REPRODUCTION, LACTATION, AND GROWTH STUDIES WITH SWINE

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TABLE OF CONTENTS

INTRODUCTION

A major problem confronting the swine industry in the United States is the continuing high annual mortality of new born pigs. It is reported by Smith (1937) that more than 34 percent of all pigs farrowed in the United States die before reaching weaning weight. While our knowledge of the factors affecting reproduction and lactation in swine has been greatly increased through research, a thorough evaluation of nutrient requirements of swine for optimum reproduction and lactation is needed. A considerable amount of research has been conducted which demonstrates that many of the common swine rations, particularly rations high in corn and soybean meal, when fed to gilts or sows in drylot or fed under conditions approximating drylot, fail to supply the nutrients essential for normal reproduction and lactation. Corn has long been one of the chief constituents of swine rations. Of recent years, soybean and various other crops producing by-products high in protein have been used to supplement corn. The desirability of feeding milk products, packing house and fish by-products as supplements to corn has been demonstrated by many different experiment stations.

The major portion of these studies involved a determination of the effect of adding various known and unknown nutritional factors to corn-soybean meal type rations in an attempt to improve reproduction and lactation performance of sows. Also, these studies included an investigation of the chemical composition of swine milk as related to feed fed, breed, pig performance, etc. The scope of these studies was broadened to include some aspects of growth of weanling pigs because of concurrent discoveries in the field of swine nutrition.

REVIEW OF LITERATURE

Reproduction and Lactation Studies with Swine

A voluminous amount of published literature pertaining to reproduction and lactation studies in swine is available. This review contains only literature directly pertinent to this investigation.

Ross, et al. (1942-44) and Cunha, et al. (1943) presented reviews of literature with respect to gestation and lactation problems in swine. These workers in a series of experiments with swine and rats fed a basal ration of 76.35 percent ground yellow corn, 17.5 percent soybean meal, 5.0 percent alfalfa meal, 0.5 percent iodized salt, and 0.65 percent calcium carbonate. They concluded that the ration was inadequate for normal reproduction and lactation in swine and in rats. Gilts raised in drylot on this ration failed to suckle their litters adequately to promote normal growth. Many pigs died before weaning while others became emaciated. Normal reproduction and lactation were obtained with both swine and rats upon addition of 10 percent alfalfa meal to the basal ration. Wheat bran, middlings, tankage, yeast, and certain B vitamins added to the basal ration 10 days prior to parturition and for 20 days following parturition did not correct the embryological abnormalities nor stimulate lactation sufficiently to raise pigs to weaning.

Cunha, et al. (1944) continued the experiments initiated by Ross, et al. to determine if certain vitamins or commercial preparations would supplement an all-plant basal ration. These workers were unable to show any supplement other than 10 percent alfalfa meal added to the basal ration which would permit normal reproduction and lactation of swine and rats fed the all-plant ration.

Fairbanks, et al. (1945) fed gilts a basal ration of corn, soybean meal, fish meal, tankage, limestone, steamed bone meal, salt and cod liver oil. The addition of either 6 percent dried corn distillers' solubles, or 10 percent alfalfa meal, or all known B vitamins to the basal ration improved breeding efficiency, fertility and vitality of pigs farrowed. These workers found that the basal ration was inadequate for normal gestation and lactation under drylot conditions. They concluded that nutrient requirements of a sow were most critical during the gestation period and the residual effect of the ration received during gestation was later manifested during lactation.

Spitzer and Phillips (1946) reported a high incidence of sterility, resorption and toxemia among rats fed corn, soybean meal, 5 percent alfalfa meal, Halibut oil, and minerals. Supplementation of additional alfalfa meal, 1:20 liver powder, a combination of casein (crude or acid washed) plus choline or fish meal improved reproduction and lactation. Brewers' yeast, fish press water, and soybean lecithin were variable in their supplemental effects. Wheat bran, wheat middlings, dehydrated oat grass, wheat germ oil and wheat germ meal were ineffective.

Spitzer (1947), using rats, supplemented a basal ration composed largely of corn and soybean meal with minerals, fatty acids, and all known vitamins. When the fortified basal ration was fed, normal reproduction resulted; however, these females failed to lactate. The addition of beef liver, lyophilized pork liver or casein to the fortified ration resulted in marked improvement in lactation. Normal survival rates of the young were not attained when the mothers were fed the fortified basal ration plus lactogenic hormone.

Krider and co-workers (1946a) found that a basal ration containing

17 percent crude protein composed of yellow corn, expeller soybean meal, 5 percent dehydrated alfalfa meal, fortified cod liver oil, and minerals was nutritionally inadequate for gestation and lactation under drylot conditions. Only 26 percent of the pigs, averaging 17.1 pounds, were weaned on this ration. The addition of either 3 or 6 percent sardine condensed fish solubles to the basal ration corrected the deficiency or deficiencies. Survival rates at weaning time were 92 and 71 percent with average weights of 31.1 and 33.7 pounds, respectively. Fall-seeded rye pasture also corrected the inadequacy of the basal ration. Gilts on rye pasture weaned 74 percent of their pigs with a weaning weight of 31.9 pounds each. A residual effect was manifested among gilts on rye pasture during gestation but not during lactation.

