigs were observed to gain slightly faster than their controls during the second 14 days (1.41 vs. 1.39 lbs.). On the other hand, the SRC travel pigs did not gain as fast as their controls until the fifth two week period (1.73 vs. 1.61 lbs.). It would seem likely that this difference can be attributed to two factors: 1) a lighter initial weight for the SRC pigs (53.8 vs. 59.8 lbs.) and 2) the confinement pigs were transported approximately two miles from the SRC to the PF the day before shipment to Westphalia. Unfortunately, the effects of these two factors are confounded.

The only significant differences in carcass measurements by treatment were for backfat (BF) and dressing percent (DP). The faster gaining SRC control pigs possessed a higher degree of backfat (1.55 vs. 1.41 and 1.35 inches) and were higher dressing (74.9 vs. 72.4 and 72.7%) than either treatment 1 or 2, respectively. Perhaps this difference can be partially attributed to a higher maintenance requirement for the pasture fed pigs.

<u>Trial II</u>

In agreement with trail I, differences in performance were not significant; however, ADG for these heavier pigs was greater and quite acceptable for both groups. The control pigs were faster gaining (1.80 vs. 1.72 lb.) and more efficient (3.31 vs. 3.41) than the travel pigs (table 7). Stated in another way, this would mean a difference of 4½ days to market on 18 lbs. less feed for pigs fed from 50 lbs. to 230 lbs.

The marketing routine did have a significant effect ($P<.05$) on the travel pigs during the first 14 day period. As shown in table 8 the control group had an average daily gain of .77 vs. .37 lbs. for the travel group. Recovery time, however, seemed to be much shorter for the older pigs of trial II than it was in trial I as indicated by the period average daily gains (table 8). The older pigs used in trial II seemed less susceptible to sickness and had a lower death loss.

Although no differences were found in carcass measurements due to treatment, it is interesting to note as in trial I, the travel group possessed a lesser amount of backfat (1.40 vs. 1.46 in.).

TABLE 1. EXPERIMENTAL DESIGN - TRIAL 1

	Treatment	No. Pigs[a]	Source[b]
1	Control	50	25 SRC 25 PF
2	Travel	50	25 SRC 25 PF
3	SRC	50	25 SRC

[a]Average initial weight of 56.7, 57.0 and 50.3 for treatments 1, 2 and 3, respectively.

[b]SRC were all barrows. PF were 22 gilts and 28 barrows.

TABLE 2. EXPERIMENTAL DESIGN - TRIAL II

	Treatment	No. Pigs[a]	Initial wt., lbs.
1	Control	50	89.0
2	Travel	50	86.0

[a]SRC barrows farrowed October-November. Represents five replicates with 10 pigs per pen.

TABLE 3. PERFORMANCE - TRIAL I

	Treatment	N	Initial Wt., lbs.	Final Wt., lbs.	ADG, lbs. 1st 14 Days	ADG, lbs.	F/G[a]
1	Control Pigs	49	56.7	231	.73[b] (.051)	1.47[b] (.017)	3.50
2	Travel	48	57.0	228	.61[b] (.051)	1.46[b] (.018)	3.12
3	SRC Control	25	50.3	230	1.23[c] (.070)	1.60[c] (.024)	3.35

[a]Represents one measure (replicate) of feed efficiency.

[bc]Means not having a superscript in common are different ($P<.05$) S.E. shown in parentheses.

TABLE 5. ADG BY PERIOD - TRIAL I[a]

14 Day Period	Treatment[b] Control Pigs	Travel	SRC Control	$\overline{X}$
1	$.73^{c}$	$.61^{d}$	1.23^{d}	$.79^{A}$
2	1.37^{d}	1.26^{f}	1.89^{c}	1.43^{B}
3	1.29^{de}	1.62^{f}	1.83^{c}	1.34^{C}
4	1.84^{f}	1.66^{eg}	1.82^{c}	1.77^{D}
5	1.21^{e}	1.84^{c}	1.26^{d}	1.47^{B}
6	1.90^{f}	1.54^{g}	1.74^{c}	1.73^{D}
7	1.13^{e}	1.76^{ce}	1.21^{d}	1.39^{BC}
$\overline{X}$	1.35^{A}	1.40^{A}	1.57^{A}	1.42

[a]Means (lb.).

[b]S.E. for treatment = .05 for treatment 1, .05 for treatment 2, .07 for treatment 3.

[cdefg]Means within a column not having at least one superscript in common are different (P<.05).

[ABCD]Means not having at least one superscript in common are different (P<.05).

TABLE 4. ADG BY SOURCE - TRIAL I

	Treatment	Source	Initial Wt., lbs.	ADG, lbs.
1	Control Pigs	SRC	53.4	1.46
		PF	59.6	1.47
2	Travel	SRC	54.2	1.42
		PF	60.0	1.49

TABLE 6. ADG BY PERIOD WITHIN SOURCE - TRIAL I[a]

14 Day Period	Source				
	SRC			PF	
	Control	Travel	SRC Control	Control	Travel
1st	.58	.44	1.23	.90	.77
2nd	1.34	1.09	1.89	1.39	1.41
3rd	1.21	1.00	1.83	1.33	1.31
4th	1.86	1.57	1.82	1.82	1.74
5th	1.16	1.73	1.26	1.26	1.95

[a]Means (lb.).

TABLE 7. PERFORMANCE - TRIAL II

	Treatment	N	Initial Wt., lbs.	Final Wt., lbs.	ADG, lbs. 1st 14 Days	ADG, lbs.	F/G
1	Control Pigs	49	89.0	240.0	.77[b] (.061)	1.80[b] (.031)	3.31[b] (.055)
2	Travel	48	86.0	238.0	.37[c] (.061)	1.72[b] (.031)	3.41[b] (.055)

[a]Analysis of variance by pen means.

[bc]Means within a column not having a superscript in common are different ($P < .05$).

S.E. shown in parentheses.

TABLE 8. ADG BY PERIOD - TRIAL II[a]

	Treatment	14 Day Period[b] 1	2	3	4	5	6	7
1	Control Pigs	.77^{c}	1.67^{d}	2.23^{c}	1.85^{c}	2.03^{c}	2.23^{c}	1.80^{A}
2	Travel	.37^{d}	1.83^{d}	1.93^{d}	1.93^{d}	1.94^{c}	2.07^{c}	1.68^{B}
	$\overline{X}$	.57^{A}	1.75^{B}	2.08^{CE}	1.89^{BD}	1.99^{CD}	2.15^{E}	1.74

[a]Analysis of variance by pen means.

[b]Means (lb.).

[cd]Means within a column not having a superscript in common are different ($P<.05$).

[ABCDE]Means not having a superscript in common are different ($P<.05$).

EFFECT OF SUPPLEMENTAL POTASSIUM AND

INITIAL WEIGHT ON FEEDER PIG PERFORMANCE[1]

George Wm. Jesse, Herman F. Mayes and Dewayne Brake

SUMMARY

During the summer of 1980 one hundred and eighty purchased feeder pigs were used in a study designed to determine the effect of supplemental potassium (control vs. .35% added K) and initial weight (Heavy vs. Light) on performance. Half of the pigs were fed a corn-soy diet supplemented with potassium chloride for the first 28 days. All pigs were provided neo-terramycin in the water for 21 days.

Average daily gain for the six week trial favored the potassium supplemented pigs (1.42 vs. 1.32 lbs.; $P<.05$). Feed efficiency on the otherhand was not different. Not unexpected was a faster rate of gain for the Heavy pigs (1.43 vs. 1.31 lbs.; $P<.05$).

A comparison of diets by weight group revealed that supplemental K produced a greater response for the Heavy pigs than the Light. However this advantage did not appear until the second and third two week period for the Heavy and Light, respectively. One possible explanation for these results is a greater feed intake by the potassium supplemented pigs. Further studies seem warranted to see if these results are repeatable.

INTRODUCTION

Reduced and/or delayed performance is a common occurrence experienced by the feeder pig finisher with each new group of purchased pigs. Several days are required to simply attain the original purchase weight. Most groups experience a shipping fever reaction. Although certain management recommendations i.e., providing dry, draft-free quarters, medicated water, etc. are known to alleviate the stresses associated with the marketing routine, research is needed to identify new management recommendations that will further decrease feeder pig morbidity and mortality.

Hutcheson (1980) compared potassium levels of .71, 1.27, 2.15 and 3.11% in a two week receiving diet of feeder cattle and found 1.27% K to be adequate to improve the health of shipped calves. Earlier work by Leibholz *et al*. (1966) showed a potassium level of 1.17 - 1.39% to be beneficial to rate of gain and feed conversion of pigs. Jensen *et al*. (1961) reported the optimum level of K for early weaned pigs to be .26% which agrees with Meyer *et al*. (1950); however, Hutcheson (mimeograph) points out that when stress occurs with dehydration or shrink, a K deficiency may exist.

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[1] Dyna K was provided by International Minerals and Chemical Corporation.

Stimulated by Hutcheson's success in improving feeder cattle performance, a trial was initiated to determine the effect of supplemental potassium on feeder pig performance.

PROCEDURES

The experimental design was a 2 x 2 factorial with dietary potassium and initial weight the independent variables as shown in table 1. The control diet (FP1) was estimated to contain .64% K. The supplemental potassium diet (FP2) was formulated to be 1.00% total K. Potassium chloride (KCL) containing 50% K was the product used. The intent was to procure two groups of pigs, one group averaging 45 lbs. and the other 55 lbs., hereafter referred to as Light and Heavy, respectively.

On July 24, 1980 one hundred and eighty feeder pigs were purchased from the MFA Tel-o-Auction at Sedalia, Missouri. Average initial weights prior to leaving the feeder pig barn were 45.8 and 50.7 for the Light and Heavy groups, respectively. These pigs left the MFA barn at 11 p.m. and were trucked 309 miles prior to delivery to the university swine farm (PF) at 7 a.m. on July 25.

Shortly after arrival the pigs were ear tagged, weighed and assigned at random within weight group to dietary treatment and replicate. The ad libitum fed receiving diets (FP1 and FP2) are shown in table 2. They were formulated to be isolysine. On day 28 all pigs were shifted to the FP3 diet for the remaining two weeks of the trial. The original intent was to medicate the water (preventative level) with neo-terramycin for 14 days; however, due to some respiratory problems all pigs received medicated water for 21 days.

The test facility was an open front barn which had panels in the back side that were opened for summer ventilation. Each pen, which accommodated 15 pigs, was 10' x 25' with 10' x 10' under roof. The floor was concrete. Each pen had one four hole self feeder, a nipple waterer and was equipped with a sprinkler for cooling.

All pigs were weighed every two weeks with the study terminating on day 42. The data were compared by analysis of variance with pen treated as the experimental unit with respect to feed efficiency.

RESULTS AND DISCUSSION

Diets

Actual potassium levels were higher than expected as noted in table 2; however, the difference between the control diet (FP1) and the potassium supplement diet (FP2) was .35% as desired.

Performance

As shown in table 3 the supplemental K pigs were faster gaining than the controls for the six week trial (1.42 vs. 1.32 lbs.; $P<.05$). However average daily gain for the first two week period (ADGP1) was not different

Feed efficiency (FG) was quite similar for both diets.

Although the pigs were not as different in weight as originally desired, weight did affect performance. The Heavy pigs were significantly faster gaining the first 28 days (1.44 vs. 1.27 lbs.; $P<.05$) and for the entire test (1.43 vs. 1.31 lbs.; $P<.05$). Feed efficiency favored the Light pigs but was not significant.

ADG and FG for all four treatments (diet x weight) are shown in table 4. Although results of the statistical analysis (indicated by superscripts) compares all four treatments, the most useful interpretation is within weight group. ADG favored the supplemental K pigs with the greatest advantage being with the Heavy pigs. This advantage however did not appear until the second two week period for the Heavy pigs and the third 14 day period with respect to the Light pigs. Feed efficiency was not different by treatment.

Feed consumption by treatment, shown in table 5 may partially explain the reason for the increased rate of gain for the supplemental potassium pigs as well as the delay in this beneficial response. Whether this increase in performance is due to increased feed consumption, increased water consumption or both is unknown. Since the increase in ADG did not occur during the first two week period one could postulate that the beneficial response does not seem to be a simple repletion of cellular K lost during the marketing process. Further studies in this area are warranted.

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TABLE 1. EXPERIMENTAL DESIGN

Treatment No.	Diet[a]	Initial wt.[b]	No. Reps	No. Pigs[c]
1	Control	Light	3	45
2	K	Light	3	45
3	Control	Heavy	3	45
4	K	Heavy	3	45

[a]Both diets are corn-soy based. Control formulated to be .64% Potassium and the K diet 1.00%.

[b]Intended purchase weights were 45 lbs. (Light) and 55 lbs. (Heavy).

[c]Represents 15 pigs per pen; hence three pens per treatment.

TABLE 2. DIETS

Ingredient	Diet FP1 lbs.	FP1 %	FP2 lbs.	FP2 %	FP3 lbs.	FP3 %
Corn, ground	1494	74.7	1494	74.7	1588	79.4
Soybean meal, 44%	420	21.0	420	21.0	348	17.4
Dicalcium phosphate	30	1.5	30	1.5	24	1.2
Ground limestone	20	1.0	20	1.0	20	1.0
TMS	10	.5	10	.5	10	.5
Vitamin mix	10	.5	10	.5	10	.5
Dyna K (KCL)	--	--	14	.7	--	--
Sand (Silica)	14	.7	--	--	--	--
Banminth	2	.1	2	.1	--	--
	2000	100.0	2000	100.0	2000	100.0

Analyses, %	FP1 Calc.	FP1 Actual	FP2 Calc.	FP2 Actual	FP3 Calc.	FP3 Actual
C.P.	15.8	16.3	15.8	16.5	14.6	14.4
Lysine	.79	--	.79	--	.70	--
CA	.72	.89	.72	.92	.66	.76
P	.62	.61	.62	.63	.56	.55
K	.64	.84	1.00	1.20	.59	.78

TABLE 3. PERFORMANCE BY DIET AND WEIGHT

Item[a]	Diet		Weight	
	Control	Potassium	Heavy	Light
Initial wt., lbs.	45.7	45.6	48.1	43.2
Ending wt., lbs.	101.2	105.1	108.1	98.1
ADGP1	1.44[b]	1.44[b]	1.53[b]	1.35[c]
ADGP2	1.23[b]	1.32[b]	1.36[b]	1.19[c]
ADG28	1.33[b]	1.38[b]	1.44[b]	1.27[c]
ADGP3	1.29[b]	1.46[c]	1.40[b]	1.35[b]
ADG42	1.32[b]	1.42[c]	1.43[b]	1.31[c]
FGP1	1.99[b]	1.99[b]	2.03[b]	1.96[b]
FGP2	2.88[b]	2.86[b]	2.82[b]	2.92[b]
FG28	2.40[b]	2.41[b]	2.40[b]	2.40[b]
FGP3	3.11[b]	3.02[b]	3.19[b]	2.94[b]
FG42	2.62[b]	2.60[b]	2.65[b]	2.56[b]

[a]P1, P2 and P3 refer to the 1st, 2nd and 3rd 14 day period.

[bc]Means within a row according to diet or weight not having a superscript in common are different ($P<.05$).

TABLE 4. PERFORMANCE OF DIET X WEIGHT

Item[a]	Heavy		Light	
	Control	Potassium	Control	Potassium
Initial wt., lbs.	48.3	47.9	43.1	43.3
Ending wt., lbs.	105.4	110.7	96.9	99.4
ADGP1	1.51^{bc}	1.55^{b}	1.37^{cd}	1.34^{d}
ADGP2	1.27^{bc}	1.45^{b}	1.19^{c}	1.20^{c}
ADG28	1.39^{bc}	1.50^{b}	1.28^{c}	1.27^{c}
ADGP3	1.30^{bc}	1.49^{b}	1.28^{c}	1.42^{c}
ADG42	1.36^{b}	1.49^{c}	1.28^{c}	1.34^{c}
FGP1	2.01^{b}	2.05^{b}	1.98^{b}	1.94^{b}
FGP2	2.84^{b}	2.79^{b}	2.92^{b}	2.93^{b}
FG28	2.39^{b}	2.41^{b}	2.40^{b}	2.41^{b}
FGP3	3.22^{b}	3.15^{b}	3.00^{b}	2.88^{b}
FG42	2.65^{b}	2.66^{b}	2.59^{b}	2.54^{b}

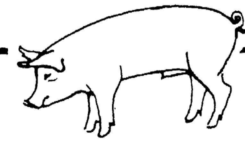
[a]P1, P2 and P3 refer to the 1st, 2nd and 3rd 14 day period.

[bcd]Means within a row not having a superscript in common are different ($P<.05$).

TABLE 5. FEED CONSUMPTION BY TREATMENT

Item[a]	Heavy		Light	
	Control	Potassium	Control	Potassium
P1, lbs./hd.	42.3	44.3	38.0	36.3
P2, lbs./hd.	50.3	56.7	48.0	49.0
P3, lbs./hd.	58.7	67.2	53.3	56.1
42 days, lbs./hd./day	3.6	4.0	3.3	3.3

[a]P1, P2 and P3 refer to the 1st, 2nd and 3rd 14 day period.



EFFECT OF OATS AND WATER MEDICATION ON FEEDER PIG PERFORMANCE

Dallas D. Hockman, George Wm. Jesse and Herman F. Mayes

SUMMARY

Two trials were conducted to measure the effect of level of oats (0 vs. 25%) and type of water medication (none vs. neo-terramycin vs. sulfathiazole) during the first 14 days on performance during the growing-finishing period. Performance during the first 14 days was quite similar for all treatments in both trials. The 25% oats - no water medication group (treatment 4) gained the slowest in both trials (trial I - .76 lb.; trial II - .67 lb.). Some differences can be seen between trials I and II when performance the first 14 days is pooled by level of oats or type of water medication. However, in both trials the pigs on 0% oats gained faster and were more efficient than the pigs on 25% oats (trial I ADG - .88 vs. .81 lbs. and F/G 2.99 vs. 3.51; trial II ADG .75 vs. .70 lbs. and F/G 3.84 vs. 4.31). Pigs receiving no water medication were slower gaining and less efficient than either medicated group in both trials. In both trials, pigs on 25% oats drank more water than the pigs on 0% oats. In addition, pigs on neo-terramycin consumed the most water per day and those on sulfathiazole the least. The incidence and severity of scouring between pigs fed 25% or 0% oats was not different for either trial.

Performance for the entire growing-finishing period was somewhat different from performance during the first 14 day period. In both trials the 0% oats pigs given neo-terramycin or sulfathiazole gained faster than the no water medication pigs; however, at the 25% oats level no significant difference occurred. In fact, in trial I the no water medication pigs out performed the water medicated pigs (1.38 vs. 1.32 and 1.35 lbs. for no medication neo-terramycin and sulfathiazole, respectively). Hence, there seems to be some interaction between oats and water medication. Pooling the data according to level of oats or type of water medication reveals the water medicated pigs gained faster than those on no water medication. Performance according to level of oats was essentially the same.

In conclusion, although some people advocate that oats will prevent or at least reduce scouring of newly purchased pigs we could not observe any great difference in the incidence of scouring or degree of scouring by treatment (0 vs. 25%). Results of this study indicate that the newly purchased feeder pig recovers quicker and performs better throughout the entire G-F period when given water medication the first two weeks upon arrival. However, no difference could be found due to the use of neo-terramycin vs. sulfathiazole. Surprisingly, the inclusion of oats with water medication did not result in an additive effect. It could be that the 25% level of oats was too high.

INTRODUCTION

The management of newly purchased feeder pigs is very important. Common to all feeder pigs are stress factors including handling, movement, possible temperature fluctuations, changes in housing and nutrition, and disease exposure. The additive effect of these stresses often results in poor performance, disease, and some death loss.

Without a doubt, management of the pigs[1] environment plays an important role in their survival and ability to grow normally during the growing-finishing period. The primary objectives of this experiment were:

1) To compare 0% vs. 25% oats in the receiving diet.

2) To determine the effect of antibiotics in the water of newly purchased pigs.

PROCEDURES

Two trials of identical design were conducted to measure the effect of dietary treatment during the first 14 days on performance during the growing-finishing (G-F) period. The experimental design was a two by three factorial which included level of dietary oats (0 or 25%) and type of water medication (none, neo-terramycin or sulfathiazole) as shown in table 1. Pigs for each trial were purchased through the MFA Tel-o-Auction at Alton, Missouri. The basal receiving diet of corn and soybean meal was 16% C.P. and included banminth and mecadox.

Trial I

One-hundred and twenty pigs averaging 54.5 lbs. were delivered to an open-front barn at the pasture facility (PF) on April 17, 1979. After unloading the pigs were weighed, sorted, tagged and randomly assigned to treatment. Water medications were added according to the manufacturer's recommendations (neo-terramycin at .255 gms and sulfathiazole at 3.55 gms/gal.). The pigs remained on oats and water medication the first 14 days. Daily water consumption per pen was recorded and the incidence of scouring was also observed during this two week period. Pride of the farm bulk tank waterers were used to enable the measurement of water consumption.