Krider, et al. (1946b), using gilts which had been on pasture, corrected the deficiencies of an all-plant ration by supplementing with rye pasture, 1 percent alfalfa meal, and either 2 or 4 percent condensed fish solubles.

Krider, et al. (1946c), using 100 pound gilts that had been fed continuously in dry lot, fed a basal ration composed of 72.5 percent of ground yellow corn, 25 percent expeller soybean meal, 0.5 percent fortified cod liver oil, and 2 percent of a complex mineral mixture plus the following amounts of crystalline vitamins per pound of feed: 1.5 mg. thiamine; 1.5 mg. riboflavin; 5.0 mg. niacin; 6.0 mg. pantothenic acid; 2.5 mg. pyridoxine; and 1.5 mg. choline chloride. The supplements fed with the percentages of pigs weaned and average weaning weight per pig in the six lots were as follows: (1) basal ration, 69 percent, 29.0 pounds; (2) basal ration plus 1.25 mg. pyracin, 136.0 mg. para-amino-benzoic acid, 454 mg. inositol, 0.2 mg. biotin, 2.8 mg. alpha-tocopherol, and 0.4 mg. of vitamin K per pound of diet, 32 percent, 24.4 pounds; (3) basal ration plus 10 percent dehydrated alfalfa meal, 97 percent, 32.4 pounds; (4) basal ration plus 1.5 percent AB liver extract, 82 percent, 34.3 pounds; (5) basal ration plus folic acid concentrate to supply 0.24 mg. of folic acid per pound of diet, 84 percent, 29.1 pounds; and (6) basal ration plus 5 percent "cerogras," 41 percent, 32.2 pounds.

Ensminger, et al. (1947) in feeding a purified ration to sows found that the deletion from the ration of any one of the three B-complex vitamins, i.e., thiamin, riboflavin, or choline resulted in unsatisfactory reproduction and lactation. Gilts receiving no thiamin lost their appetites, farrowed prematurely, and a high mortality of their pigs resulted at birth. When riboflavin was omitted from the ration all pigs were either dead at birth or died within 48 hours thereafter. Abnormalities present were enlarged front legs, generalized edema and hairlessness. Gilts fed the same ration containing no choline farrowed pigs that were weak, had muscular incoordination, fatty livers, and a high incidence of mortality. Cases of hernia, kinked tail, enlarged forelegs, liver and kidney abnormalities occurred in pigs farrowed by sows from the various lots receiving the purified rations.

Cunha, et al. (1948) found that a ration composed of ground yellow corn, expeller soybean meal, tankage, 5 percent dehydrated alfalfa meal, vitamin A and D oil and minerals was nutritionally inadequate for yearling sows and for gilts fed in drylot during gestation and lactation. Only 37 and 9 percent of the pigs were weaned, respectively, by the yearling sows and gilts fed this ration. The addition of either 0.5, 1, or 2 percent of dried fermentation solubles did not correct the deficiency of the basal ration, although a slight improvement was noted. One percent of sardine condensed fish solubles supplied the nutrients needed to correct the first limiting deficiency of the basal ration. In one of four experiments reported by these workers, almost complete lactation failure was observed. These workers reported abnormalities as previously reported by Ross (1944) and Cunha (1944).

Catron, Culbertson, and Shearer (1948) investigated the nutritional adequacy of an all-plant-protein basal ration with swine and rats. The gestation and lactation performance was not improved significantly by the addition of 10 percent high-quality dehydrated alfalfa meal. The addition of animal protein to the basal ration fed the sows during gestation and lactation failed to increase pig livability and growth significantly. Data on blood hemoglobin of pigs failed to reveal any significant differences that might be attributed to rations fed. Chemical analyses of carcasses of pigs from sows fed various rations did not show consistent differences. No definite relationship could be established between the vitamin content of the sows' milk and the livability and growth of pigs. The determination of the gamma globulin content of blood from sows and litters did not reveal differences attributable to treatment.

Cary and Hartman (1946) reported that a few milligrams of concentrated anti-pernicious anemia liver extract was effective in promoting growth of rats on a purified diet containing alcohol-extracted casein and yeast. These workers designated the growth-promoting factor as "Factor X."

Ross, Swank, Ohmen, and MacVicar (1948) studied the reproduction and lactation performance of female rats fed a practical swine ration composed of corn, soybean meal, 5 percent alfalfa meal and all known B-complex vitamins, cod liver oil and minerals. Supplements tested included Wilson's 1:20 liver concentrate powder, alcohol fractions of this liver powder, injectable liver extract (Lederle), alfalfa leaf meal, alcohol fractions of alfalfa meal, vitamin-free test casein, fish solubles and anthranilic acid. The active factor needed for optimum reproduction and lactation was found to be present in Wilson's 1:20 liver powder and in fish solubles. Vitamin-test casein was found to support normal reproduction but was inadequate for lactation.

The work of Cary and Hartman (1946), and Ross et al. (1948) as well as other similar investigations in various laboratories indicated that the rat-nutrition factor in liver, Factor "X", was possibly related to the animal protein factor necessary for poultry and swine, and the antipernicious anemia liver factor essential for human patients.

In the spring of 1948, Rickes et al. (1948), in the United States and E. L. Smith and co-workers (1948) in England announced, independently, that small quantities of a red crystalline compound-vitamin B_{12} or crystalline antipernicious anemia factor had been isolated from liver extract.

ANTIBIOTICS

Cunha and co-workers (1949), using a corn-peanut meal ration, demonstrated a difference in the response of growing swine to vitamin B_{12} concentrates, and concluded that the concentrate prepared by Lederle Laboratories from a Streptomyces aureofaciens fermentation contained vitamin B_{12} plus some other factor or factors.

Jukes, et al. (1950) reported that the antibiotic aureomycin was a constituent of the Lederle APF supplement and that in pure form aureomycin would produce a growth response in pigs.

Since the announcement by Jukes and co-workers that aureomycin supplementation resulted in a growth response in pigs, research in this field has been extensive.

Braude, Wallace, and Cunha (1953) have thoroughly summarized research on the use of antibiotics in swine rations.

PART I

REPRODUCTION AND LACTATION PERFORMANCE OF SOWS FED CORN-SOYBEAN MEAL RATIONS

A. The value of supplementation with vitamins, minerals, antibiotics and crude sources of unknown factors.

Experimental

Five experiments involving a total of 136 gilts and sows and 608 weaned pigs are reported. The basal rations fed during gestation and lactation in each of the experiments are shown in Table 1. Supplements added to the rations are shown in Tables 2, 3, 4, 5, and 6. Liver and lung meal and fish solubles were added to the experimental rations at the expense of the soybean meal on the basis of nitrogen equivalence. All other supplements were added at the expense of the entire ration. All gilts were confined to concrete pens from time of weaning and fed a ration similar in composition to those shown in Table 1 but adjusted for increased protein requirement. From breeding through lactation, all experimental animals were fed the variously supplemented rations and were confined to concrete pens unless otherwise indicated. Animals were allotted on the basis of breed, age, previous treatment and performance.

Gilts and sows were hand-fed during gestation and for ten days following farrowing, but during the remainder of the suckling period, all sows and litters were allowed access to self feeders. A small portion of clean soil was kept before the suckling pigs at all times as an anemia-preventive measure. The pigs were vaccinated for cholera (double immunization) at four weeks of age; castrated at six weeks of age; and weaned and weighed at 56 days of age. Sows and litters were sprayed periodically with benzene hexachloride for the control of lice and mange. The data were subjected to an analysis of variance (Snedecor, 1946).

TABLE 1

Basal Rations Fed During Gestation and Lactation Periods

Ingredients	Expt. 1 Percent	Expt. 2 Percent	Expts. 3, 4, & 5 Percent
Ground yellow corn	82.85	82.85	82.00
Expeller soybean meal (Staley)	11.00	11.00	11.00
Alfalfa meal, 17% dehydrated	5.00	5.00	5.00
Ground limestone	0.65	0.65	
Steamed bone meal			1.50
Salt	0.50		0.50
Iodized salt[1]		0.50	
Crude carotene concentrate[2]		6000 I.U. per lb.	

[1]Potassium iodide was mixed with salt to supply 0.014 percent iodine in the salt.

[2]The crude carotene concentrate was supplied by Valley Vitamins, Inc., McAllen, Texas, and contained 17,500,000 I.U. of carotene per lb. of material.

Experiment 1 (Spring, 1948)

Twenty Hampshire weanling gilts which had suckled sows allowed access to pasture were used in this experiment. The gilts were bred to either a Poland China or Chester White boar.

Experiment 2 (Fall, 1948)

Thirteen Duroc and five Chester White gilts which had suckled sows allowed access to pasture were used. At weaning they were confined to concrete pens and used in a growing-fattening experiment in which a corn ration supplemented with either soybean meal, tankage, or meat and bone scraps was fed. In addition, six yearling Hampshire sows from Experiment 1 that had produced one previous litter and had been fed corn-soybean meal rations since weaning were divided into lots of three sows each. All gilts and sows were fed the basal ration for 60 days prior to breeding. They were bred to a Poland China boar.

Experiment 3 (Spring, 1949)

Four Duroc gilts and at least one crossbred gilt were placed in each of Lots 1, 2, and 3. The Duroc gilts had suckled sows allowed access to pasture but at weaning time were confined to concrete pens and used in a growing-fattening experiment and fed corn rations supplemented with either soybean meal, tankage, or meat and bone scraps. The dams of the crossbred gilts had been confined to concrete pens and had been fed a corn-soybean meal ration during gestation and lactation. The crossbred gilts were fed a corn-soybean meal ration during growth. Sixteen sows from Experiment 2 were retained for Lots 4, 5, 6, and 7 of Experiment 3. All experimental animals were fed the basal ration for 45 days prior to breeding. The test rations were fed at the beginning of the breeding season and continued until the pigs were weaned. All gilts and sows were bred to a Duroc boar.

Experiment 4 (Fall, 1949)

Nineteen crossbred (Poland China x Duroc) gilts produced by the Duroc gilts in Experiment 2 and confined to concrete pens during their entire life were used in this trial. The gilts had been fed a ration of the same components, but in different proportions, as the basal during growth. In addition, nine sows from Lots 1, 2, and 3 of Experiment 3 were retained for this test. All gilts and sows were bred to a Duroc boar. The concrete pens of Lot 2 were washed daily in order to keep coprophagy to a minimum. The other pens were washed twice weekly.