After two weeks all pigs were moved approximately two miles from the PF to the University Swine Test Station where they were placed in outside pens with a concrete floor and an open-front quonset type shed. Each pen was equipped with a sprinkling system for use during hot weather. This unfortunate move was necessary due to limited finishing space at the PF. Secondly, the pigs could not be received initially at the test station because of a required negative blood test for pseudorabies and brucellosis.

During the G-F period individual pig weights and feed consumption by pen were recorded at two week intervals. Pigs were taken off test at approximately 230 lbs. Carcass data were obtained on all pigs.

Trial II

Trial II was a near replicate of trial I. One-hundred and twenty feeder pigs were purchased from the MFA Tel-o-Auction at Alton on November 6, 1979. The same experimental design was used and the pigs were subjected to nearly the same management and treatment as those in trial I (table 1). Ending weight was approximately 200 lbs. rather than 230 lbs. In addition, carcass data were only obtained on a representative sample of each treatment.

RESULTS AND DISCUSSION

Trial I

As shown in table 2, the 0% oats - neo-terramycin pigs (treatment 2) were the fastest gaining (1.49 lb.) and the most efficient (3.17) and the 0% oats - no water medication group (treatment 1) the slowest gaining (1.26 lb.) and the poorest converters (3.41) of feed to gain. Combining the data by level of oats or type of water medication (table 3) tends to dilute these differences. There was no significant difference in ADG between the 0% oats and 25% oats (1.39 vs. 1.35 lb.) or the two water medications, neo-terramycin and sulfathiazole (1.41 vs. 1.38 lb.). However, the neo-terramycin pigs gained significantly faster ($P<.05$) than the no water medication pigs (1.41 vs. 1.32 lbs.). Although not statistically analyzed, it is interesting to note that the 0% oats and both water medicated groups were more efficient converters of feed to gain than the 25% oats and the no water medication groups, respectively.

Performance during the first 14 days was quite similar for all treatments as indicated in table 4. The 25% oats - no water medication group (treatment 4) gained the slowest at .76 lbs. per day and the 0% oats - no water medication group (treatment 1) the fastest (.89 lb.). These two treatments also represented the range in feed efficiency of 4.28 and 2.56 for 4 and 1, respectively. Pigs given neo-terramycin with 0% and 25% oats drank the most water while the pigs on sulfathiazole consumed the least. When the data are pooled by level of oats or type of water medication as shown in table 5, no difference is noted in ADG by treatment. As might be expected, the pigs on 25% oats were less efficient than those without oats (3.51 vs. 2.99). On the other hand, water consumption was greatest for those fed 25% oats and lowest for the sulfathiazole pigs. Visual inspection of these data did not indicate any relationship of water consumption to performance.

There was no great difference in the incidence or severity of scouring between the pigs fed 25% oats or 0% oats. In both groups the onset of scours occurred 2 to 3 days after arrival at the facilities and lasted 7 to 10 days.

Although some differences were noted in carcass parameters a definite pattern of treatment affect was not apparent. The sulfathiazole pigs of treatments 2 and 6 did possess larger loin eyes than the other pigs with this difference being significant ($P<.05$) when compared to the neo-terramycin pigs (5.65 vs. 5.31 sq. in.)

Trial II

Overall performance of the growing-finishing trial is shown in table 6. Treatment 1 (0% oats - no water medication) as in trial 1, produced the slowest gains ($P<.05$). However, treatment 3 (0% oats - sulfathiazole) produced the fastest gains compared to treatment 2 (0% oats - neo-terramycin) in trial I. Feed efficiency was quite similar for all treatments with a range from 3.65 to 3.85.

No significant difference in ADG was found between 0 and 25% oats (1.36 vs. 1.38 lbs.) or between water medications; none, neo-terramycin or sulfathiazole (1.33 vs. 1.37 vs. 1.41 lbs.) as indicated in table 7. Feed efficiency was also quite similar for all treatments.

Performance during the first 14 days did not differ by treatment (table 8). As in trial I, the 25% oats - no water medication group (treatment 4) gained the slowest (.67 lb.) and had the poorest feed efficiency (4.72). Differences in water consumption by treatment were quite similar to trial I. It is interesting to note that the trial II pigs, received on November 6 consumed more water than the trial I pigs that were started on test on April 17. When the data are pooled by level of oats or type of water medication as shown in table 9, no significant differences are noted in ADG. As in trial I, the 25% oats pigs gained slower and were less efficient. Likewise both the neo-terramycin and sulfathiazole pigs gained faster and were more efficient than the no water medication pigs.

Few differences in carcass parameters were observed. However, loin eye area for the sulfathiazole pigs was larger (not significant) than the no water medicated and the neo-terramycin pigs which agrees with trial I. Values were 4.44, 5.15, 5.53, 5.62, 5.64 and 5.77 sq. in. for treatments 1 through 6 with treatments 3 and 6 being the sulfathiazole pigs.

TABLE 1. EXPERIMENTAL DESIGN

	Treatment		
No.	15 Day Dietary Oats,[a] %	14 Day H_2O Medication[b]	# Pigs[c]
1	0	None	20
2	0	Neo-Terramycin	20
3	0	Sulfathiazole	20
4	25	None	20
5	25	Neo-Terramycin	20
6	25	Sulfathiazole	20

[a]The basal diet was corn-soybean meal (16% C.P.). All pigs were fed Banminth/Mecadox to 75 lbs. which was provided by Pfizer, Inc. of Lee's Summit, Missouri.

[b]Medications were added according to manufacturer's recommendations. Neo-Terramycin was provided by Pfizer, Inc.

[c]Purchased via MFA Tel-o-Auction, Alton, Missouri.

TABLE 2. PERFORMANCE - TRIAL I

	Treatment	N	Initial Wt., lbs.	Final Wt., lbs.	Days on Test	ADG, lbs.	F/G[a]
1	0% Oats No H_2O Medication	20	50.9	224.2	138	1.26[d]	3.41
2	0% Oats Neo-terramycin	20	51.0	242.4	129	1.49[b]	3.17
3	0% Oats Sulfathiazole	20	51.4	234.9	131	1.40[bc]	3.27
4	25% Oats No H_2O Medication	18	51.0	232.9	132	1.38[c]	3.34
5	25% Oats Neo-terramycin	20	50.7	227.6	135	1.32[cd]	3.29
6	25% Oats Sulfathiazole	20	50.7	229.4	134	1.35[cd]	3.28

[a]Represents one measure (replicate) of feed efficiency.

[bcd]Means not having a superscript in common are different ($P<.05$).

TABLE 3. POOLED PERFORMANCE - TRIAL I

		Treatment	N	ADG, lbs.		F/G, lbs.
1-2-3		(0% Oats)	60	1.39[a]	(.020)	3.28
	vs.					
4-5-6		(25% Oats)	58	1.35[a]	(.020)	3.34
1-4		(No H_2O Medication)	38	1.32[b]	(.025)	3.37
	vs.					
2-5		(Neo-terramycin)	40	1.41[c]	(.024)	3.28
	vs.					
3-6		(Sulfathiazole)	40	1.38[bc]	(.024)	3.27

[abc]Means according to level of oats or type of water medication not having a common superscript are different ($P<.05$).

S.E. shown in parentheses.

TABLE 4. PERFORMANCE 1st 14 DAYS - TRIAL I

	Treatment	N	ADG, lbs.	F/G, lbs.	H_2O/Hd/Day, gal.
1	0% Oats - No H_2O Medication	20	.89[a] (.077)	2.56	.585
2	0% Oats - Neo-terramycin	20	.88[a] (.077)	3.14	.598
3	0% Oats - Sulfathiazole	20	.86[a] (.077)	3.27	.550
4	25% Oats - No H_2O Medication	20	.76[a] (.077)	4.28	.650
5	25% Oats - Neo-terramycin	20	.82[a] (.075)	3.27	.690
6	25% Oats - Sulfathiazole	20	.85[a] (.075)	3.03	.536

[a]Means not having a superscript in common are different ($P<.05$).

S.E. shown in parentheses.

TABLE 5. POOLED PERFORMANCE 1ST 14 DAYS - TRIAL I

		Treatment	N	ADG, lbs.	F/G, lbs.	H_2O/Hd/Day, gal.
1-2-3		(0% Oats)	60	.88[a] (.044)	2.99	.578
	vs.					
4-5-6		(25% Oats)	60	.81[a] (.044)	3.51	.625
1-4		(No H_2O Medication)	40	.83[a] (.055)	3.42	.617
	vs.					
2-5		(Neo-terramycin)	40	.85[a] (.054)	3.21	.644
	vs.					
3-6		(Sulfathiazole)	40	.85[a] (.054)	3.15	.543

[a]Means according to level of oats or type of water medication not having a common superscript are different ($P<.05$).

S.E. shown in parentheses.

TABLE 6. PERFORMANCE - TRIAL II

	Treatment	N	Initial Wt., lbs.	Final Wt., lbs.	Days on Test	ADG, lbs.	F/G[a]
1	0% Oats No H_2O Medication	20	49.4	195.0	111	1.31^{b} (.041)	3.75
2	0% Oats Neo-terramycin	20	49.5	193.3	108	1.33^{bc} (.041)	3.77
3	0% Oats Sulfathiazole	20	49.4	207.0	110	1.44^{c} (.041)	3.83
4	25% Oats No H_2O Medication	19	49.2	187.4	102	1.35^{bc} (.041)	3.66
5	25% Oats Neo-terramycin	20	49.3	197.6	105	1.41^{bc} (.041)	3.85
6	25% Oats Sulfathiazole	20	49.4	200.0	110	1.37^{bc} (.041)	3.65

[a]Represents one measure (replicate) of feed efficiency.

[bc]Means not having a superscript in common are different ($P<.05$).
S.E. shown in parentheses.

TABLE 7. POOLED PERFORMANCE - TRIAL II

		Treatment	N	ADG, lbs.	F/G, lbs.
1-2-3		(0% Oats)	60	1.36^a (.024)	3.78
	vs.				
4-5-6		(25% Oats)	59	1.38^a (.024)	3.72
1-4		(No H_2O Medication)	39	1.33^a (.029)	3.70
	vs.				
2-5		(Neo-terramycin)	40	1.37^a (.029)	3.81
	vs.				
3-6		(Sulfathiazole)	40	1.41^a (.030)	3.74

[a]Means not having a superscript in common are different (P .05). S.E. shown in parentheses.

TABLE 8. PERFORMANCE 1ST 14 DAYS - TRIAL II

	Treatment	N	ADG, lbs.	F/G, lbs.	H_2O/Hd/Day, gal.
1	0% Oats - No H_2O Medication	20	.75[b] (.056)	4.03	.681
2	0% Oats - Neo-terramycin	20	.77[b] (.056)	4.11	.693
3	0% Oats - Sulfathiazole	20	.71[b] (.056)	3.39	.522
4	25% Oats - No H_2O Medication	19	.67[b] (.056)	4.72	.719
5	25% Oats - Neo-terramycin	20	.69[b] (.057)	4.34	.804
6	25% Oats - Sulfathiazole	20	.74[b] (.056)	3.88	.607

[a]Represents one measure (replicate) of feed efficiency.

[b]Means not having a superscript in common are different ($P < .05$).

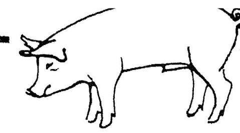
S.E. shown in parentheses.

TABLE 9. POOLED PERFORMANCE 1ST 14 DAYS - TRIAL II

		Treatment	N	ADG, lbs.	F/G, lbs.	H_2O/Hd/Day, gal.
1-2-3		(0% Oats)	60	.75[a] (.032)	3.84	.632
	vs.					
4-5-6		(25% Oats)	59	.70[a] (.033)	4.31	.731
1-4		(No H_2O Medication)	39	.71[a] (.040)	4.37	.700
	vs.					
2-5		(Neo-terramycin)	40	.73[a] (.040)	4.23	.748
	vs.					
3-6		(Sulfathiazole)	40	.72[a] (.040)	3.62	.596

[a]According to level of oats or type of water medication, means not having a superscript in common are different ($P<.05$).

S.E. shown in parentheses.



EFFECTS OF OATS, WATER MEDICATION AND A LONG-LASTING OXYTETRACYCLINE ON FEEDER PIG PERFORMANCE[1]

James R. Walker, George Wm. Jesse and Herman F. Mayes

SUMMARY

During the fall of 1980 two hundred and seventy purchased feeder pigs averaging 45 lbs. were utilized in a 2 x 3 factorial design to compare level of oats in a corn-soy receiving diet (0 vs. 15%) and type of water medication (none vs. Neo-terramycin vs. sulfamethazine). In addition a split plot design was imposed on each pen to compare the use of a long-lasting oxytetracycline (LA200). Treatments were: no injection vs. injection at the producer's farm vs. injection at the market.

Performance for the six week trial did not differ according to level of oats, type of water medication or LA200 injection. However some differences did exist by two week period. The weather for this test was excellent, which may partially explain the lack of any treatment differences.

INTRODUCTION

In two previous trials, conducted at the University of Missouri, water medication with Neo-terramycin or sulfathiazole has proven beneficial to the performance of purchased feeder pigs. Oats on the otherhand, as 25% of a corn-soy diet, have not reduced the incidence or severity of scours. The following study represents a continuing effort to evaluate various management schemes for receiving the typical Missouri feeder pig.

The primary objectives of this experiment were:

1) To compare 0% vs. 15% oats in the receiving diet.
2) To determine the effects of antibiotics in the water of newly purchased pigs.
3) To determine the effect of giving a single injection of a long-lasting oxytetracycline (LA-200) on the performance of feeder pigs.

PROCEDURES

Two hundred and seventy feeder pigs averaging 45 lbs. were utilized in a 2 x 3 factorial design to compare level of oats in a corn-soy receiving diet (0 vs. 15%) and type of water medication (none vs. Neo-terramycin vs. sulfamethazine). In addition, a split plot design was imposed on each pen to compare the use of a long-lasting oxytetracycline (LA-200). Treatments were: no injection vs. injection at the producer's farm vs. injection at the market. The experimental design is shown in table 1.

[1]Financial assistance was provided by the Missouri Pork Producers Association and by Pfizer Inc. of Lee's Summit, MO.

The pigs for this study (including 19 extras) were purchased from two South Missouri feeder pig producers via Alton Sale Co., Alton, Missouri. Two hundred and sixteen pigs from producer "A" were raised outside (woodland pasture) and another 73 pigs from producer "B" were confinement raised. Actually 202 and 68 head, respectively were used in the study. During the afternoon of October 27, 1980 one-third of the pigs on each farm (randomly selected) were ear tagged and given an intramuscular injection of LA-200. The intent was to inject approximately 9 mg of drug per pound of bodyweight; however, the rule-of-thumb employed was to give pigs weighing less than 50 lbs. 2cc and those 50 lbs. or heavier 3cc. Therefore, the light pigs received 400 mg of LA-200 and the heavy pigs 600 mg.

The outside pigs were transported to the feeder pig barn during the late afternoon of October 27. The confinement pigs were moved the following morning. While at the market another third of each source of pigs ("A" and "B") was randomly selected to receive an LA-200 injection before leaving the barn. At this point all unidentified pigs were ear tagged.

During the early afternoon of October 28 all pigs were vaccinated for erysipelas and sorted according to LA-200 treatment. At this time the producer "A" and producer "B" pigs were comingled. Pigs injected with LA-200 at the producer's farm and those not injected inadvertently had access to a water fountain approximately the last six hours prior to trucking. In addition, those not injected with LA-200 and those injected at the market had the opportunity for nose to nose contact with other pigs while at the barn, due to pen location. Departure time was approximately 6:30 p.m. on October 28. The pigs were trucked 355 miles before delivery to the University of Missouri Pasture Facility (PF) at 6:30 a.m. October 29.

The facilities used were two open-front barns of near identical design. One barn had 14 pens and the other 16 pens. All pens were 10' x 25' with a solid concrete floor. A 10' x 10' section of each pen was under roof. Each barn was equipped with two water lines and one nipple waterer per pen. Each water line served every other pen. As shown in figure 1 nine pens in each barn were used to accommodate the six main treatments replicated three times.

Upon arrival all pigs were weighed and assigned at random within LA-200 group to pen (treatment x replicate). Hence, five pigs from each of the three LA-200 groups were assigned to each pen. Two 16% C.P. receiving diets were compared (table 2). Diet 180 consisted of corn-soy and diet 280 corn-soy plus 15% oats. These diets were fed 15 days after which those pigs on diet 280 were shifted to the control diet (diet 180). All pigs were changed to a 14% CP diet (diet 380) on day 28. Water medication was also a 15 day treatment. Both Neo-terramycin and sulfamethazine were provided at a preventative level.

Individual pig weights and feed consumption by pen were obtained on day 15, 28 and 43. Data were compared by analysis of variance according to SAS with pens considered the experimental unit with respect to feed efficiency.

RESULTS AND DISCUSSION

As shown in tables 3,4 and 5 performance for the entire six week trial (43 days) did not differ according to level of oats, type of water medication or LA-200 injection. However, some differences did exist by period.

Including 15% oats in a corn-soy diet did not affect average daily gain or feed efficiency (table 3). In addition, no differences were noted in the degree or incidence of scouring. During the first two weeks pigs given medicated water were faster gaining and more efficient converters than the control pigs with the Neo-terramycin advantage being significant ($P<.05$). Although not statistically different it is interesting to note that the pigs given medicated water were more efficient for the entire test period (3.28 and 3.23 vs. 3.32).

A comparison of all six dietary regimes, as shown in table 4, reveals some differences in ADG and F/G by two week period. However, these differences did not exist for the 28 or 43 day accumulative ADG or F/G. Both the 0 and 15% oats pigs given Neo-terramycin in the water were significantly faster gaining ($P<.05$) than the controls during the first 14 days. Although this advantage did not accrue for the entire test period, it is felt that this difference in performance could be more critical given a different set of environmental conditions. The weather for this test was excellent, which may partially explain the lack of any treatment differences.

A 9 mg per pound injection of LA-200 (long-lasting oxytetracycline) did not affect ADG as shown in table 5. Certainly additional trials are needed to assess the value of this product relative to feeder pig performance. An additional treatment to be considered in future trials is an injection upon arrival at the feeder pig finishing facility.

TABLE 1. EXPERIMENTAL DESIGN

Treatment[a]				
No.	Water Medication[b]	Dietary Oats, %	No. Reps	No. Pigs[c]
1	None	0	3	45
2	Neo-terramycin	0	3	45
3	Sulfamethazine	0	3	45
4	None	15	3	45
5	Neo-terramycin	15	3	45
6	Sulfamethazine	15	3	45

[a]Water medication and oats were withdrawn on day 15. All pens contained five pigs of eachof the three LA200 treatments (no injection; injection at the producer's farm; injection at the barn).

[b]Neo-terramycin was provided by Pfizer, Inc.

[c]Represents 15 pigs per pen; hence three pens per treatment. Pigs were purchased via Alton Sale Co., Alton, Mo.

FIGURE 1. LOCATION OF TREATMENTS[a]

North Barn

Pen	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Oats, %			15	15	0		0	0	15		0	15	15			
Water Med.			Sulfa	None	Sulfa		Sulfa	None	Sulfa		Sulfa	None	Sulfa			
Rep.			1	2	1		2	3	2		3	3	3			

South Barn

Pen	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Oats, %			0	0	15		15	15	0		15	0	0	
Water Med.			Neo	None	Neo		Neo	None	Neo		Neo	Neo	Neo	
Rep.			1	1	1		2	1	2		3	2	3	

[a]Treatments:

Oats (0 vs. 15%)

Water Medication (None vs. Neo-terramycin vs. Sulfamethazine)

TABLE 2. DIETS

Ingredient	Ref. No.	180		280		380		480	
		lbs	%	lbs	%	lbs	%	lbs	%
Corn, ground	4-02-931	530	76.50	1260	63.00	1660	83.00	1716	85.80
Oats, ground	4-03-313	---	-----	300	15.00	----	-----	----	-----
Soybean Meal, 44%	5-04-604	405	20.25	375	18.75	294	14.70	237	11.85
Dicalcium Phosphate	6-01-080	15	.75	20	1.00	6	.30	7	.35
Ground Limestone	6-02-632	25	1.25	20	1.00	22	1.10	22	1.10
TMS		10	.50	10	.50	10	.50	10	.50
Vitamin Mix		8	.40	8	.40	8	.40	8	.40
Mecadox[a]		5	.25	5	.25	----	-----	----	-----
Banminth[a]		2	.10	2	.10	----	-----	----	-----
Calculated Analyses, %		2000	100.	2000	100.	2000	100.	2000	100.
C.P.		16.1		16.0		14.1		13.1	
Lysine		.72		.71		.58		.50	
Ca		.67		.65		.50		.50	
P		.51		.55		.41		.41	

[a]Provided by Pfizer, Inc.