Experiment 5 (Spring, 1950)

Twenty-four gilts produced by the Duroc gilts in Experiment 3 and confined to concrete pens since birth were used in this trial. The gilts had been fed a ration composed of the same ingredients as the basal ration during growth. In addition, eight crossbred sows from Experiment 4 were used in this test. The concrete pens of each lot were washed daily.

Results and Discussion

Experiment 1

The data of Experiment 1 are shown in Table 2. An extremely high percentage of deaths occurred in most litters. Practically all of the pigs exhibited vomiting and diarrhea. Within a few hours the pigs became weak, emaciated, dehydrated, and developed a rough hair coat. The pigs generally nursed until they became too weak to stand, then went into coma, and died. The most consistent autopsy findings were gastroenteritis, congested mesenteric blood vessels, yellowish curd in the stomach, and urate deposits in the kidneys. A typical litter is shown in Figure 1. The percentage of pigs weaned of those born alive was not satisfactory in any lot, although 66.7 percent of the pigs born alive of those gilts fed alfalfa silage (Lot 2) were weaned. The pigs that survived had rough hair coats, rough skins, and appeared unthrifty. The exact cause of high mortality on all rations was not established although it was assumed to be an infectious type of enteritis. High incidence of mortality was observed by Ross et al. (1942, 1944) and Krider and others (1946a) when sows were fed corn-soybean meal rations. However, similar symptoms and high death losses have been attributed to other causes by Doyle and Hutchings (1946).

Fig. 1—A typical affected litter. These pigs were 3 days old when the picture was taken. Of the litter of 9, 2 died before the picture was taken and all of the others died the following day.

The sows of Lot 2 fed alfalfa silage weaned a much higher percentage of the pigs that were born alive; and in addition, the pigs were considerably heavier at weaning than those of Lot 1, whose dams were fed the basal ration. However, one sow in Lot 2 farrowed twelve dead pigs. Stillbirths and resorptions were observed in all lots.

TABLE 2

Experiment 1, Spring, 1948, Rations and Results

Lot	Ration	No. Sows per Lot	No. Sows Farrowed	Percent Weaned of Pigs Born Alive	No. Pigs Weaned Per Sow	Average Weaning Weight, Pounds
1	Basal	5	3	16.7	1.0	19.8
2	Basal ≁ Alfalfa silage ad lib.	4	3	66.7	3.3	26.6
3	Basal ≁ buttermilk, ½ gal. per gilt per day	4	3	27.3	2.0	21.5
4	Basal ≁ 3% liver and lung meal	4	4	0.0	0.0	--
5	Basal ≁ liver extract[1]	2	2	38.9	3.5	23.7
6	Basal ≁ cut green rye forage[2]	1	1	16.7	1.0	7.5

[1] Two cc. (30 U.S.P. injectable units) of Lederle's antipernicious anemia liver extract solution were injected intramuscularly per week into each gilt in Lot 5.

[2] The freshly cut green rye forage was fed ad lib. 14 days before farrowing and during lactation.

Experiment 2.

The data of Experiment 2 are shown in Table 3. Iodine and carotene were added to the basal ration because the incidence of stillbirths and resorptions observed in Experiment 1 suggested that the ration might be deficient in these nutrients. Gilts (Lot 1) and sows (Lot 7) confined to concrete pens and fed the basal ration weaned 84.6 and 81.5 percent, respectively, of the pigs born alive. These livability figures are in direct contrast to those obtained in Experiment 1. Gilts confined to a dirt pen (Lot 5) and fed the basal ration weaned more pigs than those confined to a concrete pen. Gilts (Lot 2) and sows (Lot 8) fed the basal ration supplemented with fish solubles weaned 96.9 and 93.3 percent, respectively, of the pigs born alive. Gilts fed the basal ration supplemented with 10 percent alfalfa meal (Lot 3) or injected with liver extract (Lot 4) weaned a lower percentage of the pigs born alive; but, because larger litters were farrowed, they weaned more pigs per litter than gilts fed the basal ration (Lot 1).

The weaning weights of the pigs in all lots were considered suboptimal. The use of liver extract (Lederle) or fortification of the basal ration with either 4 percent fish solubles, 10 percent alfalfa meal, or 0.5 percent B_{12} supplement No. 1 (Merck) did not significantly increase the weaning weights of the pigs from gilts. Differences in weaning weights among lots were not statistically significant. However, the average weaning weights of pigs suckling sows fed fish solubles were greater than those suckling sows fed the basal ration.

Many of the gilts and sows of this experiment were lame. One gilt in Lot 5 died. Fracture of the vertebrae was found upon postmortem examination, suggesting a possible calcium and/or phosphorus deficiency.

TABLE 3

Experiment 2, Fall, 1948, Rations and Results

Lot	Ration	No. Sows per Lot	No. Sows Far-rowed	Percent Weaned of Pigs Born Alive	No. Pigs Weaned Per Sow	Average Weaning Weight, Pounds
Gilts						
1	Basal	4	3	84.6	7.3	19.8
2	Basal ≁ 4% fish solubles[1]	4	4	96.9	7.8	22.8
3	Basal ≁ 10% alfalfa meal	4	2	72.7	8.0	20.9
4	Basal ≁ injectable liver extract[2]	3	2	75.0	7.5	20.2
5	Basal (in dirt lot)[3]	2	2	100.0	8.0	21.2
6	Basal ≁ 0.5% Merck's B_{12} supplement[4]	1	1	100.0	7.0	22.1
Sows						
7	Basal	3	3	81.5	7.3	21.5
8	Basal ≁ 4% fish solubles	3	2	93.3	7.0	26.0

[1] Fish solubles were obtained from James H. Seley and Co., Los Angeles, California.