TABLE 3. PERFORMANCE BY LEVEL OF OATS AND TYPE OF WATER MEDICATION

Item[a]	Oats, %		Water Medication		
	0	15	None	Neo-Terramycin	Sulfamethazine
Initial wt., lbs.	45.2	44.6	45.6	44.8	44.4
Ending wt., lbs.	94.4	95.3	95.4	94.1	95.0
ADGP1	1.29[b]	1.33[b]	1.24[b]	1.38[c]	1.31[bc]
ADGP2	1.11[b]	1.11[b]	1.17[b]	1.05[c]	1.11[bc]
ADG28	1.21[b]	1.23[b]	1.21[b]	1.23[b]	1.22[b]
ADGP3	1.03[b]	1.08[b]	1.07[bc]	1.00[b]	1.10[c]
ADG43	1.14[b]	1.18[b]	1.16[b]	1.15[b]	1.18[b]
FGP1	3.07[b]	2.93[b]	3.17[b]	2.88[c]	2.95[bc]
FGP2	2.73[b]	2.87[b]	2.65[b]	2.87[b]	2.87[b]
FG28	2.91[b]	2.89[b]	2.93[b]	2.87[b]	2.91[b]
FGP3	4.24[b]	3.98[b]	4.21[b]	4.22[b]	3.90[b]
FG43	3.32[b]	3.24[b]	3.32[b]	3.28[b]	3.23[b]

[a]P1, P2 and P3 refer to the 1st and 2nd 14 day period and a third period of 15 days.

[bc]Means within a row according to oats or water medication not having a superscript in common are different ($P < .05$).

TABLE 4. PERFORMANCE OF OATS X WATER MEDICATION

Item[a]	Trt. No.	1	2	3	4	5	6
	Oats, %	0	0	0	15	15	15
	Water Med.	None	Neo	Sulfa	None	Neo	Sulfa
Initial wt., lbs.		45.8	44.9	45.0	45.5	44.8	43.7
Ending wt., lbs.		95.8	93.1	94.5	95.1	95.2	95.5
ADGP1		1.22^{c}	1.35^{bd}	1.29^{bc}	1.26^{cd}	1.40^{b}	1.34^{bc}
ADGP2		1.19^{b}	1.05^{c}	1.09^{bc}	1.14^{bc}	1.06^{c}	1.13^{bc}
ADG28		1.21^{b}	1.21^{b}	1.20^{b}	1.21^{b}	1.24^{b}	1.24^{b}
ADGP3		1.07^{b}	$.95^{c}$	1.06^{bc}	1.07^{bc}	1.05^{bc}	1.14^{b}
ADG43		1.16^{b}	1.12^{b}	1.15^{b}	1.16^{b}	1.17^{b}	1.21^{b}
FGP1		3.25^{b}	2.92^{bc}	3.06^{bc}	3.09^{bc}	2.85^{c}	2.84^{c}
FGP2		2.50^{b}	2.77^{bc}	2.92^{c}	2.80^{bc}	2.97^{c}	2.82^{bc}
FG28		2.89^{b}	2.86^{b}	2.98^{b}	2.96^{b}	2.89^{b}	2.83^{b}
FGP3		4.30^{b}	4.43^{b}	3.98^{b}	4.12^{b}	4.01^{b}	3.82^{b}
FG43		3.32^{b}	3.33^{b}	3.30^{b}	3.32^{b}	3.23^{b}	3.16^{b}

[a]P1, P2 and P3 refer to the 1st and 2nd 14 day period and a third period of 15 days.

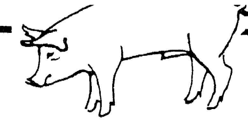
[bc]Means within a row not having a superscript in common are different ($P<.05$).

TABLE 5. AVERAGE DAILY GAIN BY LA200 TREATMENT

Item[a]	LA200 Injection		
	None	At Producer's Farm	At Market
Initial wt., lbs.	44.9	46.2	43.7
Ending wt., lbs.	95.6	95.4	93.5
ADGP1	1.33[b]	1.29[b]	1.31[b]
ADGP2	1.12[b]	1.07[b]	1.14[b]
ADG28	1.23[b]	1.19[b]	1.23[b]
ADGP3	1.08[b]	1.07[b]	1.02[b]
ADG43	1.18[b]	1.15[b]	1.16[b]

[a] P1, P2 and P3 refer to the 1st and 2nd 14 day period and a third period of 15 days.

[b] Means within a row not having a superscript in common are different ($P<.05$).



EFFECT OF INTRAVAGINAL DEVICES ON PERFORMANCE OF GROWING GILTS

D.E. Jewell, J.P. Mateo and T.L. Veum

SUMMARY

Intravaginal devices were evaluated in gilts weighing 33 kg at 10 weeks of age. Of the gilts examined, 12.5% lost the device during the first 2 weeks and 6.25% lost the device between the second week and the termination of the study. Average daily gain, gain:feed ratio, estimated backfat thickness and loineye area of the gilts with intravaginal devices were similar to that of the non-deviced control group. In the deviced gilts, 12.5% of the devices had penetrated or become imbedded in the vaginal wall.

INTRODUCTION

This research was done to evaluate the effect of a molded nylon device that was inserted intravaginally into growing gilts. The theory being tested was that intravaginal stimulation might cause some hormonal changes that would lead to increased average daily gain or more efficient utilization of feed.

EXPERIMENTAL PROCEDURES

Four experiments were conducted using a total of 272 crossbred gilts. The two treatments were: (1) pigs that were inserted with the device and (2) control pigs without the device. All experiments were conducted in the same environmentally-regulated facility with 100% concrete slats. Each 2.1 X 2.9 m pen contained eight pigs, a self feeder and a nipple waterer. The gilts were all fed the diets shown in Table 1. All diets were standard ground corn and soybean meal diets. The gilts were fed the 16% crude protein (CP) diet until approximately 45 kg weight, the 14% Cp diet to 85 kg and the 13% CP diet until the end of the study. Performance was evaluated by average daily gain (ADG), gain:feed ratio (G:F) and carcass characteristics. Pigs and feed consumed were weighed every two weeks. In three of the experiments, the deviced gilts were examined for the presence of the device 2 weeks after insertion. Those gilts in which the device was no longer present were re-deviced. The deviced gilts were also examined for the presence of the device at the end of the study and the devices removed when possible.

RESULTS

The deviced and non-deviced (control) gilts were similar in ADF, ADG and G:F during the grower, developer and finisher phases and overall (table 2). Both groups were also similar in backfat and loineye area (table 3).

In conclusion, intravaginal devices did not improve pig performance or carcass characteristics.

TABLE 1. EXPERIMENTAL DIETS

	Diets		
	G16	D14	F13
Ground corn (%)	75.89	81.71	84.85
Soybean meal 44% (%)	20.72	15.07	12.24
Dicalcium PO_4 (%)	1.35	1.17	0.95
Limestone (%)	1.04	1.05	1.06
Trace mineral salt (%)	0.50	0.50	0.50
Vitamins (%)	0.50	0.50	0.40
	100.00 %	100.00 %	100.00 %

TABLE 2. THE EFFECT OF VAGINAL STIMULATION ON GROWTH

	Avg daily gain	
	Control	Deviced
Variable		
Initial wt., kg	33.86	33.81
Final wt., kg	95.18	94.59
Avg daily gain, kg:		
Grower	.73	.71
Developer	.72	.74
Finisher	.78	.72

TABLE 3. THE EFFECT OF VAGINAL STIMULATION ON FEED INTAKE

	CONTROL	DEVICED
	Means[1]	Means
Avg daily feed intake, kg:		
Grower	1.99	1.98
Developer	2.49	2.47
Finisher	2.76	2.63
Overall	2.40	2.35

[1]All values are means in kg.

TABLE 4. THE EFFECT OF VAGINAL STIMULATION ON FEED EFFICIENCY

	CONTROL	DEVICED
	Means	Means
Gain:feed ratio[1]		
Grower	.37	.36
Developer	.29	.30
Finisher	.28	.27
Overall	.31	.31

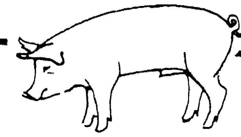
[1]All values are means of average daily gain/average daily feed.

TABLE 5. THE EFFECT OF VAGINAL STIMULATION ON BACKFAT AND LOINEYE AREA

	CONTROL	DEVICED
Variable	Mean	Mean
Backfat[1]	2.64	2.66
Loineye[2]	32.25	31.08

[1]Values are means in cm.

[2]Values are means in cm^2.



MULTIPLE PEN FINISHING IN CONFINEMENT

George Wm. Jesse, JoAnn L. Gerard and Russell W. Massa

SUMMARY

Barrows fed in either 2,3 or 4 different pens during a 100 lb. G-F period were faster gaining than those which remained in one pen throughout the entire period. Feed intake (pen basis) expressed as a percent of body weight was greater for all of those pigs moved; hence, it appears that changing the pig's environment (pen) may act as an appetite stimulant.

Performance of pigs finished in one versus two pens during the G-F period was not different for trials 1 or 2; however, initial weight was greater than for trial 3 hence the time between moves was less frequent.

If the advantage in performance observed in trial 3 for treatment 3 is real, then perhaps the producer should use several different sized pens during the G-F period rather than providing a pen to accomodate a given number of pigs throughout the entire G-F period. This would also encourage greater efficiency of space utilization.

INTRODUCTION

A total of 168 crossbred barrows and gilts were utilized in three separate growing-finishing (G-F) trials to ascertain whether or not movement to a different pen or relocation of the self feeder in the same pen during the G-F period would affect performance. An assumption has often been made that a confinement-raised pig is bored; hence the idea of this study was to provide the pig with a new environment (pen) in an effort to stimulate appetite.

PROCEDURES

The experimental design for all three trials is shown in table 1. Littermate barrows and gilts were used for trials 1 and 2 which began on July 20 and August 1, 1978, respectively. Barrows in trial 3 were placed on test November 9, 1979. All pigs were randomly assigned within weight group to treatment. The barrows in trials 1 and 3 were fed to an average pen weight of 230 lbs. whereas the gilts of trial 2 were fed to 220 lbs. Pigs assigned to treatment 1 were fed in the same pen throughout the G-F period; treatment 2,3 and 4 barrows were moved to a different pen after they had accrued approximately 1/2, 1/3 and 1/4, respectively of their G-F gain. On the otherhand, the self feeder for the treatment 2 gilts (trial 2) was moved from one side of the pen to the other at the half-way point.

All pigs were *ad libitum* fed a corn-soy diet (meal form) formulated to meet NRC recommendations which included 14% C.P. to 132 lbs. and 13% C.P. thereafter. The G-F facility was environmentally controlled and the floor was totally slotted with an under the slat flush. Each 7' x 10' pen had one four hole self feeder and one nipple waterer. During the first two trials all pigs were weighed every two weeks with the treatment 2 pigs being moved between weigh periods if necessary to approximate movement at the predetermined weight. During trial 3 some pens of pigs were weighed as often as seven days in an attempt to be within 10 lbs. of the predetermined movement weight(s). The data were analyzed by analysis of variance with pen treated as the experimental unit with respect to feed efficiency (F/G).

RESULTS AND DISCUSSION

Performance during trials 1 and 2 was not affected by treatment as can be seen in tables 2 and 3. However, differences in ADG, F/G and feed intake did occur in trial 3, although not statistically significant. All three treatment groups that were moved to one or more pens during the G-F period were faster gaining than the controls. Although these differences were not of great magnitude, ADG between treatments 3 and 1 were significantly different at the $\alpha = .06$ level. Although the treatment 3 pigs were the only ones to exceed the controls in feed efficiency, all pigs that were moved consumed more feed on a percent of body weight basis. Hence, it appears that changing pen did stimulate the pigs appetite.

TABLE 1: EXPERIMENTAL DESIGN

Trial	Treatment[a]			
	1 Control	2 One Move	3 Two Moves	4 Three Moves
1[b]	24	24		
2[c]	32	32		
3[d]	14	14	14	14

[a]Treatment number is synonomous with the number of pens occupied during the G-F period.

[b]Three replicates (pens) of eight barrows per treatment.

[c]Four replicates (pens) of eight gilts per treatment.

[d]Two replicates (pens) of seven barrows per treatment.

TABLE 2: PERFORMANCE - TRIAL 1

Item	Treatment	
	1 Control	2 One Move
Initial Wt., lbs.	85.4	83.8
Final Wt., lbs.	229.5	231.7
Gain, lbs.	144.1	147.9
Days	84.	84.
ADG (56 days), lbs.	1.67[b]	1.67[b]
ADG (84 days), lbs.	1.72[b]	1.76[b]
Feed (56 days), lbs.[a]	442.3	420.0
Feed/day, % of body wt.	4.2	4.0
F/G (56 days)	3.16[b]	3.00[b]

[a]All feed records after day 56 were lost.

[b]Means in the same line not having a superscript in common are different ($P<.05$).

TABLE 3: PERFORMANCE - TRIAL 2

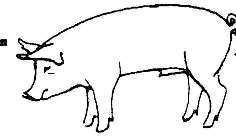
Item	Treatment	
	1 Control	2 One Change
Initial wt., lbs.	93.6	95.8
Final wt., lbs.	213.4	213.9
Gain, lbs.	119.8	118.1
Days	70.	70.
ADG, lbs.	1.71[a]	1.69[a]
Feed, lbs.	340.4	338.0
Feed/day, % of body wt.	3.2	3.1
F/G	2.84[a]	2.86[a]

[a]Means in the same line not having a superscript in common are different ($P<.05$).

TABLE 4: PERFORMANCE - TRIAL 3

Item	Treatment			
	1 Control	2 One Move	3 Two Moves	4 Three Moves
Initial wt., lbs.	132.1	133.4	130.8	134.5
Final wt., lbs.	234.8	240.6	237.6	238.6
Gain, lbs.	102.7	107.2	106.8	104.1
Days	55.5	55.5	52.5	55.5
ADG, lbs.	1.85[a]	1.93[a]	2.03[a]	1.89[a]
Feed, lbs.	405.5	426.5	406.0	427.0
Feed/day, % of body wt.	4.0	4.1	4.2	4.1
F/G	3.95[a]	4.01[a]	3.80[a]	4.11[a]

[a,b]Means in the same line not having a superscript in common are different ($P<.05$).



PROTEIN SUPPLEMENT WITHDRAWAL DURING A PORTION OF THE FINISHING PHASE

George Wm. Jesse

SUMMARY

Withdrawal of all of the protein supplement during a 20 lb. increment of the finishing phase was studied during four trials which utilized 321 crossbred barrows and gilts. Six dietary regimes were compared which differed in level of crude protein from 180 to 200 lbs. and from 200 lbs. to a slaughter weight of either 220 or 240 lbs.

Average daily gain, feed efficiency and feed cost of gain for the entire growing-finishing period were quite similar for all six dietary regimes. However, as expected, performance during the withdrawal period significantly favored the control pigs. Protein supplement withdrawal had little effect on carcass parameters (i.e. backfat, loin eye, etc.).

The results of this study indicate that all of the protein supplement can be removed from the finishing diet for a 20 lb. increment without substantially affecting performance, if it is removed after the pig reaches 200 lbs. Removal of the protein supplement during the last 20 lbs. of gain produced the better results of the two withdrawal periods and would seem to be the most feasible from a producer's standpoint.

INTRODUCTION

Although protein does not represent the major feed cost of the growing-finishing (G-F) pig, it is the primary out-of-pocket feed cost for most operations. On occasion when the relative cost of protein supplementation increases, many swine producers are inclined to reduce the level of dietary protein during some phase of the G-F period. Others feel this is the time when it is most critical that protein requirements be met to insure maximum performance (daily gain and feed efficiency) and maximum returns.

Numerous G-F studies have been conducted during the past fifteen years comparing static protein levels (Cunningham et al., 1973; and Davey, 1976) and protein sequences (Hale and Southwell, 1967; Meade et. al., 1969; Wahlstrom et al., 1971; Tjong-A-Hung, 1972; and Gilster et. al., 1973a, 1973b) that are lower than the present NRC (1979) recommendations. Most results are in agreement that the lower crude protein diets cause a decrease in performance and a fatter carcass. On the otherhand, Kornegay et al. (1973), Irvin et al. (1975) and Christian et al. (1980) report that low protein levels have little effect on performance during the latter half of the G-F period.

The primary objective of this study was to determine the feasibility of withdrawing all of the protein supplement during a 20 lb. increment of the finishing phase.

PROCEDURES

Three hundred and twenty-one crossbred barrows and gilts were utilized in four trials comparing six dietary regimes which differed in level of crude protein (C.P.) from 180 to 200 lbs. and from 200 lbs. to slaughter weight. Pigs assigned to treatments 1-3 were slaughtered at an average pen weight of 220 lbs. and those of treatments 4-6 at 240 lbs.

All pigs were *ad libitum* fed a corn-soy diet (meal form) formulated to meet NRC (1973) requirements for C.P. to an average pen weight of 180 lbs. As shown in table 1, treatments 1 and 4 were the controls for their respective slaughter group; hence, these pigs were continued on a 13% C.P. diet for the duration of the trial. Pigs assigned to treatments 2 and 5 were fed corn plus vitamins and minerals (GWJ9) during their last 20 lbs. of gain and those of treatments 3 and 6 received the protein deficient diet during the next to the last 20 lbs. of gain. Dietary changes were based upon average pen weight. Composition of the diets fed is presented in table 2.

Specific dietary treatments compared by trial and number of pigs per treatment are shown in table 1. Each trial included three pens per treatment with either seven or eight pigs per pen. Pigs were assigned to treatment at random within sex and weight group with the exception of group 3 of trial 2 which contained an equal number of barrows and gilts. Average initial weight per animal group ranged from 71.6 to 90.0 lbs., 88.5 to 107.8 lbs., 51.6 to 71.4 lbs., and 102.9 to 115.6 lbs. for trials 1 through 4, respectively. Starting dates per trial were 12/28/77, 12/15/78, 6/27/79 and 9/7/79.

The pigs were fed in a totally-enclosed, slotted floor facility which had negative pressure ventilation and an under-the-floor-flush waste handling system. All pens were 7' by 10' and had one four-hole self feeder and one nipple waterer.

Pig weights and pen feed consumption were determined ever 14 days and whenever a dietary change was made during trial 1 to enable the determination of overall and by period performance. Feed consumption during the various C.P. sequences was not determined for the controls (treatments 1 and 4) during trials 2-4; hence, by period performance could not be computed. Prices used to compute feed costs were $132, 124 and 120 and 106 per ton of 16, 14, 13 and 9% C.P. diets, respectively.

Carcass data were collected on 187 of the 189 barrows and 48 of the 132 gilts tested. This excluded group 1 of trials 1 and 2 and half of group 3 in trial 2. Pigs in trial 1 were slaughtered at Hunter Packing Company, E. St. Louis, Illinois and all others at Clennin Meats, of California, Missouri. Individual pig weights were taken just prior to shipping for use in adjusting backfat (BF) and loin eye area (LEA) to a 230 lb. basis.

The data were analyzed by analysis of variance utilizing SAS (Helwig and Council; 1979).

RESULTS AND DISCUSSION

Diet Analyses. The actual and calculated dietary values for crude protein, lysine, calcium and phosphorus are shown in table 2. Crude protein values were close to the expected levels except for the 16% diet. Lysine was higher than anticipated which probably reflects a higher value for corn than the NRC tabled value. Calcium was also higher than expected which resulted in a Ca:P of approximately 1.6:1.

Performance - Trial 1. As shown in table 3, average daily gain (ADG), feed efficiency (F/G), and feed cost of gain (FCOSTGA) were quite similar for all six dietary regimes. The control pigs (trt 1) fed to 220 lbs. were significantly faster gaining ($P<.05$) than those fed a 9% diet from 180 to 200 lbs. (trt 3) which indicates that withdrawing the protein supplement at this lighter weight had a detrimental effect. Removal of the soybean meal during the last increment of gain (treatment 2) did not hurt performance. Likewise, ADG was nearly the same for treatments 4, 5 and 6 indicating that protein deprivation, for a short period of time as pigs neared slaughter weight (220-240 lbs.) did not have an overall effect on performance during the G-F period. As expected, the barrows were faster gaining than the gilts; however, F/G and FCOSTGA were not different. Although not shown, a comparison of treatment by animal group revealed more variable performance of the gilts to protein withdrawal than the barrows.

Overall performance during the G-F period was quite similar for all treatments; however, withdrawing the protein supplement reduced ADG during the withdrawal period as expected (table 4). The decrease in rate of gain was approximately 25% for those slaughtered at 220 lbs. On the otherhand, when pigs were fed to 240 lbs. the detrimental effect was less significant.

Treatment effects on several quantitative carcass traits were essentially nil as can be seen in table 5. No differences were noted for backfat (BF) or loin eye area (LEA) when adjusted to a weight constant basis. It should be pointed out that the small LEA average for treatment 6 represents only eight carcasses due to the loss of eight LEA tracings at the slaughter plant. Gilts had less backfat and larger loin eyes than the barrows; hence it would seem reasonable to expect a protein deficiency to be more detrimental to gilts.

Performance - Trials 2, 3 and 4. The performance of pigs during trials 2, 3 and 4 is shown in tables 6, 7 and 8. No differences by treatment were observed for any of the performance traits measured.

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TABLE 1. EXPERIMENTAL DESIGN

Treatment		Number of Pigs[b]			
		Trial[c]			
No.	Dietary C.P.[a],%	1	2	3	4
1	13-13	24	24		
2	13-9[d]	24	24		
3	9-13	24	24		
4	13-13-13	24		21	21
5	13-13-9	24		21	21
6	13-9-13	24		21	

[a]Fed during average pen weights of: 1) 180-200 lbs; 2) 200-220 lbs.; and 3) 220-240 lbs.

[b]Represents three pens of equal numbers per treatment.

[c]Starting date: 1) 12/28/77; 2) 12/15/78; 3) 06/27/79; and 4) 09/07/79.

[d]Represents an estimated C.P. value for corn.

TABLE 2. DIETS FED

Ingredient	Internat'l Ref. No.	GWJ 16 lbs	GWJ 16 %	GWJ 14 lbs	GWJ 14 %	GWJ 13 lbs	GWJ 13 %	GWJ 9 lbs	GWJ 9 %
Corn, ground	4-02-931	1534	76.70	1657	82.85	1716	85.80	1947	97.35
Soybean Meal, 44%	5-04-604	401	20.05	290	14.50	235	11.75	----	-----
Dicalcium Phosphate	6-01-080	15	.75	6	.30	7	.35	13	.65
Ground Limestone	6-02-632	25	1.25	22	1.10	22	1.10	20	1.00
Trace Mineral Salt[a]		12	.60	12	.60	12	.60	12	.60
Vitamin Mix[b]		8	.40	8	.40	8	.40	8	.40
Antibiotic (ASP-250)		5	.25	5	.25	----	-----	----	-----
		2000	100.	2000	100.	2000	100.	2000	100.
Analyses, %		Calc.	Act.[d]	Calc.	Act.	Calc.	Act.	Calc.	Act.
C.P.		16.01	14.4	14.01	13.9	13.02	13.2	8.66	8.8
Lysine		.77	.76	.63	.72	.56	.62	.24	.30
Ca		.67	.65	.50	.65	.50	.63	.50	.67
P		.51	.38	.41	.39	.41	.39	.42	.39

[a]Provides the following in the complete feed: Selenium, .1 ppm; Iron, 100 ppm; Copper, 15 ppm; Zinc, 100 ppm; Manganese, 50 ppm and Salt, .5%.

[b]A level of .4% provides the following per ton of complete feed: 4,000,000 I.U. Vitamin D_3; 16,000 I.U. Vitamin E; 1.6 g Thiamine; 4 g Riboflavin, 20 g Pantothenic Acid; 24 g Niacin; 400 g Choline Chloride; .024 g Vitamin B_{12}; 1.6 g Menadione; .8 g Folic Acid; .8 g Pyridoxine Hydrochloride; .32 g Biotin and 40 g Ethoxyquin.

[c]Calculated values based on NRC (1973) except for adjusted amino acid values.

[d]Actual values.

TABLE 3. PERFORMANCE FROM 83.9 LB. TO SLAUGHTER - TRIAL 1.

Treatment		No.	Least squares means		
No.	Dietary C.P., %	Hd.	ADG, lb.	F/G, lb.	FCOSTGA,[a] $/cwt.
1	13-13	24	1.72[c]	3.48[ce]	21.22[cd]
2	13-9	21	1.64[cd]	3.46[c]	20.59[d]
3	9-13	24	1.58[d]	3.62[de]	21.49[cd]
4	13-13-13	23	1.62[d]	3.53[cd]	21.46[cd]
5	13-13-9	23	1.66[cd]	3.68[d]	22.03[c]
6	13-9-13	24	1.63[cd]	3.55[cd]	21.15[cd]
Animal group					
No.	Description[b]				
1	Light gilts	45	1.54[c]	3.48[c]	20.90[c]
2	Heavy gilts	47	1.59[c]	3.60[d]	21.60[d]
3	Heavy barrows	47	1.80[d]	3.58[cd]	21.47[cd]

[a]Feed cost per hundred weight of gain.

[b]Average beginning weight by group: 1) 71.6 lb.; 2) 90.0 lb.; and 3) 89.5 lb.

[cde]Means in the same column within dietary treatment or animal group not having a superscript in common are different (P<.05).

TABLE 4. AVERAGE DAILY GAIN FROM 180 LB. TO SLAUGHTER - TRIAL 1

Treatment		Period		
		I	II	III
		Live weight, lbs.		
No.	Dietary C.P., %	180-200	200-220	220-240
1	13-13	1.60^{a}	1.55^{b}	---
2	13-9	1.59^{a}	1.19^{c}	---
3	9-13	1.17^{b}	1.78^{a}	---
4	13-13-13	1.60^{a}	1.41^{bc}	1.54^{a}
5	13-13-9	1.82^{a}	1.27^{c}	1.24^{b}
6	13-9-13	1.30^{b}	1.37^{bc}	1.79^{c}

[abc]Means in the same column not having a superscript in common are different (P<.05).

TABLE 5. QUANTITATIVE CARCASS TRAITS - TRIAL 1

Treatment		No.	Least squares means[a]				
No.	Dietary C.P., %	Hd.	Length, in.	BF[b], in.	LEA[b], sq. in.	Dressing percent	Muscle[c], %
1	13-13	16	30.9^{d}	1.30^{d}	4.79^{d}	75.2^{de}	54.4^{de}
2	13-9	15	31.0^{de}	1.27^{d}	4.76^{d}	74.6^{e}	54.7^{d}
3	9-13	16	30.8^{d}	1.30^{d}	4.88^{d}	75.0^{e}	54.5^{d}
4	13-13-13	16	31.4^{ef}	1.28^{d}	4.77^{d}	75.2^{de}	53.8^{de}
5	13-13-9	15	31.8^{f}	1.35^{d}	4.81^{d}	76.5^{d}	53.1^{e}
6	13-9-13	16	31.8^{f}	1.25^{d}	4.40	74.9^{e}	53.7^{de}
Animal group							
No.	Description						
2	Heavy gilts	47	31.5^{d}	1.24^{d}	4.99	75.7^{d}	54.6^{d}
3	Heavy barrows	47	31.1^{e}	1.35^{e}	4.52	74.8^{e}	53.4^{e}

[a]Least squares means of LEA for treatment six and by animal group were not determined due to missing date.

[b]Adjusted to a 230 lb. basis.

[c]Derived from the following NPPC recommended formula for estimating pounds of muscle, Lbs. muscle = (21.3 + (HCRWT * .55) - (Avg. BF * 17.75).

[def]Means in the same column within dietary treatment or animal group not having a superscript in common are different (P<.05).

TABLE 6. PERFORMANCE FROM 96.8 LB.
TO SLAUGHTER-TRIAL 2.

Treatment		No.	Least squares means		
No.	Dietary C.P., %	Hd.	ADG, lb.	F/G, lb.	FCOSTGA[a], $/cwt.
1	13-13	24	1.63[c]	3.68[c]	22.25[c]
2	13-9	24	1.61[c]	3.75[c]	22.19[c]
3	9-13	24	1.58[c]	3.78[c]	22.34[c]
Animal group[b]					
No.	Description				
1	Gilts	24	1.45[c]	3.75[c]	22.42[c]
2	Barrows	24	1.69[d]	3.70[c]	22.03[c]
3	Barrows and Gilts	24	1.68[d]	3.75[c]	22.33[c]

[a]Feed cost per hundred weight of gain.

[b]Average beginning weight by group: 1) 88.5 lb.; 2) 94.3 lb.; and 3) 107.8 lb.

[cd]Means in the same column within dietary treatment or animal group not having a superscript in common are different (P<.05).

TABLE 7. PERFORMANCE FROM 61.6 LB.
TO SLAUGHTER - TRIAL 3

Treatment		No.	Least squares means		
No.	Dietary C.P., %	Hd.	ADG, lb.	F/G, lb.	FCOSTGA[a], $/cwt.
4	13-13-13	19	1.69[c]	3.05[c]	18.64[c]
5	13-13-9	21	1.65[c]	3.22[c]	19.62[c]
6	13-9-13	21	1.68[c]	3.10[c]	19.57[c]
Animal group[b]					
No.	Description				
1	Barrows	21	1.69[c]	3.29[c]	19.91[c]
2	Barrows	21	1.73[c]	3.10[c]	19.81[c]
3	Barrows	19	1.59[c]	2.98[c]	18.10[d]

[a]Feed cost per hundred weight of gain.

[b]Average beginning weight per group: 1) 71.4 lb.; 2) 61.2 lb.; and 3) 51.6 lb.

[cd]Means in the same column within dietary treatment or animal group not having a superscript in common are different (P<.05).

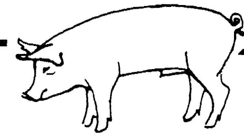
TABLE 8. PERFORMANCE FROM 116.2 LB. TO SLAUGHTER-TRIAL 4.

Treatment		No.	Least squares means		
No.	Dietary C.P., %	Hd.	ADG, lb.	F/G, lb.	FCOSTGA[a], $/cwt.
4	13-13-13	21	1.77[c]	3.61[c]	21.77[c]
5	13-13-9	21	1.68[c]	3.76[c]	22.01[c]
Animal group[b]					
No.	Description				
1	Barrows	14	1.79[c]	3.75[c]	22.04[c]
2	Barrows	14	1.71[c]	3.72[c]	22.18[c]
3	Barrows	14	1.67[c]	3.60[c]	21.44[c]

[a]Feed cost per hundred weight of gain.

[b]Average beginning weight per group: 1) 130.3 lb.; 2) 115.6 lb.; and 102.9 lb.

[c]Means in the same column within dietary treatment or animal group not having a superscript in common are different ($P<.05$).



EFFECTS OF EPERYTHROZOONOSIS ON SOW PRODUCTIVITY

G. M. Zinn and G. W. Jesse

SUMMARY

The effects of subclinical eperythrozoonosis was studied using piglets from 56 sows and gilts. The breeding animals were divided into seropositive or seronegative groups using the Indirect Hemagglutination (IHA) test. Pigs from the seropositive group of sows had a significantly ($P<.05$) higher mortality during the first 21 days plus they had significantly ($P<.01$) lower litter weights at 21 days. Also, the seropositive animals had a significant increase in the number of pigs born dead ($P<.01$).

A comparison of the packed cell volume (PCV) and hemoglobin (Hb) levels in 318 pigs from the above breeding animals indicated significantly ($P<.01$) lower PCV and Hb values in the piglets from the seropositive group.

No significant differences were noted in the following parameters measured: number pigs born alive, mummies, total birth weight, total live birth weight, total number pigs born and the interval of sows coming into heat.

INTRODUCTION

Before 1970, eperythrozoonosis was considered to be a problem mainly in feeder pigs. It caused a classic icteroanemia with a low morbidity and a high mortality. Some early investigators did mention finding the causative organism in blood smears from clinically normal sows which exhibited a mild non-clinical anemia. Low level infection was not associated with clinical disease until the early 1970's. Development of the indirect hemagglutination (IHA) test led to an appreciation of the widespread nature of the disease in American swine. Serological sampling of swine sera in 1977 by Smith (University of Illinois) indicated approximately 20% of the animals were positive at a titer of 40 or more using the IHA test. Patterns associating titers with clinical disease began to develop, and it is now believed that eperythrozoonosis is clinically evident at four production stages: (Splitter and Williamson, 1950; Smith, 1978)

1) Reproductive failure as a result of delayed estrus, early embryonic death and late-gestation abortion.
2) Anemia, mild icterus and weakness in newborn pigs.
3) A "delayed marketing syndrome" in which the expected rate of gain is not realized.
4) The classic ictero-anemia of stressed feeder pigs.

A condition exists where clinically normal sows show a positive titer to the IHA test, but do not apparently show any of the above clinical signs of the disease. Thus, it became evident that research is necessary to clarify the status of these seropositive animals.

The objectives of this research are to determine the effects of subclinical eperythrozoonosis on a number of sow performance indices (number pigs born alive, mummies, number pigs born dead, number pigs at 21 days, litter weight at 21 days, total birth weight, total live birth weight, total number of pigs born and interval of sows coming into heat) plus determination of possible pig effects by measuring packed cell volume and hemoglobin levels at two weeks of age.

PROCEDURE

Fifty-six brood sows and gilts from the University of Missouri Swine Herd were utilized in this experiment. Two weeks prior to farrowing, blood samples were collected via anterior vena cava puncture. Sera from these samples were submitted to the NADL Laboratory at Ames, Iowa for Indirect Hemagglutination (IHA) test. Results of this sampling were used to assign the sows to seronegative (titer <80) or seropositive groups (titer >80).

The following parameters were measured on piglets from both groups of breeding animals:

1) Number pigs born alive
2) Number of mummies
3) Number pigs born dead
4) Number pigs at 21 days
5) Litter weight at 21 days
6) Total birth weight
7) Total live birth weight
8) Total number pigs born
9) Interval of sows coming into heat

In addition, 43 litters, involving 318 pigslets from the above sows and gilts were monitored for packed cell volume (PCV) and Hemoglobin (Hb) at two weeks of age. This was accomplished via blood collection from the medial canthus of the eye.

RESULTS

Using the IHA test data, 22 of the 56 sows and gilts used in this experiment were assigned to the seropositive group and 34 were assigned to the seronegative group. The farrowing results from these animals, shown in Table 1, indicated the following significant differences.

1) Pigs from the seropositive group of sows had a higher mortality during the first 21 days ($P<.05$) plus they had lower litter weights at 21 days ($P<.01$).
2) The seropositive sows farrowed a significantly higher number of dead pigs at birth ($P<.01$).

No significant differences were noted in the following parameters:

1) Number of pigs born alive
2) Number of mummies
3) Total birth weight

4) Total live birth weight
5) Total number pig born
6) Interval of sows coming into heat

The PCV and Hb data on 318 pigs (see Table 2) which came from 18 seropositive and 25 seronegative sows and gilts indicated a significant decline in both values in the pigs from the seropositive group ($P<.01$).

TABLE 1. SOW PRODUCTIVITY MEANS

Item	Epe Titer[a] Seronegative	Epe Titer[a] Seropositive
Number born alive	9.18[d]	9.36[d]
Number born dead	.50[d]	1.36[e]
Total number born[b]	9.68[d]	10.72[d]
Number mummies	.53[d]	.27[d]
Number at 21 days	7.97[d]	7.29[e]
Total live birth weight, lbs.	29.41[d]	30.43[d]
Total birth weight, lbs.	30.80[d]	32.41[d]
Litter weight at 21 days, lbs.	110.26[d]	94.81[e]
Days to estrus[c]	35.17[d]	36.10[d]

[a]Titers less than 80 were considered negative and those ≥ 80 positive.

[b]Excludes mummies.

[c]Postweaning days to estrus.

[de]Means with different superscripts are different ($P < .05$).

TABLE 2. PIG MEANS

Item	Epe Titer[a] Seronegative	Epe Titer[a] Seropositive
Birth weight, lbs.	3.5[b]	3.4[b]
21 day weight, lbs.	12.8[b]	12.9[b]
Packed cell volume, %	42.0[b]	40.8[c]
Hemoglobin, g/100cc	12.4[b]	11.9[c]
Serum protein, g/100cc	5.4[b]	5.5[b]

[a]Refers to titer group of the dam.

[bc]Means with different superscripts are different ($P < .05$).

MISSOURI FEED SAMPLING SURVEY

John C. Rea

SUMMARY

During the period 1978 to 1981, 216 hog feed samples were analyzed for protein, calcium and phosphorus. In addition, 43 samples of hog finishing rations and 37 samples of other feed ingredients were analyzed for sulfa residue.

Results indicate many of the swine rations being fed in Missouri are not containing proper nutrient levels of protein, calcium, and phosphorus. Forty-nine percent of the finishing rations contained detectable sulfa and 16% contained sulfa levels in amounts sufficiently high to cause a residue in hogs at the violative rate.

These data suggest an urgent need for producers to more carefully evaluate their ration formulation and their feed mixing and handling procedures.

PROCEDURES

Data on the nutrient analysis of hog feeds were collected as part of a swine research panel which was established in 1978. Partial support of this project was provided by the Missouri Pork Producer's Association. Producers were asked to collect sow, starter, grower, and finishing rations and send them to the University of Missouri for analysis by the Agriculture Experiment Station. In addition to these samples, the tables include data from 29 swine feeds furnished by participants of the 1981 Feminine Farrowing School at the University of Missouri.

The 80 samples analyzed for sulfa residues were collected by the Area Extension Livestock Specialists in Missouri from hog producers. This was part of a national survey involving the National Pork Producers' Council, The USDA, FDA, and the Swine Industry. This program was initiated to help producers identify possible problems in their production systems that could lead to violative sulfa residues. Feed samples were taken from the feeder or from batches of soybean meal or other protein and grains. A total of 80 samples were collected and data obtained. Forty-three of these were complete finishing feeds and the remainder were various feeding ingredients, including soybean oil meal, other protein, and grain. The complete-mix feeds were broken down into commercial mix feeds and on-farm mix feeds. Results of the nutrient and sulfa residue data are shown in tables one through six.

The 26 grower feed samples had less range than the previous two groups. Again on the average they were satisfactory for this weight pigs with a few samples that would be considered too low in protein and calcium and one sample at the upper end of the range on calcium that might contain enough to limit feed intake.

TABLE 3. GROWER FEED SAMPLE ANALYSIS

Analysis	No.	Avg. %	Range %	NRC %
Crude Protein	26	15.9	12.0-19.1	16.0
Calcium	26	.8	.3- 1.3	.65
Phosphorus	26	.6	.3- .9	.50

Sixty-two finishing rations were analyzed. Protein averaged 14.6%, calcium .71%, and phosphorus .52%. The range on protein was wide going from 11.4 to 20.4%. There were a total of six samples that were under 12% or over 16%. The lower values would probably limit performance and those over 16% on a finishing ration would unnecessarily add to the total feed cost. The range on calcium was .2 to 1.2%, however, there were only a few samples that were out of the normal range for calcium. Phosphorus ranged from .4 to .8% so all were well within the normal limits. The higher levels of phosphorus would not be necessary however and with the current cost of phosphorus would add to ration cost.

TABLE 4. FINISHING FEED SAMPLE ANALYSIS

Analysis	No.	Avg. %	Range %	NRC %
Crude Protein	62	14.6	11.4-20.4	13.0
Calcium	62	.71	.2- 1.2	.5
Phosphorus	62	.52	.4- .8	.4

Results from the sulfa residue sampling are shown in tables 5 and 6. These data show that on the mill-mix feeds, 50% had detectable sulfa levels. Twenty-one percent of these samples had over 1 ppm sulfa which would be enough when fed to hogs being marketed to cause a residue problem of over

RESULTS AND DISCUSSION

The 84 sow samples analyzed had an average protein of 14.54%, .90% calcium, and .62% phosphorus. Comparisons with NRC Requirement indicate these rations on the average should be satisfactory for meeting nutrient requirements for sows. There was a wide range in the analysis of samples however. Protein ranged from 9.0 to 20.4%, calcium .01 to 1.8%, and phosphorus .31 to 1.2%. Approximately 20% of the rations analyzed were far enough above or below requirements that one could expect either some decrease in performance or some unnecessary increase in cost or both.

TABLE 1. SOW FEED SAMPLE ANALYSIS

Analysis	No.	Avg. %	Range %	NRC %
Crude protein	84	14.54	9.0-20.4	13.0
Calcium	84	.90	.01-1.8	.75
Phosphorus	84	.62	.31-1.2	.50

Forty-four starter rations were analyzed. Average protein for the starter rations was 16.5 with a range of 11.8 to 20.9%. This compares with a normal NRC Requirement of around 18%. Twelve of these samples had a protein analysis of under 16%. This is not high enough to meet protein requirements of this weight pig. Calcium levels averaged .85% compared to NRC Requirement of .80%. Here again the range was wide with a low level of .4% and a high calcium level of 1.3%. Phosphorus analysis on the 44 starter samples averaged .63 with a range of .43 to .78%. Samples on the low range (under .5%) could cause some reduction in performance and bone development.

TABLE 2. STARTER RATION SAMPLES ANALYSIS

Analysis	No.	Avg. %	Range %	NRC %
Crude protein	44	16.5	11.8-20.9	18.0
Calcium	44	.85	.4- 1.3	.8
Phosphorus	44	.63	.4- .8	.6

.1 ppm. On the farm mix samples 48% had detectable sulfa levels, but only 14% had over 1 ppm or levels enough to probably cause sulfa residues in pork.

In table 6 data are given which shows the range of sulfa contamination in mill-mix feed, farm mix feed, as well as samples of soybean oil meal, other protein and grains. The levels of sulfa in soybean and protein point up the fact that part of the contamination may be in handling and mixing facilities at central mills.