[2] Two cc. of Lederle's antipernicious anemia liver extract solution were injected intramuscularly per week into each gilt in Lot 4.

[3] One gilt died due to fracture of vertebrae. Pigs were removed from gilt 7 days prior to weaning date.

[4] Merck's B_{12} Supplement No. 1 was a mixture of crude B_{12} concentrate, charcoal and soybean flour which, according to the manufacturer, had a B_{12} activity of about four times that of fish solubles.

Experiment 3

The good survival rates obtained in all lots of Experiment 2 contrasted with those of Experiment 1 suggested the possibility that in Experiment 2 the addition of iodine or the crude carotene concentrate in the basal ration might have been beneficial. One phase of Experiment 3 was designed to study specifically the supplemental effects of iodine and vitamin A. A summary of results is given in Table 4. The addition of iodine, or iodine plus vitamin A, to the basal ration failed to improve the reproduction and lactation performance of gilts. In this experiment, the survival rates were excellent but the weaning weights were suboptimum. No appreciable differences were observed in the weaning weights or survival rates among the pigs suckling sows in Lots 4, 5, 6, and 7. Differences in weaning weights among lots were not statistically significant.

The addition of 1.5 percent steamed bone meal to the rations resulted in less lameness than was observed in Experiment 2. This suggests that the basal ration fed in Experiments 1 and 2 may have been suboptimal in calcium and/or phosphorus.

Experiment 4

The data of Experiment 4 are presented in Table 5. In this experiment the sows and gilts of the lot fed the basal ration raised more than 80 percent of the pigs given them to suckle. The performance of the gilts and sows fed an identical ration but confined to pens which were washed daily (Lot 2) was definitely inferior to the performance of those confined to pens washed twice weekly. Since it was observed in all experiments that the confined animals occasionally consumed a portion of their droppings, it may be that coprophagy is

TABLE 4

Experiment 3, Spring, 1949, Rations and Results

Lot	Ration	No. Sows per Lot	No. Sows Farrowed	Percent Weaned of Those Given To Raise[1]	No. Pigs Weaned per Sow	Average Weaning Weight, Pounds
Gilts						
1	Basal	6	5	92.5	7.4	22.2
2	Basal ≠ iodine	5	3	95.5	7.0	21.2
3	Basal ≠ iodine ≠ vitamin A	5	5	92.1	7.0	21.6
Sows						
4	Basal ≠ iodine ≠ vitamin A	4	4	96.9	7.8	23.4
5	Basal ≠ iodine ≠ crude carotene	4	4	87.5	7.0	26.9
6	Basal ≠ iodine ≠ vitamin A ≠ 4% fish solubles	4	4[2]	95.8[3]	7.7	24.9
7	Basal ≠ iodine ≠ vitamin A ≠ Merck's B_{12} Supp. No's. 1 and 2	4	4	100.0	7.0	23.1

The supplements indicated were fed as follows: Iodine - Potassium iodide was mixed with salt to supply 0.014 percent iodine in the salt. Vitamin A — supplied in form of halibut liver oil secured from Thompson Hayward Chemical Co., added to the feed to supply 6000 I.U. of vitamin A per pound of feed. Crude carotene concentrate — added to the feed to supply 6000 I.U. of carotene per pound of feed. Merck's B_{12} concentrate No. 1 - fed at a rate of 0.5 percent. No. 2 was fed at a rate of 1.25 percent. No. 2 was used because an insufficient supply of No. 1 was available to complete the trial. No. 2 was a Fuller's earth adsorbate containing soybean meal as a diluent which, according to the manufacturer, had an activity of 1.7 gamma of B_{12} per gram of material.

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[1] This refers to the number of pigs actually charged the sow to raise. All litters were decreased to 8 pigs at 5 days of age. Example: if a sow farrowed 10 live pigs, the number of pigs was reduced to 8 and she was charged with raising 8 pigs. If a sow farrowed 6 live pigs and one died 2 days after farrowing, the sow was charged with raising 6 pigs.

[2] One sow died of unknown causes. All pigs in this litter died.

[3] Based on number of sows that completed the experiment.

a factor of major importance in such studies. It has been reported that a factor(s) is present, under favorable environmental conditions, in the feces of certain species of animals which will increase growth of rats and chicks, and increase hatchability of the eggs from the hens fed a corn-soybean meal ration. The climate of Oklahoma is such that microbial growth could continue in the feces for considerable period of time after defecation. Such an environment may not exist in more northerly states during the early spring and late fall farrowing seasons.

TABLE 5

Experiment 4, Fall, 1949, Rations and Results

Lot	Ration	No. Sows per Lot	No. Sows Farrowed	Percent Weaned of Those Given To Raise[1]	No. Pigs Weaned per Sow	Average Weaning Weight, Pounds
1	Basal - pens washed twice weekly	8	6	82.6	6.3	24.4
2	Basal - pens washed daily	7	7	59.2	4.1	21.9
3	Basal ≁ 4% fish solubles	7	5	94.7	7.2	19.2
4	Basal ≁ 0.5% Merck's B_{12} supplement 3[2]	6	4	96.2	6.3	28.8

[1] This refers to the number of pigs actually charged the sow to raise. All litters were decreased to 8 pigs at 5 days of age. Example: if a sow farrowed 10 live pigs, the number of pigs was reduced to 8 and she was charged with raising 8 pigs. If a sow farrowed 6 live pigs and one died 2 days after farrowing, the sow was charged with raising 6 pigs.