TABLE 5. SULFA STUDY

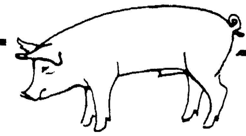
Summary of Analysis of Swine Finishing--Withdrawal Feeds in Missouri

Type of Feed	# Samples	Feed of Sulfa		Detectable Sulfa		More than 1 ppm	
		#	%	#	%	#	%
Mill mix	14	7	50	7	50	3	21
Farm mix	29	15	52	14	48	4	14
Total	43	22	51	21	49	7	16

TABLE 6. MISSOURI SAMPLES

Laboratory Analysis of Finishing--Withdrawal Feeds in Missouri, 1979

Detectable Level (PPM)	Complete Mill Mix	Feed Farm Mix	SBOM	Other Protein	Grain
0	7	15	8	6	7
.01- .09	4	10	9	6	-
1.0 - 1.9	-	-	-	-	-
2.0 - 2.9	-	1	-	1	-
3.0 - 4.9	1	-	-	-	-
5.0 - 9.9	1	1	-	-	-
10.0 -19.9	-	2	-	-	-
20.0 -29.9	1	-	-	-	-



CONTROLLED REPRODUCTION

B. N. Day, Mary Ann Gall, Steve Meredith, Dale Redmer and T. C. Cantley

SUMMARY

Experiments have been conducted to define the fundamental mechanisms controlling estrus and parturition in swine as well as to develop practical methods for controlling the onset of estrus and parturition. These studies have shown that feeding allyl trenbolone (Regumate) to gilts for a period of 18 days will synchronize estrus and ovulation without affecting fertility level at the first post-treatment heat period. Efforts are underway to gain approval of the use of this compound for producers. Controlled farrowing has been realized by injecting sows with prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) on day 111 to 113 of pregnancy. Further studies in progress are designed to develop a sequential treatment involving $PGF_{2\alpha}$ that would provide even more precise control of the onset of parturition. A primary purpose of developing a controlled farrowing management system is to permit increased adoption of supervised farrowing in an effort to reduce the level of stillbirths.

INTRODUCTION

Management practices are in use that have been found to be practical and helpful in controlling reproductive events to occur during a restricted period of time. These include the group movement and exposure to the boar of gilts in order to synchronize first heat, and weaning of pigs from a group of sows at a given time to synchronize post-weaning estrus. Management practices such as only breeding on the first of the week have also been adopted in an effort to schedule labor requirements more efficiently. Frequently, these management practices, such as the maintenance of a gilt pool to provide gilts that exhibit estrus at the same time as a group of sows, involve some loss in production efficiency and adjustments to the most desired management system. On balance, however, these practices are recommended due to the major importance of reproduction to overall efficiency.

Research continues in efforts to develop improved methods for the precise control of reproductive events in gilts and sows. Experimentation has demonstrated that the desired control can be achieved by the administration of hormones or other compounds according to a defined treatment schedule. Practical application of these treatments have also been demonstrated.

Perhaps the one event in the reproductive cycle that is the key point for the development of a complete controlled reproduction program is the ability to control estrus and ovulation in gilts. The advantages of breeding a group of gilts or sows by natural mating or artificial insemination on a predetermined day are well recognized. Induced farrowing combined with a program of synchronized estrus would make it possible to have very precise control over the reproductive cycle. Significant developments have been made in both of these areas in recent years and optimism exists that in the future adoption of effective treatments by the swine industry will be possible.

RESULTS

Control of Estrus and Ovulation. An acceptable method for the control of estrus and ovulation should be practical to administer, control the occurrence of estrus in a group of gilts to a period of 1 to 4 days, have no adverse effect on ovulation rate and, most importantly, not result in a decrease in conception rate at the synchronized estrus. A compound, Regumate, that we have tested in several studies during recent years would appear to meet these criteria.

Regumate (allyl trenbolone) is an orally effective progestin that is incorporated in the ration and fed at a level of 15 mg/gilt/day for a period of 18 days. Estrus is blocked in treated gilts and sows during the treatment period. Upon withdrawal of the compound from the feed, there is a uniform rebound effect in ovarian activity that will then result in the group of animals showing estrus at approximately the same time. Similar types of compounds have been tested previously and, although estrus was synchronized, side-effects including cystic follicles and reduced fertility were frequently observed at the first post-treatment estrus. Available evidence suggest that only minimal detrimental side-effects are encountered by treatment with Regumate. It should be remembered, however, that animals not showing estrus prior to treatment, for example sexually-immature gilts, will not be in estrus after treatment.

Estrus and Ovulation Rate. Table 1 summarizes the effectiveness of Regumate to control estrus and ovulation in sexually-mature gilts. It can be noted that estrus was effectively synchronized at the levels tested without a decrease in ovulation rate.

Pregnancy Rate and Litter Size. In a separate study, the fertility level of sows treated with Regumate was compared with control sows (table 2). This study and others have shown that fertility level at the first post-treatment estrus is not adversely affected by treatment with Regumate.

Controlled Farrowing. Agreement generally exists that supervised farrowing can be recommended as a means of decreasing the mortality rate of pigs at birth. But it is often much easier said than done due to competing labor requirements. Controlled farrowing could make supervised farrowing a reality. In addition, benefits associated with the restriction of farrowings to week-days, more extensive use of facilities, and group-production practices including cross-fostering of pigs, all-in all-out animal movement and group weaning of sows would be increased by the use of a controlled farrowing program.

A practical and effective method to control the time of farrowing in pigs has been developed (table 3). Treatment consists of a single injection of 10 mg of prostaglandin $F_{2\alpha}$ on day 111 to 113 of gestation in herds with an

Mary Ann Gall, Ph.D. candidate, awaits birth of pigs from the sow in the background. By treating sows with hormones, scientists are seeking improved control of the time of farrowing.

average gestation period of 114 days. Treatment prior to day 111 will induce parturition but may result in immature, weak pigs. The average interval from injection to farrowing has been found to be about 28 to 30 hr in several studies. The frequency of stillbirths is not different between induced and control sows. The average birth weight of pigs from induced sows is generally the same or slightly less than pigs delivered by control sows. Induced farrowing has been found to have no effect on the performance level of pigs from birth to weaning.

Experimentally, $PGF_{2\alpha}$ has been found to be an effective compound for the control of farrowing in sows. It, however, has not yet been made commercially available for this purpose. Additional research is in progress in an effort to reduce the number of pigs stillborn at the induced farrowing.

LITERATURE CITED

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TABLE 1. DOSE EFFECT OF REGUMATE ON THE OCCURRENCE OF ESTRUS, INTERVAL TO POST-TREATMENT ESTRUS AND OVULATION RATE IN GILTS

Dose[a]	No. gilts treated	No. gilts exhibiting estrus	Interval from withdrawal to estrus, days[b]	Total no. of corpora lutea[b]
0.0	10	10	---	12.8
10.0	10	9	4.1 ± .4	12.6
12.5	10	10	4.0 ± .3	14.7
15.0	10	10	4.6 ± .2	13.5
17.5	10	10	4.7 ± .3	13.5
20.0	10	9	5.1 ± .5	13.8

[a]Regumate, mg/gilt/day.

[b]Mean ± standard error.

TABLE 2. FERTILITY IN CONTROL AND REGUMATE-TREATED SOWS BRED AT THE FIRST POST-TREATMENT ESTRUS

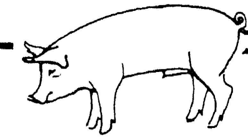
(Adapted from Webel, 1978)

Treatment	Number of sows		Bred sows farrowing (percent)	Litter size (mean ± S.D.)
	Allotted	In estrus and bred		
Control	70	64	66	10.0 ± 3.3
Progestogen	68	63	75	11.3 ± 2.8[a]

[a]Litter size was greater ($P<.05$) in sows treated with Regumate.

TABLE 3. CONTROLLED FARROWING WITH PROSTAGLANDIN $F_{2\alpha}$ (Field Trial)

$PGF_{2\alpha}$ dose	10 mg
Day of pregnancy injected	111 to 113
Number of animals treated	149
Number farrowing within 48 hours	141 (95%)
Before 8:00 a.m.	16%
8:00 a.m. to 8:00 p.m.	65%
After 8:00 p.m.	18%
Number farrowing more than 48 hr post-injection	8 (5%)



TAX BRACKET, EQUITY, PRODUCTION LEVEL AND INTEREST RATE IMPACTS ON AFTER TAX CASH FLOWS FOR A FEEDER PIG FACTORY

James B. Kliebenstein

SUMMARY

This study evaluates how tax brackets, equity levels, pig production levels per sow, and interest rates effect feeder pig factory cash flows. Annual after tax cash flows are compared over a ten year period for selected levels of the above items. When combining impacts of tax brackets, equity levels, production levels, and interest rates after tax cash flows are affected rather dramatically. The difference in after tax cash flows between the zero and fifty percent tax bracket was approximately equivalent to four pigs per sow per year. In general, if pigs per sow per year are reduced by two pigs per sow per year, equity level will need to be increased by 10 percent to remain at the same after tax cash flow. The impact of reducing interest rates from 14 to 10 percent had an impact similar to that of increasing the tax bracket from zero to 50 percent. This trade-off was on the average two pigs per sow per year. It was four pigs per sow during the first year of operation and one pig per sow during the tenth year.

INTRODUCTION

For today's farmers, financial management may be as important to survival as production management. Annual dollars of inflow need to be adequate to meet the annual demands for those dollars. Dollar flows are affected by producers tax brackets, equity levels, interest rates, and production levels. All too often, this dollar inflow-outflow analysis is done on a before tax money flow rather than after tax money flow basis. However, the more valid comparison is an after tax basis. Producers tax brackets can have an effect on their production cost. It can be argued that present policies, including tax policies, create competitive advantages for larger firms. In essence, tax policies may be aiding and possibly even encouraging the increased concentration and specialization that is occurring at an ever increasing rate in U.S. Agriculture. Others contend that tax rules may be as important as technology in forcing farmers to even larger sizes.

The broiler production and cattle feeding industries are dominated by large firms. The swine production industry is rapidly gaining momentum in its movement towards increased concentration. One phase of this movement in swine production has been the increased number of feeder pig factories. These factories are capital intensive requiring labor and management which is highly skilled.

The purpose of this study is to evaluate tax bracket, production level, interest rates, and equity level impacts on the competitive position of farmers. A highly specialized capital intensive feeder pig production system is used as a case study in completing the analysis. The study compares after tax cash flows for the factory given selected combinations of interest rates, tax brackets, production and equity levels. Results reported are not unique to feeder pig factories as they are applicable to any investment with a capital structure similar to that of a feeder pig factory. Similar investments would include cattle feedlots, dairy production systems, and broiler production systems.

PROCEDURES

The feeder pig factory selected as the case study is operated by a full-time hired manager with supplemental labor also hired. Farrowing is continuous. Production, cost, and return records are maintained by the feeder pig factory, and used to provide a base for the analysis.

To evaluate tax impacts on cash flows, tax brackets of 0, 20, 30, 40, and 50 percent were compared in the study. These tax brackets represent average tax levels for investors--marginal tax brackets would be higher. To indicate the importance of equity levels on cash flows, equity levels were varied from 20 to 50 percent in ten percent increments. Interest rates compared were 10 and 14 percent.

In addition to varying tax bracket equity, and interest rate levels, three levels of feeder pig production were also assumed. The levels were 6,300 (low), 7,200 (medium), and 8,100 (high), pigs per year for the 450 sow operation. This represents 14, 16, and 18 pigs per sow per year respectively. These levels represent goals of the feeder pig factories. Evidence has shown that some factories do not attain these levels while others may exceed them.

In this report, after tax cash flows represents the price that is necessary to cover all cash production costs including taxes. Labor and administration (management) are treated as cash production costs since these are salaried employees in many feeder pig factories. Cash expenses, excluding principal and interest, for the three production efficiency levels are $22.14, $20.60, and $19.06 per 30 pound pig respectively. Total investment in the factory was $647,000. The initial loan was paid off in 10 years. It was an even principal payment loan with interest on outstanding balances. Principal and interest were paid annually.

The depreciation method was straight line with buildings, equipment, and miscellaneous items depreciated over 10 years while the boars and initial sow herd were depreciated over three years. Replacement sows were raised within the herd, whereas all boars were purchased. Initially there were 12 boars purchased at $450.00 each while the 450 sows were purchased for $192.00 each. Using this information, total depreciation was $81,670 the first three years and $52,800 the last seven years.

RESULTS

Equity Level Impacts

It is not surprising that after tax cash flows are affected by the equity level (Table 1). However, the magnitude of the impact is important. For example, with the low production level (14 pigs per sow) after tax cash flows per pig decreased from $35.40 ($1.18 per lb.) when equity was 20 percent to $26.90 ($.90 per lb.) when equity was 50 percent--a reduction of $.28 per pound. Relative reductions in after tax cash flows due to equity level changes were similar for all production levels.

Production Level Impacts

Increased equity levels can be used to offset low pig production levels. Some interesting relationships are revealed in Table 1 when equity and pig production levels are combined. Some are as follows:

- After tax cash flows for the medium pig production level (16 pigs per sow) are the same as the low pig production (14 pigs per sow) when equity is 10 percent greater for the low production level. For example, after tax cash flows for medium production level with 20 percent equity is approximately the same as for the low production level with 30 percent equity.

- In general if pigs per sow per year are reduced by two, equity level will need to be increased by ten percent to remain at the same after tax cash flow level.

- Pig production levels are important. When equity is 20 percent after tax cash flows are reduced by $6.96 per pig by increasing production from 14 to 18 pigs per sow per year. This difference is $.23 per pound of feeder pig produced--an annual difference of $56,276 for the system.

- Given the assumption of this study, production efficiency and/or equity needs to be quite high if the market price is to be greater than after tax cash flows during the first few years of the operation. For some combinations, an after tax cost of $1.00 per pound of feeder pig is exceeded. Most combinations exceed $.83 per pound of feeder pig or $25.00 per 30 pound feeder pig.

- After tax cash flows for the high production low equity individual (20%) are only $1.50 more per pig than for the low production high equity (50%) individual--a difference of $.05 per pound of feeder pig produced.

It is imperative that the highly leveraged (low equity) operation maintain a high production level if it is to meet after tax cash flow committments. Above average production levels are vital to survival at these high leverage levels; there is less room for error, such as breeding problems, etc. The importance of production levels to business or firm survival is magnified by comparing after tax cash flows for the low production level (14 pigs per sow per year) and 50 percent equity with those for the high production level (18 pigs per sow per year) and 20 percent equity. After tax cash flows for the high production highly leveraged combination were only slightly higher than for the low leverage low production position. This exemplifies the fact that limited dollars can be spread much further if production levels are kept up.

Tax Bracket Impacts

Tax bracket impacts shown in Table 2 quickly point out that pig production levels have a greater impact on after tax cash flows than do the tax brackets. Differences between the high and low production levels are greater than the differences between the zero and 50 percent tax brackets. Nonetheless, tax brackets do have an impact. For the low production level, after tax cash flows decreased from $35.10 to $32.60 per 30 pound pig as the tax bracket increased from zero to 50 percent--a difference of $2.50 per pig produced. This may seem insignificant but for 6,300 pigs (14 pigs x 450 sows) this represents a difference of $15,750 in after tax cash flows to the system due to differences in the tax bracket. For the high production level this annual difference in after tax cash flow due to tax brackets, was $15,957.

Interest Rate Impacts

Interest rate comparisons are shown in Table 3. For the zero percent tax bracket, producers in the low production range could reduce production cost by $1.57 per pig with 10 percent rather than 14 percent interest rates. For the medium and high production levels these differences were $1.39 and $1.24 respectively.

Summary comments on Table 3 would include the following:

- In general, reducing interest from 14 to 10 percent had an impact similar to that of increasing the tax bracket from zero to 50 percent. These movements tended to offset each other.

- The difference in after tax cash flows between the zero tax bracket, 14 percent interest rate producer and the 50 percent tax bracket, 10 percent interest rate producer is about two pigs per sow per year. As an example, after tax cash flow for the 50 percent tax bracket, 10 percent interest rate and high pig production level (18 pigs) producer was equivalent to that for the medium pig production level (16 pigs) zero tax bracket and 14 percent interest rate producer.

In summary, there are differences in after tax cash flows for feeder pig producers. Tax brackets, production levels, equity levels, and interest rates all are important in the survival of the feeder pig factory. In year one, after tax cash flows were almost cut in half when moving from the highest to lowest cash flow scenario. The lowest cash flow scenario was the low interest rate high tax bracket, high production level, and high equity. The high cash flow scenario was just the reverse of the above respective items. Production levels appear to be the most vital to survival, followed by the equity level, the interest rate, and the tax bracket.

IMPLICATIONS

Implications of this study are many and varied. They vary according to assumptions made. The study shows that cash flows for feeder pig production in a factory setting are influenced substantially by the swine producers tax bracket, equity level, per sow production level, and interest rates. Listed below are some questions that can be influenced by the direction swine production takes.

1. What are the implications for a young individual getting started in swine production? What is and will be the competitive situation for these types of individuals?

2. In what resources do beginning young farmers have a competitive advantage in swine production? Can these resources offset areas where they are in a competitive disadvantageous position, such as the tax bracket and possibly interest rates?

3. What role should the tax structure and production efficiency play in the success or failure of a swine operation?

4. What are the implications for the future structure of the swine production industry? In the same vein, are there implications for the swine marketing system?

5. What will be the impacts on concentration of swine production?

6. What are the implications with respect to labor and management in swine production?

7. What are the implications for the swine cycle?

8. What are the implications for financial institutions servicing the swine industry?

9. What about problems of waste disposal in swine production?

10. Will disease problems become more of a concern for swine producers?

This is not an exhaustive list but are some which are felt to need further examination for possible answers.

TABLE 1

After Tax Cash Flows Per 30 Pound Feeder Pig by Equity Level and Pig Production Level; Interest Rate of 14% and 50% Tax Bracket

Pig Production Level (Pigs/Sow/Year)	Equity Level			
	20	30	40	50
			Ten Year Average	
14	35.40	32.60	29.70	26.91
16	32.27	29.80	27.29	24.80
18	28.44	27.23	25.00	22.80
			First Year	
14	37.36	33.88	30.71	26.94
16	33.99	30.94	27.88	24.83
18	30.97	28.26	25.54	22.82
			Last Year	
14	31.62	29.43	27.25	25.06
16	28.94	27.02	25.10	23.17
18	26.48	24.77	23.06	21.35

TABLE 2

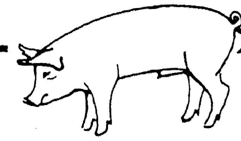
After Tax Cash Flows Per 30 Pound Feeder Pig By Tax Bracket and Pig Production Level; Interest Rate of 14% and 30 Percent Equity Level

Pig Production Level (Pigs/Sow/Year)	Tax Bracket				
	0	20	30	40	50
			Ten Year Average		
14	35.12	34.49	34.03	33.42	32.57
16	32.03	31.46	31.06	30.53	29.78
18	29.23	28.73	28.37	27.89	27.23
			First Year		
14	39.63	38.19	37.17	35.80	33.88
16	35.99	34.73	33.82	32.62	30.94
18	32.75	31.63	30.83	29.75	28.26
			Last Year		
14	30.62	30.32	30.11	29.83	29.43
16	28.06	27.80	27.62	27.37	27.02
18	25.70	25.47	25.30	25.08	24.77

TABLE 3

After Tax Cash Flows Per 30 Pound Feeder Pig by Tax Bracket, Interest Rate, and Pig Production Level; Equity Level is 30%.

Pig Production Level (Pigs/Sow/Year)	Tax Bracket 0 Interest Rate		Tax Bracket 50 Interest Rate	
	14%	10%	14%	10%
	Ten Year Average			
14	35.12	33.55	32.57	31.00
16	32.03	30.64	29.78	28.40
18	29.23	27.99	27.23	26.00
	First Year			
14	39.63	36.77	33.88	31.03
16	35.99	33.47	30.94	28.42
18	32.75	30.51	28.26	26.02
	Last Year			
14	30.62	30.33	29.43	29.15
16	28.06	27.81	27.02	26.77
18	25.70	25.48	24.77	24.55



A COMPARISON OF SWINE PRODUCTION COSTS FOR PASTURE, INDIVIDUAL, AND CONFINEMENT FARROW-TO-FINISH PRODUCTION FACILITIES[1]

J. B. Kliebenstein, C. L. Kirtley, and M. L. Killingsworth

SUMMARY

Cost and return values for Missouri Mail-In-Record swine producers are compared by facility type. The four facility types are pasture, individual unit on confinement--confinement facilities are split into those with more than 75 sows and those with less than 75 sows. Feed efficiency in terms of pounds of feed per 100 pounds of pork produced was the best in the smaller confinement system and the worst in the pasture system. Labor costs per 100 pounds of pork produced were higher for the confinement than for the other two systems. Also veterinary and medicine costs for the confinement system was more than double those costs for the pasture or individual unit system. Total costs of producing 100 pounds of pork ranged from $40.18 in the pasture system to $42.97 in the individual unit system.

INTRODUCTION

Pork is produced in many varied types of facilities in Missouri. These facilities can range from a totally confined environmentally controlled system to a pasture system where housing facilities are very minimal. Arguments both, pro and con, abound on these systems. Some claim that feed efficiency, production costs, etc., vary by type of production facility. Yet most budgets on swine production use average data for all swine producers. Facilities for those individuals can vary from pasture to totally confined operations.

PROCEDURE

A study currently in process at the University of Missouri collected cost, return and facility data from Missouri swine producers for the years 1978 and 1979. Producers were members of the Missouri Mail-In-Record program. In addition to their regular monthly reports on swine expenses, receipts, etc., the producers gratefully supplied data on their production facilities, breeding practices, marketing practices, etc.

This report represents a brief review of a small segment of the data supplied. It prepares a look at production costs and returns in 1979 for the farrow-to-finish swine producers. Costs and returns are aggregated by facility type. The

[1]Financial assistance was provided by the Missouri Pork Producers Association and by Pfizer Inc. of Lee's Summit, MO.

four facility types are pasture, individual units, confinement with less than 75 sows, and confinement with more than 75 sows. A pasture system is where sows are farrowed with minimum facilities. Pasture feeding facilities also had little if any shelter. In contrast, individual units were similar to pasture systems in that they are low investment facilities. However, for individual unit systems the houses were lined up on a row and most had wood or cement porches. Some also had automatic watering capabilities for each individual unit. Confinement facilities were, as the term says, facilities where hogs were confined during the production process. These facilities may have slats or a solid floor with crates and/or pens.

RESULTS

The first four lines of Table 1 illustrate information on market hog average weights; average feed efficiency; average labor efficiency; and average size of the four production facilities. Average market hog weight was the heaviest for the pasture system and the lightest for the individual unit system. Hogs from the pasture system were sold at an average weight of 237 pounds while hogs from the individual unit system weighed an average of 204 pounds. Confinement hogs from the smaller confinement operations weighed 221 pounds while those from the larger confinement operations averaged 218 pounds. Pasture systems averaged selling 539 market hogs. This compared with 959 for individual unit systems; 345 for the smaller confinement system; and 1165 for the larger confinement systems.

Hours of labor per 100 pounds of pork produced was the lowest for the pasture system and the highest for the smaller confinement system. The pasture system used 1.09 hours of labor per 100 pounds of pork produced; the individual unit system 1.11 hours; the larger confinement system 1.13 hours; and the smaller confinement system 1.25 hours. This appears to be contrary to the commonly held notion that pasture systems are more labor intensive than are confinement systems. A logical explanation for this relative labor relationship has not been determined.

Feed efficiency in terms of pounds of feed per 100 pounds of pork produced was the best in the smaller total confinement system and the worst in the pasture system. The pasture system used 502 pounds of feed per 100 pounds of pork produced as compared to 467 for the individual unit system; 445 for the larger confinement systems and 435 for the smaller confinement system.

Cost and return information for the four systems are also shown in Table 1. Variable costs such as feed, veterinary, utilities, etc., are shown. Also costs fixed to the operation such as real estate taxes, depreciation, and interest costs on buildings, machinery, etc., are provided. Cost and return data is on a per hundred weight of pork produced basis. Return information is provided as value of production. Value of production includes adjustments for inventory changes.

Even though feed efficiency for the pasture system was the lowest there was only one system, the smaller confinement system, that had lower feed costs per hundred pounds of pork produced. This is a rather clear demonstration of the need for feed costs to be included with feed efficiency measures. Producers using the pasture system were using relatively less commercial feed (prepared feeds, supplements, etc.) and more grain. Commercial feeds are substantially more costly than are the grains. In essence, the pasture producers were offsetting decreased

Table 1

Swine Production Costs Per Cwt. by Farrow-to-Finish Production Facility Type (1979)[1]

Item	Production Facility: Pasture	Individual Houses	Confinement ≤ 75 Sows	Confinement > 75 Sows
Market Hog Weight	237	204	221	218
Lbs. Feed/100# Gain	502	467	435	445
Labor Hours Per Cwt.	1.09	1.11	1.25	1.13
Number of Market Hogs Sold	589	959	345	1165
Commercial Feed	$11.40	$14.74	$12.47	$13.12
Grain	15.66	14.86	14.24	14.06
TOTAL FEED COSTS	$27.06	$29.64	$26.71	$27.18
Feed Preparation	$ .35	$ .02	$ .14	$ .12
Veterinary & Medicine	.35	.34	.84	.74
Other Livestock Materials	.71	.35	.37	.38
Labor	3.48	3.88	4.40	4.03
Machinery	1.35	1.90	1.68	1.25
Utilities	.38	.58	.97	.79
Insurance	.14	.11	.20	.23
Taxes	.06	.06	.13	.08
Real Estate Maint. & repair	.40	.67	.60	.64
Miscellaneous Overhead	.10	.11	.15	.12
Operating Interest	2.00	1.85	1.79	1.73
TOTAL VARIABLE COSTS	$36.38	$39.51	$37.98	$37.29
Real Estate Taxes, Interest, and Depreciation	$ 2.13	$ 1.31	$ 2.23	$ 2.53
Interest on breeding herd	.37	.40	.44	.44
Machinery depreciation and Interest	1.30	1.75	1.44	1.40
TOTAL FIXED COSTS	$ 3.80	$ 3.46	$ 4.11	$ 4.37
TOTAL COSTS	$40.18	$42.97	$42.09	$41.66
VALUE OF PRODUCTION	$36.25	$35.71	$34.54	$37.40
RETURN TO MANAGEMENT	-$ 3.93	-$ 7.56	-$ 7.55	-$ 4.26

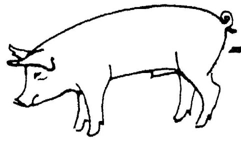
[1]Data from Missouri Mail-In-Record Program for 1979.

feed efficiency with decreased feed costs. Another point on these cheaper rations is that hogs will usually take longer to get to market weight with these rations. For the larger confinement producers time may be very valuable as one group of hogs may need to be moved out as quickly as possible to make room for the next group. For producers who produce one or two groups of market hogs per year time is not as important. For them a ration that provides faster gains would not be as important.

Labor costs per hundred pounds of pork produced were higher for the confinement system than for the other two systems. The larger confinement producers were more efficient in their labor use than were the smaller confinement producers. Their labor costs per 100 pounds of pork produced were lower even though their labor charge per hour was slightly higher. The pasture system had the lowest labor cost.

Veterinary and medicine costs were larger for the confinement systems than for either the pasture or individual unit systems. They were approximately twice as great for the confinement systems. Utility costs per hundred pounds of pork produced were the lowest for the pasture system ($.38) and the highest ($.97) for the smaller confinement producers.

Variable production costs per hundred weight were the highest for the individual unit system and the lowest for the pasture system. They were $36.38, $37.29, $37.98, and $39.51 for the pasture, large confinement, small confinement, and individual unit systems respectively. Fixed costs were highest for the large confinement system and lowest for the pasture system. Total costs of producing 100 pounds of pork ranged from $40.18 in the pasture system to $42.97 in the individual unit system. This represents a difference of $6.14 for a 220 pound market hog produced in the two respective systems. Return to management was negative in 1979 for all four systems. The best situation (least loss) was for the pasture and larger confinement units. The return to management per hundred weight was -$3.93 and -$4.26 for the pasture and large confinement system respectivley. The small confinement and individual unit systems had management returns of -$7.56 per hundred weight respectively.



N-NITROSOPYRROLIDINE AND QUALITY OF BACON CURED WITH DRY SALT CONTAINING LIMITED AMOUNTS OF NITRITE

M. E. Bailey, H. B. Hedrick, H. D. Naumann and W. C. Stringer

Abstract: Bellies were treated with dry salt to give 0, 40, 120 and 625 ppm sodium nitrite, 550 ppm sodium ascorbate, 1.5% salt and 0.6% sugar. Some samples were processed with sucrose and others with dextrose. The bellies were cured for 7 days at 4°C and smoked either at 50°C or 38°C. After slicing and vacuum packaging, bacon was stored at 4°C for 6 weeks and examined periodically for changes in pH, sodium chloride, sodium nitrite, flavor desirability, bacterial counts and N-nitrosamines.

The flavor of nitrite-treated bacon was more desirable than that of samples without nitrite. Bacon cured with 40 ppm sodium nitrite was as acceptable as that processed with higher levels of nitrite during storage at 4°C for 6 weeks. Sodium nitrite at 625 ppm significantly ($P<0.05$) decreased bacterial, yeast and mold counts compared to treatment with lower nitrite levels. Dextrose inhibited N-nitrosopyrrolidine (NPYR) formation at all levels of nitrite compared to sucrose.

INTRODUCTION

There are two important reasons for adding sodium nitrite to meat. One is that it retards growth of *Clostridium botulinum* and other microorganisms that might create a health hazard (Christiansen *et al.*, 1973; Christiansen *et al.*, 1974; Hustad *et al.*, 1973), and the other is that it prevents undesirable oxidative flavor in pre-cooked, table-ready processed meats (Bailey and Swain, 1973; MacDonald *et al.*, 1980; Bailey *et al.*, 1980).

The use of nitrite as a processing ingredient for cured meats has been questioned for several years due to the formation of N-nitrosamines under certain conditions when it reacts with secondary and tertiary amines. This problem is extremely important for bacon since this product is processed and cooked under conditions which result in production of N-nitrosopyrrolidine (NPYR) (Fazio *et al.*, 1973; Fiddler *et al.*, 1974; Pensabene *et al.*, 1974).

The nitrosamine problem is of extreme importance in the production of dry salt-cured bacon since the in-going level of sodium nitrite is so high. It was recently found that 46% of dry salt-cured bacon examined contained NPYR exceeding 17 ppb (FSQS, 1980) which is probably a conservative estimate of NPYR produced when dry salt-cured bacon is cooked by the consumer.

In anticipation of more stringent regulations regarding use of sodium nitrite as a curing ingredient in dry salt-cured bacon, this study was designed to determine the influence of reduced quantities of sodium nitrite employed with sodium ascorbate and dextrose on the quality and NPYR content of dry salt-cured bacon.

EXPERIMENTAL

Fresh bellies less than 5.5 kg in weight and not more than 2 days old were purchased from a local packer. They were trimmed to 4 to 5 kg and dry salt applied in a mixture prepared immediately before use to give a sample that contained 0, 40, 120 or 625 ppm sodium nitrite, 500 ppm sodium ascorbate, 1.5% salt and 0.6% of either sucrose or dextrose. The ingredients of the curing mixture were mixed in a Waring Blendor to assure homogeneity.

The bellies were cured in individual pans at 4°C for 10 days, excess salt was washed off with cold tap water, the bellies dried in a smokehouse at 43°C for 2 hr and smoked at 57°C to an internal temperature of 50°C. One group of samples containing sucrose and nitrite at 0, 40, 120 or 625 ppm was smoked at 43°C to an internal temperature of 33°C. After chilling overnight at 4°C, the bacon was sliced to 3 mm thickness and vacuum packaged. The bacon was stored up to 6 wks at 4°C and examined periodically for pH, sodium chloride, sodium nitrite, flavor desirability, total and aerobic bacteria, yeasts and molds and volatile nitrosamines.

pH was measured potentiometrically on slurries made by mixing 10 g ground bacon with an equal volume of CO_2-free distilled water.

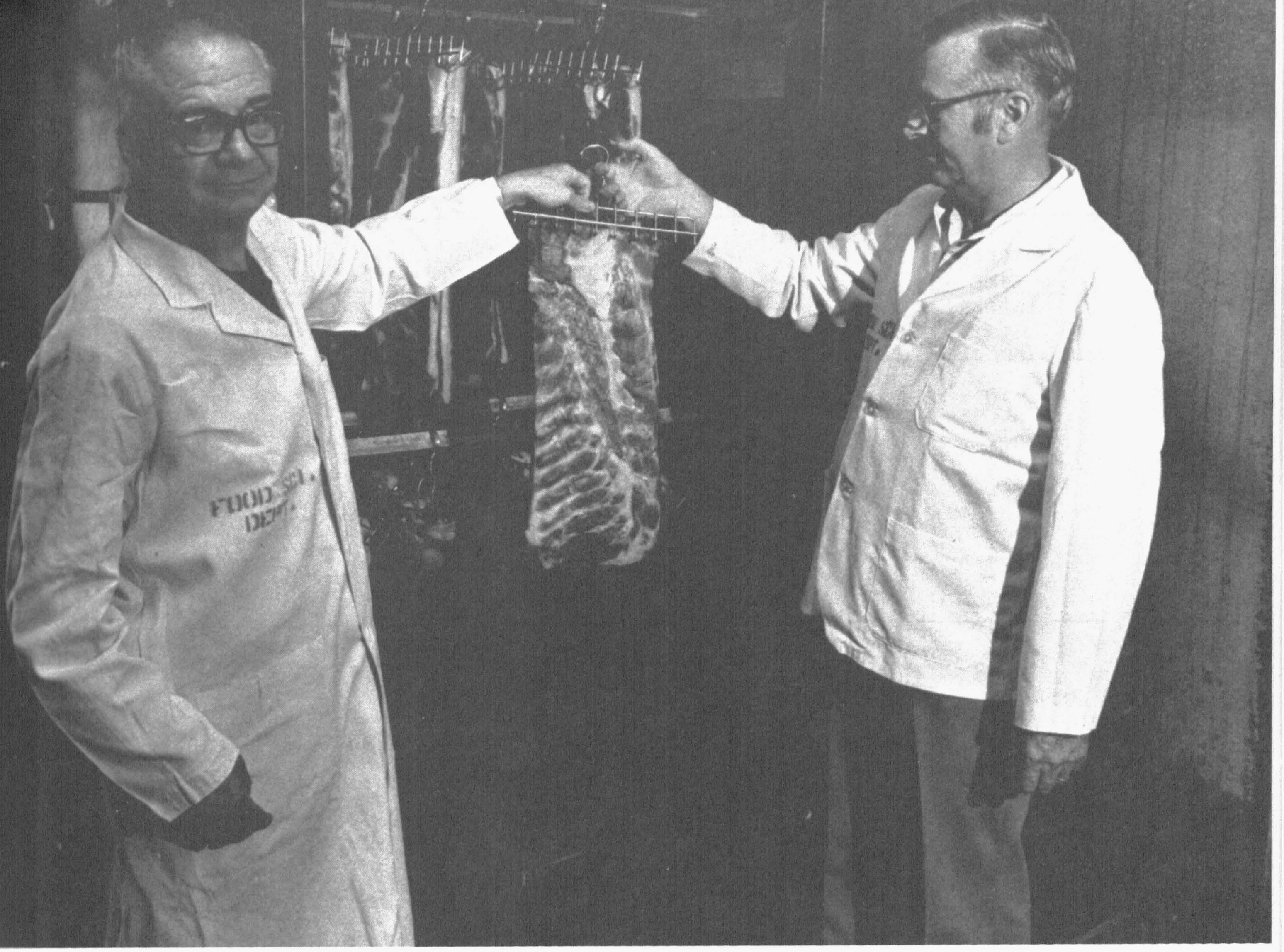
Sodium chloride was analyzed by an argintimetric method as described by Kramlich et al. (1973).

Sodium nitrite was determined by a modification of the AOAC method (1975). A 10 g sample was analyzed instead of 5 g recommended by the AOAC. ACS sodium nitrite was used as the standard instead of silver nitrite and since proteins were completely precipitated by the heating step, it was not necessary to use mercuric chloride as a precipitant.

Bacon was judged for flavor desirability by a panel consisting of 8 members who rated cooked product on a 6-point hedonic scale; 6 being "very acceptable" and 1-"very unacceptable." The bacon was cooked in a 171°C oven for 6 min on each side. Samples were analyzed at 0-storage time and after 1, 3 and 6 wk storage at 4°C. Panel members were experienced in tasting bacon, but were not trained for flavor preferences. They were served single pieces of bacon approximately 3 cm in length and were restricted to 12 samples per session.

Total bacterial plate counts were made using the procedures of Clark et al. (1978). Eleven g samples were blended with 99 ml sterile 0.1% Bacto peptone as the first dilution in meat sample preparations. Incubation was at 21°C. Anaerobic counts were made using the same technics substituting Bacto anaerobic agar as a growth medium and incubating at 32°C in a vacuum incubator. Yeasts and molds were grown on potato-dextrose agar incubated at 21°C for 3-5 dy.

Samples were analyzed for N-nitrosodimethylamine (NDMA), N-nitrosodiethylamine (NDEA), N-nitrosodibutylamine (NDBA), N-nitrosopiperidine (NPIP), N-nitrosopyrrolidine (NPYR) and N-nitrosomorpholine (NMOR) from 0.9 kg bacon that had been fried 6 min on each side at 171°C in a Saladmaster 7817 electric skillet. These nitrosamines were analyzed by the procedure outlined by FSQS (1978). Average recovery of the internal nitrosamine standard (N-dipropylnitrosamine) was 78%.



Milton Bailey, L, and Harold Hedrick, professors of food science, have lowered the nitrite levels in bacon by two-thirds and still produce a flavorful product.

RESULTS AND DISCUSSION

pH

There was no significant different in pH due to chemical treatment when all samples during storage were considered. Samples without nitrite had the lowest average pH (5.68), while samples treated with 625 ppm sodium nitrite had the highest average pH (5.79).

pH decreased during storage at 4°C when all treatments were considered (see Table 1). It was significantly higher ($P<0.05$) at 0-time compared to samples stored 3 and 6 wk.

Sodium Chloride

The mean sodium chloride content (Table 1) was 1.46% and was significantly ($P<0.05$) higher after 6 wk storage at 4°C than during other periods of the study. This was possibly due to sample dehydration during storage. Residual

Table 1. Influence of storage at 4°C on pH, salt and sodium nitrite of bacon[1,2]

Storage time (weeks)	pH	Salt (%)	Sodium nitrite (ppm)
0	5.81[a]	1.48[a]	26.05[a]
1	5.75[a,b]	1.45[a]	14.55[b]
3	5.70[b]	1.34[b]	11.31[b]
6	5.71[b]	1.57[c]	4.72[c]

[1]N=48

[2]Means within a column having the same letter are not significantly different ($P<0.05$).

salt content was close to the desired amount (1.5%) and is an indication of the adequacy of the processing procedures. Salt added to the level of 2% or higher resulted in bacon judged "too salty" by the sensory panel.

Sodium Nitrite

Considering all treatments at different levels, the sodium nitrite content of the raw bacon decreased during storage from an average of 26.05 ppm at 0-time to 4.72 ppm after 6 wk storage (Table 1) at 4°C. Decreases for samples treated with 40, 120 and 625 ppm sodium nitrite are shown in Table 2. Sodium nitrite content was reduced to essentially zero in samples treated with 20 and 120 ppm sodium nitrite after 6 wk storage at 4°C and for samples processed with 625 ppm sodium nitrite, the minimum was 18 ppm after 6 wk storage.

Flavor Desirability

Table 3 contains data for flavor desirability of bacon as influenced by nitrite, sugar and processing temperature. Samples cured without nitrite were less acceptable than those cured with nitrite. For the dextrose-containing samples, those cured without nitrite were significantly ($P<0.05$) less desirable than samples cured with 40, 120 or 625 ppm sodium nitrite.

Table 2. Residual sodium nitrite of samples during storage at 4°C.

Sodium nitrite added (ppm)	Storage time (weeks)	Sodium nitrite (ppm)
40	0	10.10
	1	1.54
	3	1.97
	6	0.00
120	0	17.13
	1	6.67
	3	4.01
	6	0.89
625	0	71.19
	1	49.84
	3	39.30
	6	17.98

[1]N=12

Changes in flavor desirability during storage at 4°C for 6 wk are given in Figures 1 and 2. For both dextrose and sucrose-treated samples, the bacon without nitrite was less desirable than nitrite-cured bacon. There was little difference in flavor acceptability of bacon treated with various amounts of nitrite during storage in vacuum packages at 4°C for 6 wk. These data suggest that curing with 40 ppm sodium nitrite can produce dry salt bacon with desirable flavor that has flavor stability comparable to that of bacon cured with 625 ppm sodium nitrite during storage at 4°C for 6 wk.

Bacteria, Yeasts and Molds

Bacon was evaluated for total bacteria, yeasts and molds as influenced by nitrite, sugar, processing temperature and storage at 4°C. The total bacterial plate counts of samples cured with various concentration of nitrite at

Table 3. Influence of nitrite, dextrose and processing temperature on flavor desirability of dry-salt cured bacon.

NO_2^- (ppm)	Sugar	Processing Temperature	Flavor Desirability (Mean)[1,2]
0	S	H	3.7[a,b]
40	S	H	4.1[a]
120	S	H	3.8[a,b]
625	S	H	4.0[a]
0	D	H	3.3[c]
40	D	H	3.8[a,b]
120	D	H	3.9[a,b]
625	D	H	3.8[a,b]
0	S	L	3.6[b,c]
40	S	L	3.8[a,b]
120	S	L	3.7[b,c]
625	S	L	3.9[a]

[1]N = 32

S - Sucrose; D - Dextrose; H - 50°C; L - 33°C

[2]Means followed by the same letter are not significantly ($P<0.05$) different.