[2] A Fuller's earth adsorbate which, according to the manufacturer, had an activity of 12.5 mg. of vitamin B_{12} per pound.

There were highly significant differences in weaning weights among the four lots. The gilts and sows fed fish solubles (Lot 3) raised more pigs than gilts and sows fed the basal ration (Lot 1). Contrary to the results obtained in Experiments 2 and 3, the weaning weights of pigs suckling gilts and sows fed fish solubles were lower than those of pigs suckling gilts and sows fed the basal rations. This difference may have been due to the larger number of pigs suckled by the gilts and sows fed fish solubles.

The sows fed Merck's B_{12} Supplement No. 3 (Lot 4) weaned a higher percentage of pigs than those fed the basal ration. The pigs were also heavier at 56 days of age. These results are in agreement with those reported by Van Poucke, et al. (1950) and by Anderson and Hogan (1950).

The pooled average survival rate of 78 percent obtained on the basal rations in Experiments 2, 3, and 4 was considerably higher than those reported by Ross et al. (1944), Cunha et al. (1944), and Krider et al. (1946a). They employed basal rations that were similar to those fed in these experiments. No logical explanation is available for these differences. The previously mentioned climatic conditions at this experiment station might have favored synthesis of a missing factor in the droppings.

Experiment 5

During this experiment an infectious type of digestive disturbance was encountered. Diarrhea was evident in sows and pigs in all lots. The diarrhea was less severe in sows and pigs fed the basal ration plus B-vitamins (Lot 2) and the APF supplement containing vitamin B_{12} and aureomycin (Lot 4) than in the other lots.

The lactation performance of gilts and sows was unsatisfactory in all lots. Mortality was extremely high among pigs suckling sows fed the basal ration (Lot 1) and basal ration supplemented with riboflavin, niacin, calcium pantothenate and vitamin B_{12} (Lot 3). The infectious type of digestive disturbance was considered the primary cause of excessive death losses rather than inadequate nutrition of the sows and pigs. Although the gilts and sows fed the basal ration plus B-vitamins (Lot 2) weaned about as many pigs as those of Lot 4, the average weaning weight was 8.5 pounds less than that of the pigs raised by the sows of Lot 4. In addition, many of the pigs in Lot 2 died shortly after weaning. The results of Experiment 5 are given in Table 6.

TABLE 6

Experiment 5, Spring, 1950, Rations and Results

Lot	Ration	No. Sows per Lot	No. Sows Farrowed	Percent Weaned of Those Given to Raise[1]	No. Pigs Weaned per sow	Average Weaning Weight, Pounds
1	Basal	8	7	39.2	2.9	17.9
2	Basal + B-Vitamins[2]	8	6	73.8	5.2	18.9
3	Basal + V-Bitamins + B_{12} supplement[3]	8	5	34.6	1.8	23.1
4	Basal + B-Vitamins + B_{12} and aureomycin[4]	8	8	73.4	5.9	27.4

[1] This refers to the number of pigs actually charged the sow to raise All litters were decreased to 8 pigs at 5 days of age. Example: If a sow farrowed 10 live pigs, then the number of pigs was decreased to 8 and she was charged with raising 8 pigs. If a sow farrowed 6 live pigs and one died 2 days after farrowing, the sow was charged with raising 6 pigs.

[2] Supplements were added as follows: Riboflavin, 2.5 mg. per lb. of feed; nicotinic acid, 15 mg., and calcium pantothenate, 10 mg.

[3] Fed at the rate of 0.5 percent of the ration as a source of B_{12}.

[4] Fed at the rate of 1.0 percent of the ration as a source of B_{12} and aureomycin.

The weaning weights of the suckling pigs in all lots were suboptimum. Pigs suckling sows fed the ration containing aureomycin (Lot 4) were heavier at 56 days of age and were thriftier and sleeker in appearance than pigs from the sows of the other lots.

The occurrence of the digestive disturbance makes interpretation of the data difficult from the standpoint of nutritional adequacy of the rations. It would appear that feeding sows a corn-soybean meal ration plus B-vitamins and a supplement containing vitamin B_{12} and aureomycin provided considerable protection for the sows and their pigs against this disorder. Suckling pigs were allowed access to the self-feeders, and it was observed that the pigs consumed some of the feed fed the sows of the respective lots. It is possible that the better appearance and heavier weight of the pigs of Lot 4 might have been due to the consumption of feed containing aureomycin. It has been demonstrated by Maddock et al. (1952) however, that sows fed aureomycin secrete some of this antibiotic in the milk, which in this trial might have afforded some protection against digestive disturbances.

Summary

Data are presented concerning the adequacy of a corn-soybean meal ration, as well as the value of several supplements, for reproduction and lactation of the sow. The livability of pigs from sows of all lots fed corn-soybean meal rations in the spring of 1948 was very low; this was attributed to a severe digestive disturbance in the suckling pigs.

Sows in the three subsequent experiments fed basal rations composed of ground yellow corn, expeller soybean meal, alfalfa meal, salt, and minerals weaned an average of 78 percent of their pigs. The weaning weights were considered suboptimal.

Fortification of the basal rations with fish solubles increased survival rates of the young in all experiments and increased weaning weights in two out of three experiments.

The performance of gilts and sows fed the basal rations during reproduction and lactation was as good as that of gilts and sows fed basal rations fortified with either 10 percent alfalfa meal, iodine, vitamin A, or B_{12} supplements No. 1 and 2 (Merck) or injected with liver extract (Lederle).

Gilts and sows fed a corn-soybean meal ration supplemented with B_{12} Supplement No. 3 (Merck) raised a higher percentage of pigs than the sows fed the basal ration, and the pigs weighed slightly more at weaning.

Sows fed a corn-soybean meal ration and confined to pens which were washed daily, raised fewer pigs than sows fed the same ration but confined to pens which were washed twice per week. Slightly lower weaning weights were also obtained. Sows confined to a dirt pen during the experimental period raised a higher percentage of pigs than sows confined to a concrete pen. These differences may have been due to the sows obtaining a factor(s) from the droppings necessary for normal reproduction and lactation.

Lameness of the gilts and sows was less prevalent when 1.5 percent steamed bone meal replaced 0.65 percent ground limestone in the basal ration.

The addition of aureomycin to the basal ration in Experiment No. 5 was beneficial in increasing survival rates and weaning weights of the young. The beneficial effect of aureomycin supplementation might have been due to its therapeutic effect on an outbreak of an infectious type of digestive disturbance among the sows and pigs in Experiment 5.

Of the 136 gilts and sows involved in the five experiments, 23 failed to conceive or show signs of estrus.

PART I

B. The toxicity and nutritional adequacy of milk from sows suckling pigs showing symptoms of baby pig disease.

Observations

During recent years a high percentage of the death losses of pre-weaning swine have been attributed to the malady "baby pig disease." Symptoms of pigs reported having the so-called "baby pig disease" are varied but, in general, have followed a rather definite pattern. It has been suggested that a toxic substance was present in the milk of sows nursing pigs having the disease. It had been also suggested that a deficiency of some nutrient or nutrients may occur in the milk of some sows, under certain conditions, causing the symptoms of the disease. The object of this study was to investigate the possibility of the presence of a toxic substance or the lack of some dietary essential in the milk of sows nursing pigs having the disease by rat bioassay.

In the spring of 1948, (Experiment 1, previously described), virtually all pigs from 16 gilts fed experimental corn-soybean oil meal rations developed symptoms sometime during the suckling period similar to those described by R. Graham et al. (1941); J. Sampson et al. (1942); L. L. Madsen et al. (1944); L. P. Doyle et al. (1946); G. A. Young, Jr. et al. (1948). A high percentage of deaths occurred in most litters. The first noticeable symptoms were vomiting and diarrhea. Within a few hours, the pigs became weak, emaciated, dehydrated, and developed a rough hair coat. The pigs generally nursed until they became too weak to stand, then went into coma and died. The most consistent autopsy findings were gastroenteritis, congested mesenteric blood vessels, yellowish curd in the stomach, and urate deposits in the kidneys.

Experimental Procedure

Milk samples were obtained from the lactating gilts by the intravenous injection of 1 to 2 cc. of pitocin (Parke, Davis & Co.) as described by Whitehair et al. (1948), and Braude et al. (1947). Milk was collected during the period in which the most severe symptoms were noted in the baby pigs.

Milk samples were frozen immediately in sealed containers. To test the milk for toxicity or for a deficiency of a nutrient or nutrients, the milk, supplemented with iron, copper, and manganese, was fed ad libitum to weanling rats. No water or food other than the milk was supplied to the rats. Milk was also obtained from a sow in a separate herd free of disease and was fed to a second group of rats; this sow raised 10 healthy pigs to an average weaning weight of 38 pounds. For purposes of comparison, a third group of rats was fed milk from a Jersey cow. Growth and physical appearance of the rats were used as a measure of toxicity and adequacy.

Results and Discussion

Tables 7 and 8 summarize the death loss data of the pigs from the 16 sows.

None of the rats (Table 9) exhibited any apparent toxic effects from the milk of sows nursing diseased pigs. Significant growth differences among the lots were not observed. Similar results were reported by Whitehair et al. (1948). The growth rates given in Table 9 suggest that the supplemented milk from the experimental sows was nutritionally adequate for the rats.

TABLE 7

Mortality

Number of sows	16
Number of litters born	16
Number of pigs alive at birth	104
Number of pigs that died from birth to weaning	78
Percent of pigs that died from birth to weaning	75

TABLE 8

Age Death Occurred

Days from Birth until Death	Number of Pigs	Percentage Death Loss
1 - 5	44	56.4
5 - 10	16	20.5
11 - 15	10	12.8
16 - 30	7	9.0
31 - 56	1	1.3
Total	78	100.0

TABLE 9

Effect of Milk Fed Ad Libitum Supplemented with Iron, Copper, and Manganese[1]

Source of Milk	Number of Rats	Weeks on Experiment	Percentage Death Loss
Jersey cow	4	4	30.3
Control sow (raised 10 healthy pigs)	3	4	28.5
Experimental sows suckling affected pigs	10	4	30.7

[1]Five, one, and one mg., respectively, per 100 ml. of milk

Summary

A severe digestive disturbance occurred in suckling pigs from 16 experimental sows. Symptoms observed were diarrhea, vomiting, emaciation, dehydration, rough hair, coma, and death.