FIGURE 1

INFLUENCE OF NITRITE ON FLAVOR DESIRABILITY OF DRY-SALT CURED BACON CONTAINING SUCROSE

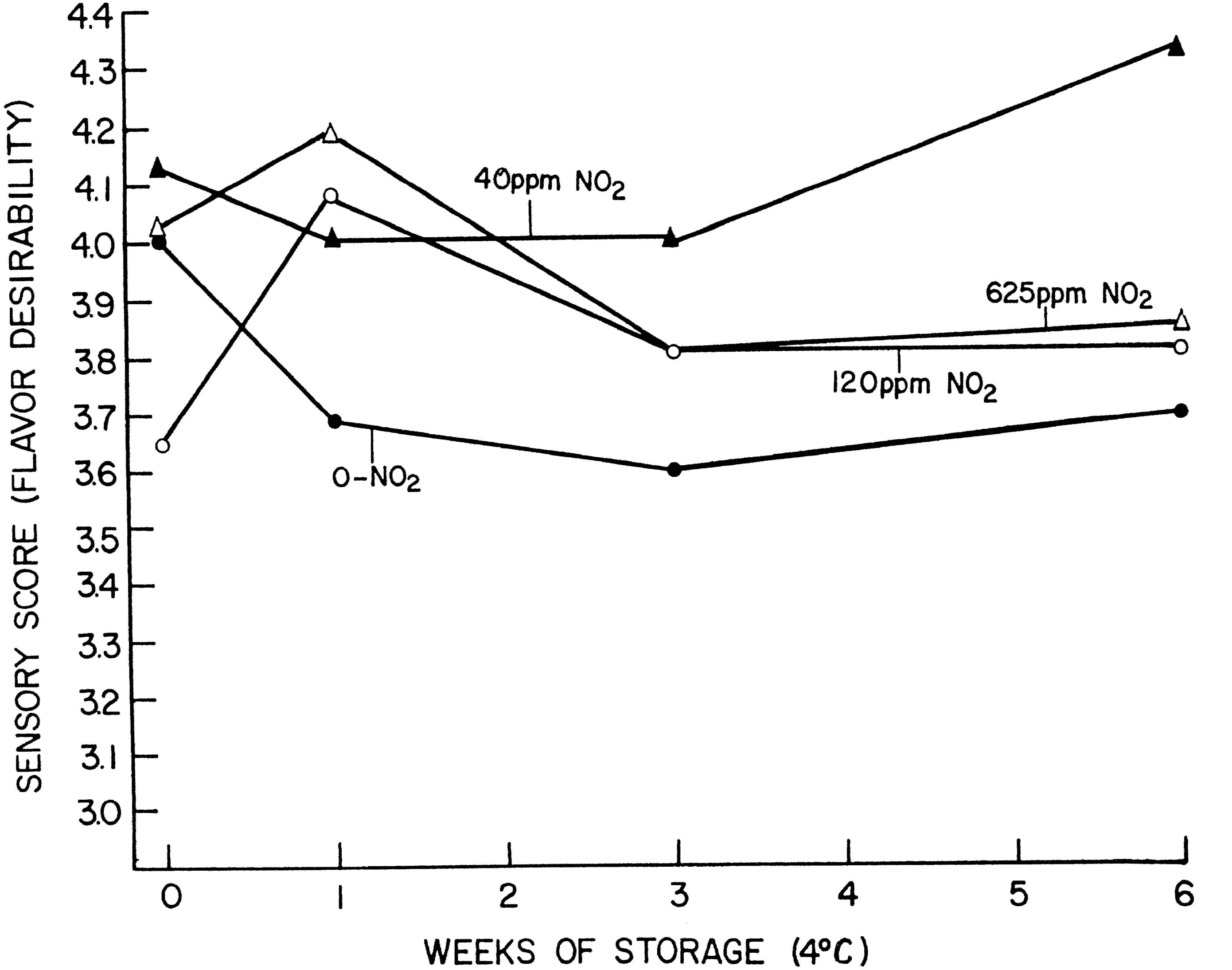
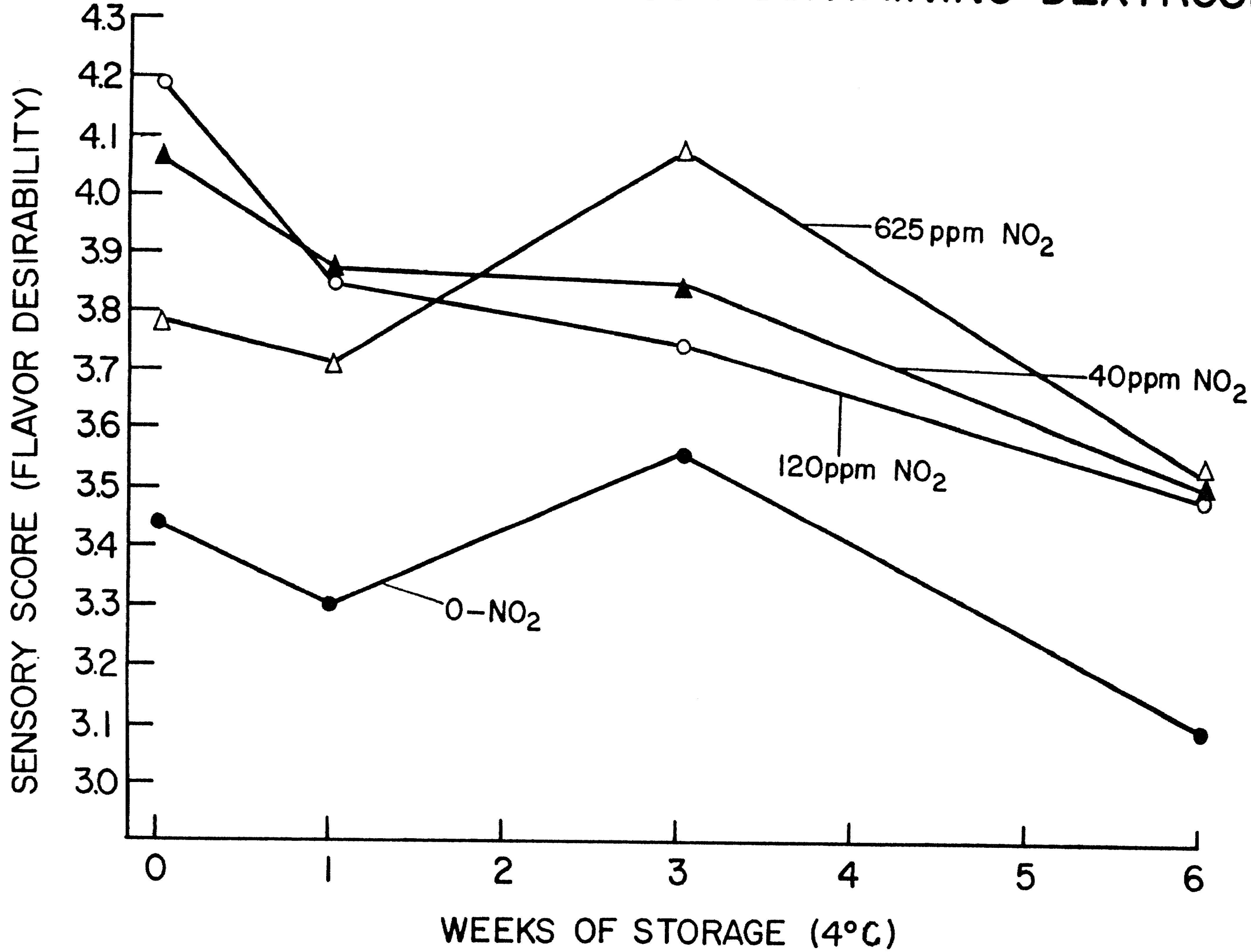


FIGURE 2

INFLUENCE OF NITRITE ON FLAVOR DESIRABILITY OF DRY-SALT CURED BACON CONTAINING DEXTROSE



high or low smoking temperature for all storage periods are given in Table 4. Samples containing sucrose and 625 ppm sodium nitrite had significantly ($P<0.05$) lower counts than those containing sucrose but no sodium nitrite. Other samples containing 625 ppm sodium nitrite were lower than those having less sodium nitrite.

If only nitrite content is considered and data from all storage periods included (Table 5), there was an inverse relationship between sodium nitrite added and total bacterial counts. A similar relationship was found between sodium nitrite concentration and total yeasts and molds counts (Table 6).

Curing with 625 ppm sodium nitrite clearly inhibited bacterial growth on bacon during storage for 6 wk at 4°C compared to samples cured with less sodium nitrite (Figures 3 and 4).

Growth of bacteria during storage at 4°C for 6 wk was greatest for samples processed without sodium nitrite but was not significantly ($P<0.05$) different from that of samples cured with 40 or 120 ppm sodium nitrite.

N-Nitrosamines

The only nitrosamines detected were NDMA, NPIP and NPYR. For samples containing 625 ppm sodium nitrite, the NDMA and NPIP contents averaged 6 and 2 ppb respectively. At the lower levels of nitrite concentration, NDMA concentrations averaged 1.6 ppb and NPIP was not detected. There was an average inhibition of NDMA of 26% by dextrose compared to sucrose.

Contents of the NPYR of bacon as influenced by sodium nitrite added and sugar are given in Table 7. Data for the individual replicates and mean values are given for the various samples. The nitrosamine content increased directly with the amount of sodium nitrite added as expected. The average NPYR content of bacon samples cured with 40 ppm sodium nitrite was less than 10 ppb, the accepted level for commercial brine-cured bacon. The average level of nitrosamine in bacon cured with 120 ppm sodium nitrite was greater than 10 ppb unless the samples were treated with dextrose. All samples processed with 625 ppm sodium nitrite contained NPYR greater than 10 ppb and the mean levels of the nitrosamine for these samples would be unacceptable relative to standards set for brine-cured bacon.

Dextrose inhibited NPYR formation in all except two samples compared to sucrose-containing samples. These results support the conclusions of Mandagere (1979) and Bailey and Mandagere (1980) concerning the inhibition of NPYR by dextrose.

Conclusions

Treatment of dry salt-cured bacon with 40 to 625 ppm sodium nitrite results in bacon that has greater sensory acceptability and lower bacterial counts than similar bacon without sodium nitrite during storage for 6 wk. At least 40 ppm sodium nitrite is necessary to maintain desirable flavor of bacon during storage at 4°C.

Curing with sodium nitrite at 625 ppm essentially retards bacterial growth in dry salt-cured bacon during storage at 4°C for 6 wk, but unacceptable levels of N-nitrosopyrrolidine are formed when this bacon is fried.

Table 4. Influence of treatment on total bacterial plate count.

	NO_2^- (ppm)	Sugar	Processing Temperature	Log_{10} Total Plate Count (Mean)[1,2]
1	0	S	H	2.92[a]
2	40	S	H	2.75[a,b]
3	120	S	H	2.85[a]
4	625	S	H	1.54[c]
5	0	D	H	2.66[a,b]
6	40	D	H	2.70[a,b]
7	120	D	H	2.22[a,b,c]
8	625	D	H	2.19[a,b,c]
9	0	S	L	2.65[a,b]
10	40	S	L	2.49[a,b,c]
11	120	S	L	2.38[a,b,c]
12	625	S	L	1.75[b,c]

[1] N = 16

[2] Means followed by the same letter are not significantly ($P<0.05$) different.

S - Sucrose; D - Dextrose; H - 50°C; L - 33°C

Table 5. Total bacterial plate counts of bacon treated with varying amounts of nitrite[1].

Nitrite added (ppm)	Bacterial counts/g
0	61,090
40	51,042
120	43,605
625	4.908

[1]N = 60

Table 6. Total yeasts and molds of bacon treated with varying amounts of nitrite[1].

Nitrite added (ppm)	Bacterial counts/g
0	45,202
40	6,919
120	22,078
625	474

[1]N = 60

Table 7. N-Nitrosopyrrolidine in cooked dry-cured bacon.

Nitrite added (ppm)	Sugar added	N-Nitrosopyrrolidine (ppb) 1	2	3	4	Mean	% Inhibition by dextrose
40	Sucrose	2.6	7.1	17.9	2.9	7.6	
	Dextrose	2.3	2.5	7.3	6.2	4.6	39.5
120	Sucrose	18.3	4.8	49.5	10.5	20.8	
	Dextrose	2.8	2.2	3.1	8.0	4.0	80.7
625	Sucrose	71.2	18.4	51.2	30.3	42.8	
	Dextrose	47.7	17.6	13.7	45.7	31.2	27.0

FIGURE 3

INFLUENCE OF NITRITE ON TOTAL BACTERIAL PLATE COUNTS OF DRY-SALT CURED BACON CONTAINING SUCROSE

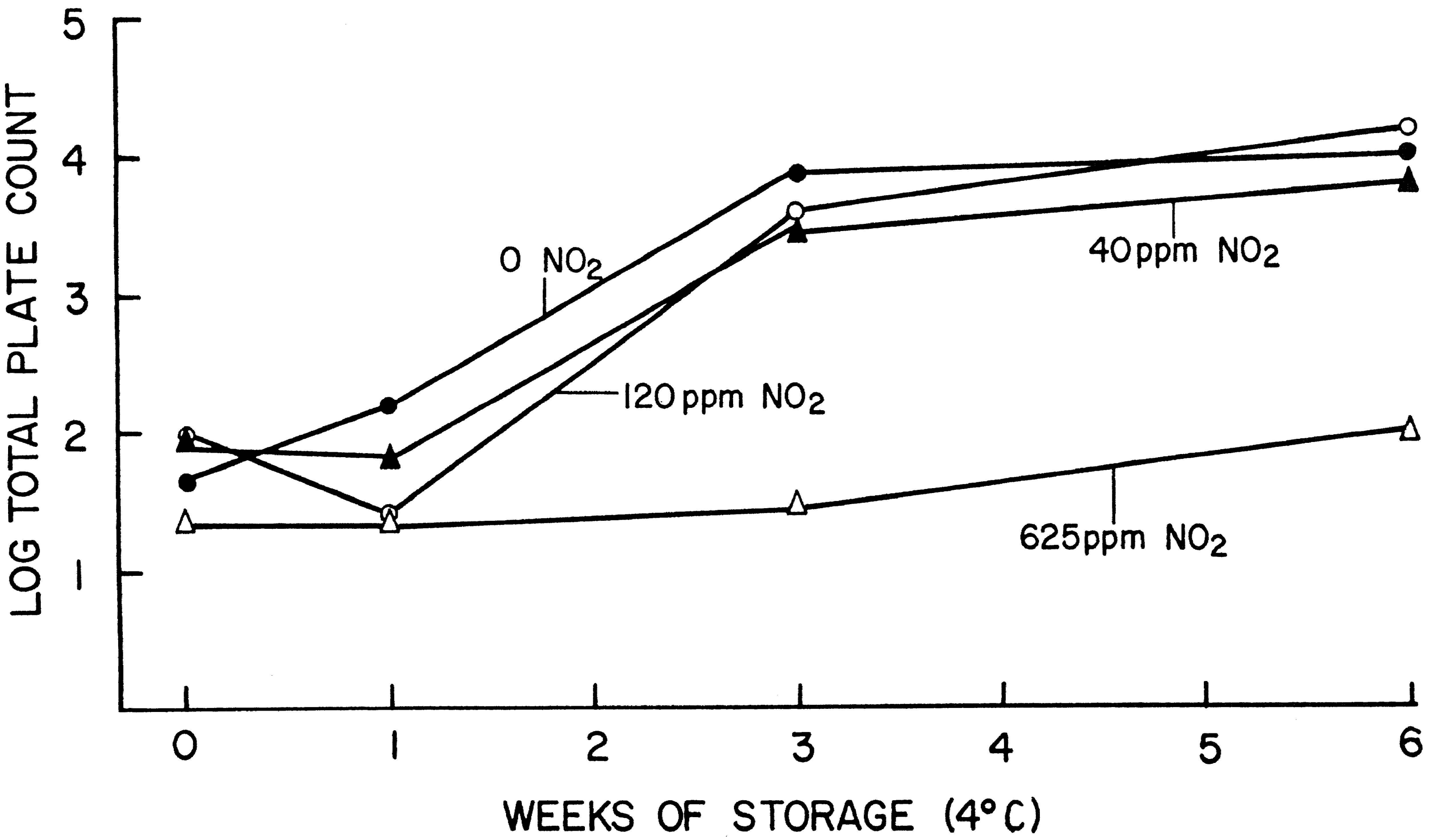
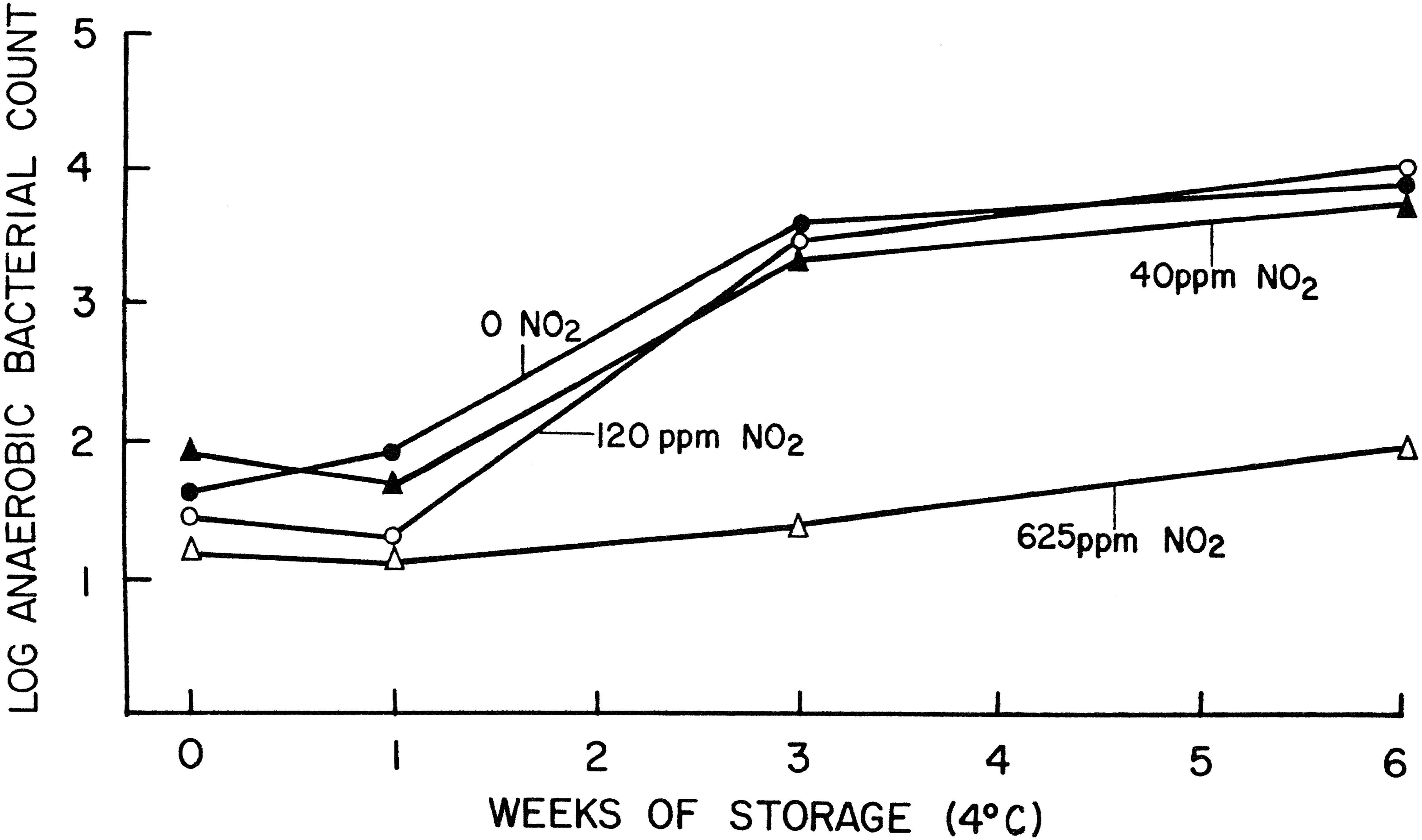


FIGURE 4

INFLUENCE OF NITRITE ON ANAEROBIC BACTERIAL COUNTS OF DRY-SALT CURED BACON CONTAINING SUCROSE



Dextrose (0.6%) inhibits N-nitrosopyrrolidine formation in dry salt-cured bacon compared to equal levels of sucrose and in the presence of this sugar sodium nitrite at 120 ppm does not produce unacceptable levels of nitrosamines.

Acceptable dry salt-cured bacon with storage life to 6 wk at $4^{\circ}C$ can be made with 40-120 ppm sodium nitrite, 550 ppm sodium ascorbate, 0.6% sucrose and 1.5% salt.

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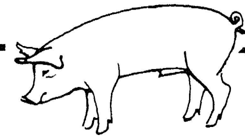

FEEDLOT PERFORMANCE AND SOUNDNESS OF BOARS TESTED ON HEAVIER WEIGHTS[1]

A. L. Goetsch, George Wm. Jesse, J. P. Gerke, R. K. Leavitt and M. R. Ellersieck[2]

SUMMARY

Average daily gain (ADG), feed efficiency (G/G) and structural soundness scores (SS) were analyzed for 538 purebred boars tested at the University of Missouri-Columbia Swine Test Station over a two year period to determine changes in performance parameters and soundness at weights above 230 lbs.

Performance during 30 lb increments of gain after 200 lbs live weight was quite variable and more reflective of the individual's ability to perform at heavier weights than the accumulative data. Durocs and Yorkshires gained fastest while Durocs and Hampshires were most efficient. Correlations of by period gain and efficiency at weights above 230 lbs were not well related to performance prior to 230 lbs.

Subjective soundness scores taken at on-test weights were of limited value in predicting overall soundness at 230 or 290 lbs.

INTRODUCTION

Presently, numerous swine test stations utilize an ending weight of 230 lbs. During the last decade considerable interest has been shown by the industry in the marketing of heavier hogs. This interest can be attributed to an increased per head rearing and slaughtering cost and the development of a later-maturing pig (Christian, 1970). It has been stated that a boar is 20 to 50 lbs heavier than a barrow at the same physiological age (Kuhlers *et al.*, 1976); thus selecting a boar on performance to 230 lbs is in actuality selecting for the performance of a barrow to 180 or 210 lbs.

The purpose of this study was to determine the performance of purebred boars from 230 to 290 lbs. Specific objectives were to investigate growth patterns, average daily gain (ADG), feed efficiency (F/G) and structural soundness.

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[1]Financial support for this study was provided by the Missouri Pork Producers Association.

[2]The authors wish to thank Mr. Ross Hamilton, Mr. Mike Kautz, Drs. J. W. Massey, J. C. Rea and Mr. Lyndle Vanskike for serving on the soundness committee for one or more trials.

PROCEDURES

Data for this study were collected during four separate tests (Summer 1978, Winter 1979, Summer 1979, and Winter 1980) conducted at the University of Missouri-Columbia Swine Test Station. The data collected included production records and visual soundness scores from 538 producer-owned purebred boars with only the Duroc, Hampshire and Yorkshire boars being tested in sufficient numbers to be included in the breed comparison analyses.

For the most part, the boars were handled according to standard operation procedures. All boars received at 18% C.P. ration the first 35 days followed by a 16% C.P. ration. Calcium and phosphorus were calculated to be .80 and .60%, respectively. The pigs were started on test at a pen average of 70 lbs ADG and F/G measures were obtained 35 days after the on-test date and at pen averages of 200, 230, 260, and 290 lbs, dividing determined by a committee of five by visual appraisal on a five point scale (1 = extremely unsound, 2 = unsound, 3 = borderline, 4 = sound and 5 = extremely sound). These scores were made shortly after the on-test date, and at approximate pen averages of 230 and 290 lbs.

RESULTS AND DISCUSSION

Production Traits. Least-squares means for season and breed ADG are presented in Table 2. Accumulative means to 230 and 290 lbs were quite similar (2.04 vs 2.00 lbs, respectively for all boars); however, differences did exist in the by period means which give a more accurate depiction of performance at heavier weights.

Linear regression of ADG on time revealed 35 boars displaying nonsignificant linear slopes. Twenty-two (4.1%) of the total 538 boars possessed negative growth patterns and 13 (2.4%) positive growth patterns (Figure 1). These data indicate that performance testing to 230 lbs did not allow full expression of growth patterns and could lead to inaccurate selection.

Least-squares means for season and breed F/G are shown in Table 3. These means display the typical decrease in efficiency with increasing age and body weight. Accumulative F/G means to 290 lbs (not shown) indicate that Duroc and Hampshire boars were the most efficient while Yorkshires were the poorest converters of feed to gain (2.77 and 2.79 vs 2.85 lbs, respectively).

Phenotypic Correlations. Simple correlation coefficients of average daily gain and feed efficiency by period are presented in Table 4. These values are in agreement with most research. The highest mean relationship observed was -.49 in period V, while smaller coorelation coefficients of -.45 and -.42 were found for periods IV and III. These figures imply that the relationship between gain and efficiency increases with increasing live weight.

Phenotypic correlations between the five periods of gain (Table 5) and feed efficiency (Table 6) reflect that performance at heavier weights is not highly related to performance during earlier periods. The relationship between period III and IV ADG was negative and highly significant (-.23) indicating that faster gaining boars from 200 to 230 lbs tended to gain slower from 230 to 260 lbs. Mean coorelations for F/G between periods I and II, III, IV and V are all positive indicating that more efficient boars from on-test to mid-term were also more efficient to 290 lbs.

The use of stepwise regression to predict boar performance from 260 to 290 lbs from performance to 260 lbs was not reliable. Coefficients of determination ranged from .003 to .223.

Soundness Scores. Correlations of subjective soundness scores at on-test (SS1), 230 lbs (SS2) and 290 lbs (SS3) as shown in Table 7 were determined in an attempt to examine the predictability of feet and leg soundness. Mean "r" values of .39 and .27 for correlations between SS1 and SS2 and SS1 and SS3 indicate that the on-test score was not a useful predictor of soundness at 230 or 290 lbs. However, the correlation between SS2 and SS3 (.62) reveals than an appraisal at 230 lbs is highly related to soundness at 290 lbs.

Conclusions. Based upon this data, it appears that utilization of performance information beyond the standard 230 lb off-test weight will enable a producer to make more rapid progress in his selection for improvement of some of the economically important traits. This is valud however, only if the producer is interested in performance of boars beyond 230 lbs. Perhaps a need exists to determine the relationship of boar performance beyond 230 lbs to the performance of his progeny (barrows and gilts) to 230 lbs or to heavier weights.

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TABLE 1. DIVISION OF TEST BY PERIOD

Period	Start	Finish
I	Day 1	Midterm[a]
II	Midterm	200 lbs.
III	200 lbs.	230 lbs.
IV	230 lbs.	260 lbs.
V	260 lbs.	290 lbs.

[a]Day 35.

TABLE 2. ADG LEAST-SQUARES MEANS[a]

Item	Period				
	I	II	III	IV	V
All boars	1.91	2.15	2.10	2.03	1.80
Breed					
Duroc	1.96[b]	2.18[b]	2.17[b]	2.12[b]	1.80[b]
Hampshire	1.89[b]	2.10[b]	2.08[bc]	2.04[b]	1.71[b]
Yorkshire	1.90[b]	2.20[b]	2.04[c]	2.08[b]	1.80[b]
Season					
Summer	1.89[b]	2.10[b]	2.09[b]	2.05[b]	1.79[b]
Winter	1.94[b]	2.20[c]	2.10[b]	2.00[b]	1.80[b]

[a]Range in number of boars: All boars (538-464), Breed (176-99), Season (285-220).

[bc]Means in the same column by breed or season not having a superscript in common are different (P<.05).

FIGURE 1

GROWTH CURVES BY PERIOD

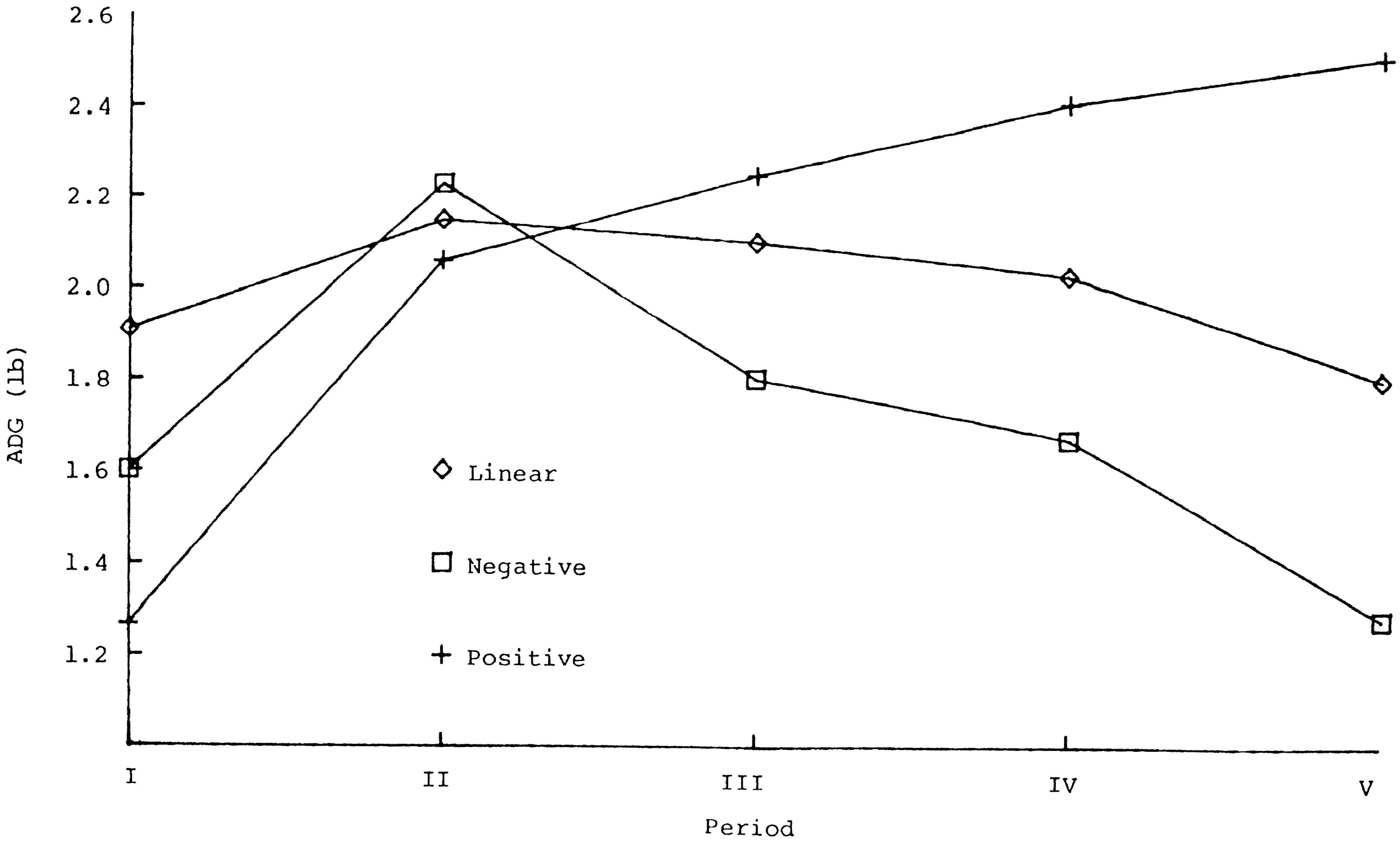


TABLE 3. F/G LEAST-SQUARES MEANS[a]

Item	Period				
	I	II	III	IV	V
All boars	2.33	2.74	3.13	3.45	3.72
Breed					
Duroc	2.28[b]	2.71[b]	3.03[c]	3.28[bc]	3.56[d]
Hampshire	2.30[b]	2.70[b]	3.14[bc]	3.26[c]	3.75[c]
Yorkshire	2.36[b]	2.69[b]	3.30[b]	3.45[b]	3.99[b]
Season					
Summer	2.25[b]	2.69[b]	3.02[b]	3.28[b]	3.44[b]
Winter	2.42[c]	2.79[b]	3.26[c]	3.65[c]	3.98[c]

[a]Range in number of boars: Season (285-221), Breed (176-99), All boars (538-463).

[bcd]Means in the same column by breed or season not having a superscript in common are different (P<.05).

TABLE 4. SIMPLE CORRELATION COEFFICIENTS OF ADG WITH F/G[a]

Period	Period				
	I	II	III	IV	V
I	-.22				
II		-.25			
III			-.42		
IV				-.45	
V					-.49

[a]All "r" values were significant (P<.01).

TABLE 5. SIMPLE CORRELATION COEFFICIENTS OF ADG BY PERIOD

Period	Period II	III	IV	V
I	.33**	.18**	.03	.06
II		.06	.28**	.05
III			-.23**	.04
IV				-.02

**P < .01.

TABLE 6. SIMPLE CORRELATION COEFFICIENTS OF F/G BY PERIOD

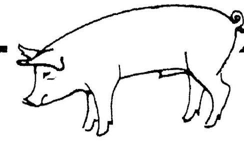
Period	Period II	III	IV	V
I	.20**	.14**	.21**	.10*
II		-.25**	.15**	.05
III			-.09*	.12**
IV				-.12*

*P < .05. **P < .01.

TABLE 7. SIMPLE CORRELATION COEFFICIENTS OF SOUNDNESS SCORES (SS)[a]

Item	SS2	SS3
SS1	.39	.27
SS2		.60

[a]All "r" values were significant (P <.01).



BACKFAT AND LOIN EYE AREA AND THEIR RELATIONSHIP TO PERFORMANCE OF BOARS TESTED TO HEAVIER WEIGHTS[1]

A. L. Goetsch, George Wm. Jesse, J. P. Gerke,
R. K. Leavitt and M. R. Ellersieck

SUMMARY

Data from four tests involving 538 boars tested at the University of Missouri-Columbia Swine Test Station were analyzed to determine backfat (BF) and loin eye area (LEA) and their relationship at 230 lbs and at a heavier than normal test station weight of 290 lbs.

Average BF and LEA at 230 and 290 lbs were .76 in. and 5.68 sq in. and 1.03 in. and 6.46 sq in, respectively. Correlations of BF and LEA for the two measurements were low indicating that prediction of the 290 lb value from the 230 lb measurement is not likely. Correlations of BF and LEA with ADG and F/G were higher at the latter measurements, revealing an increasing relationship with increasing weight.

Linear regression coefficients for BF and LEA on live weight were lower than NSIF values.

INTRODUCTION

During the past couple of decades the primary method of improving the quantitative and qualitative traits of swine has been through genetics. Central test stations are often referred to as "a tool for swine improvement" since they offer the opportunity to test and compare individuals under standardized conditions. Swine test station data and field observations provide evidence of the superior efficiency of leaner, meatier pigs (Christian, 1970).

Relationships regarding the carcass traits at heavier weights have received little research emphasis. Kuhlers et al. (1976) reported that boars were .15 in. leaner than barrows at 150 lbs and .30 in. leaner at 300 lbs. They concluded that to predict the fat depth of barrows at any weight, boars should be tested to a weight 50 lbs heavier than the barrow's slaughter weight.

The purpose of this study was to examine backfat deposition and loin eye size and their relationship to performance at weights above the standard swine test station off-test weight of 230 lbs.

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[1]Financial support for this study was provided by the Missouri Pork Producers Association.

PROCEDURES

Individual daily gain (ADG) and pen feed efficiency (F/G) were determined at day 35 and at pen averages of 200, 230, 260, and 290 lbs dividing the entire test into five periods as shown in Table 1 of the preceeding report. Backfat and loin eye area (LEA) were measured ultrasonically using an Ithaco Scanoprobe (Model 731-A) at pen averages of 230 and 290 lbs. The backfat reported represents an average of three determinations taken approximately 1.5 in. off the midline at the following locations: 1) top of the shoulder - approximately 1 in. posterior and perpendicular to the elbow; 2) last rib; and 3) halfway between the last rib and the base of the tail. Loin eye area was calculated by multiplying longissimus dorsi thickness (inches) at the tenth rib by 2.65.

RESULTS AND DISCUSSION

Carcass Traits. Least-squares means for breed and season are presented in Table 1. Average BF and LEA at 230 and 290 lbs were .76 in. and 5.68 sq in. and 1.03 in. and 6.46 sq in., respectively. As expected, the increase in BF thickness from 230 to 290 lbs was greater than the increase in LEA.

Differences in breed means for BF at both measurements were slight with only Yorkshires carrying significantly less BF ($P < .05$) at both weights (.75 and 1.01 in.). Hampshires possessed the most BF at 230 lbs (.78 in.) and were intermediate at 290 lbs (1.02 in.), while Durocs were intermediate at 230 lbs (.77 in.) and the fattest at 290 lbs (1.05).

Yorkshires possessed the smallest loin eyes at both measurements (5.64 and 6.45 sq in.); Hampshires were largest (5.72 and 6.50 sq in.) and Durocs intermediate (5.70 and 6.48 sq in.).

Phenotypic Correlations. Simple correlation coefficients of BF, LEA, and BF and LEA are presented in Table 2. Correlations of BF to BF and LEA to LEA at different weights were low, indicating that prediction of the 290 lb value from the 230 lb measurements is not likely. The "r" value between BF and LEA at the same measurement was doubled at 290 lbs (.27 vs .15) indicating an increasing relationship with increasing live weight.

Simple correlation coefficients of BF and LEA with ADG and F/G are presented in Table 3. Higher values were at the latter measurement indicate the relationships between performance parameters and the carcass parameters increased with increasing live weight.

Prediction Equations. Linear regression was used to determine LEA and BF adjustment factors for differences in live weight. Currenly, this station as well as many others, use the National Swine Improvement Federation's (NSIF) recommended linear conversions of .004 in. and

.015 sq in. per pound of difference between the desired measuring weight for BF and LEA, respectively. Linear regressions of these data produced conversion figures of .004 in. and .010 sq in. per pound for BF and LEA, respectively. Coefficients of determination were .50 and .38 for BF and LEA, respectively.

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Kuhlers, P. L., L. L. Christian and H. L. Tsou. 1976. Performance differences between boars and barrows taken to heavier weight. Duroc News. Vol. 50, #7:301.

TABLE 1. BF AND LEA LEAST-SQUARES MEANS[a]

Item	BF (in.)		BF (sq in.)	
	230 lbs	290 lbs	230 lbs	290 lbs
All boars	.76	1.03	5.68	6.46
Breed				
Duroc	.77[b]	1.05[b]	5.70[bc]	6.48[b]
Hampshire	.78[b]	1.02[c]	5.72[b]	6.50[b]
Yorkshire	.75[c]	1.01[c]	5.64[c]	6.45[b]
Season				
Summer	.77[b]	1.01[b]	5.66[b]	6.44[b]
Winter	.76[b]	1.05[c]	5.69[b]	6.48[b]

[a]Range in number of boars: All boars (538-381); Breed (176-84); Season (285-174).

[b,c]By period means in the same column by breed or season not having a superscript in common are different (P <.05).

TABLE 2. SIMPLE CORRELATION COEFFICIENTS OF BF, LEA AND BF WITH LEA

Item	BF 290 lbs	LEA 230 lbs	LEA 290 lbs
BF 230 lbs	.13**	.15**	.03
BF 290 lbs		.01	.27**
LEA 230 lbs			.12*

* $P < .05$.
** $P < .01$.

TABLE 3. SIMPLE CORRELATION COEFFICIENTS OF BF AND LEA WITH ADG AND F/G

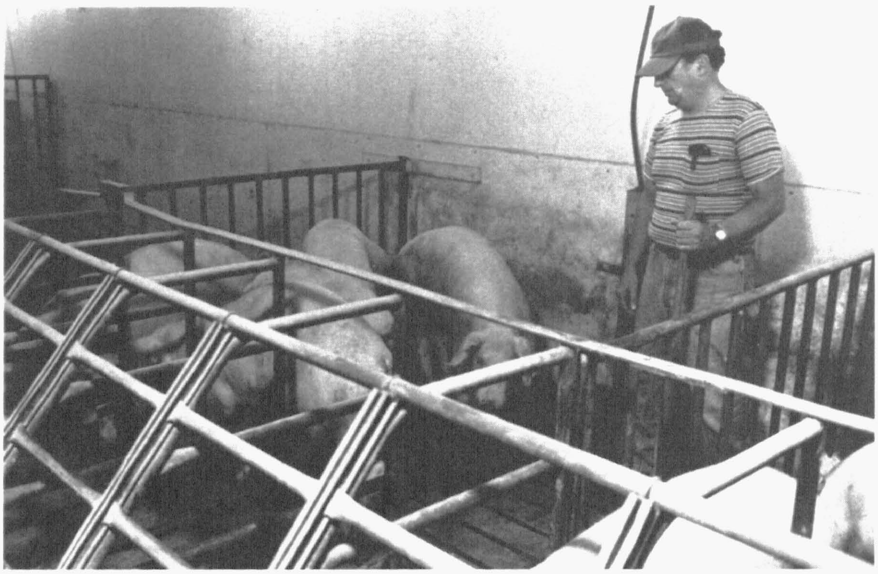
Item	Accumulative ADG		Accumulative F/G	
	230 lbs	290 lbs	230 lbs	290 lbs
BF	.18**	.26**	.05	.15**
LEA	.17**	.37**	-.05	-.17**

**$P < .01$.

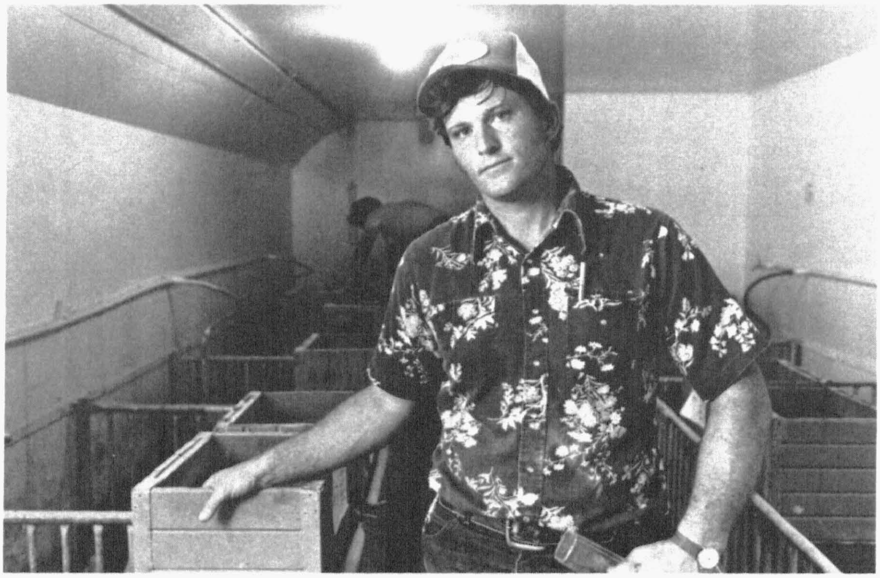
HERDSMEN

S0273

Tom Davison
Chief Animal Technician



Laverne Dowell
Chief Animal Technician



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