Seventy-five percent of the suckling pigs died before reaching weaning age and 56 percent of that number died at 5 days of age or younger.

Toxic substances or nutritional deficiencies could not be demonstrated in the milk of sows nursing "diseased" pigs, when the milk was fed to rats for a period of four weeks.

PART II

A STUDY OF THE CHEMICAL COMPOSITION OF SWINE MILK

Introduction

Knowledge of the nutritive properties of sow's milk is limited. It is necessary that we know more about the relationship between baby pig losses and properties of the dam's milk. Information is needed on the effects of ration, season, breed, and age on the nutrient content of sow's milk. Such information would be very valuable for compounding formulas for artificial rearing of pigs or for providing supplements for suckling pigs.

This portion of the thesis was previously published in the form of two journal articles in the Journal of Nutrition. These articles are reproduced here verbatim.

A. Major constituents and carotene, vitamin A and vitamin C

Because milk is the principal source of nutrients to the young during the lactation period, its major constituents have been determined for many species of animals. Until recently it has not been possible to obtain satisfactory milk samples from sows for chemical analysis. The stimulatory effect of injections of the oxytocic principle of the pituitary, however, has provided a means whereby representative samples of the whole milk can be readily obtained. Using such a technique, Braude et al. ('47) were able to obtain samples adequate for analysis, and the results of their investigations constitute the first reliable information on the composition of the milk of this species following a complete milking. More recently, Bowland and others ('49a,b) have studied the effect of the plane of nutrition on the composition of swine colostrum and milk.

In the course of an investigation at this station on the relation of nutrition to the reproduction and lactation performances of swine, samples of milk were collected to determine its chemical composition and nutritive value. It was found by Heidebrecht et al. ('50a) that rats made excellent growth on milk from sows that failed to raise a satisfactory number of pigs to weaning.

This paper reports the percentages of major constituents and the levels of vitamins A and C in milk from sows of several breeds fed a variety of rations.

Experimental

Materials

An experiment designed to study the reproduction and lactation performances of sows confined to concrete pens and fed various rations has been reported by Heidebrecht et al. ('50b). For the present work the milk was collected from the sows in experiments 1, 2, and 3 of this study.

Colostrum and milk samples were obtained for chemical analysis in the spring of 1948 (experiment 1) from 15 Hampshire gilts producing their first litters and one Duroc sow producing her third litter. In the fall of 1948 (experiment 2) milk samples were collected from 9 Durocs, 5 Chester Whites, and 5 Hampshires producing their first or second litters. In experiment 3, the effect of vitamin A and carotene supplementation of the ration upon the vitamin A content of the milk was studied. Milk samples were obtained on the 5th and 25th days of lactation from 10 Duroc and three crossbred gilts, and 4 Hampshire, 3 Chester White and 8 Duroc sows. A detailed account of the methods of management, rations fed, and reproduction and lactation performances of the sows in each experiment has been given by Heidebrecht _et al._ ('50b).

Colostrum was obtained during parturition by manual expression of the udder. Milk samples were obtained on the 5th, 15th, and 55th days of lactation by manual expression following intravenous injection of 1 to 2 ml. of pitocin.[2] The sows were separated from the pigs for a period of approximately two hours prior to milking. The samples were obtained by completely milking the entire udder. Carotene, vitamin A, and ascorbic acid determinations were made as soon as possible after sampling. The remaining portion of the sample was quick-frozen in sealed containers and analyzed later for total solids, solids-not-fat, fat, protein, ash, thiamine, riboflavin, niacin, and pantothenic acid. Colostrum samples were not analyzed for major constituents. The B-vitamin content of the colostrum and milk will be reported in a subsequent paper.

The following analytical methods were employed in this study: total solids, solids-not-fat, and ash were determined by the A.O.A.C. methods; fat by the Mojonnier extraction procedure; protein by the Kjeldahl method, the value for nitrogen being multiplied by the factor 6.38; carotene and vitamin A by a slight modification of the method of Boyer et al. ('44); and ascorbic acid by titration of a protein-free filtrate with a 2,6 dichloro-phenol-indophenol solution.

Results and Discussion

The average values obtained for total solids, fats, solids-not

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[2] Parke, Davis and Co.

fat, crude protein, ash, carotene, vitamin A, and ascorbic acid are given in Table 1.

TABLE 1

Composition of Swine Milk[1]

Component	Colostrum		5th Day		15th Day		55th Day	
	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.	Mean	St.Dev.
Solids (%)			20	2.0	19	1.9	20	2.2
Solids-not-fat (%)			11	0.7	11	1.4	13	2.0
Fat (%)			9	1.7	8	1.5	7	0.9
Crude protein (%)			6	0.8	5	0.6	7	0.9
Ash (%)			0.9	0.09	0.9	0.09	1.3	0.05
Vitamin A (mcg/100 ml)	132	70.7	33	19.1	22	6.2	19	6.6
Vitamin C (mg/100 ml)	19	7.0	13	4.0	11	2.0	11	2.6

[1] A minimum of 22 observations was used in computing the mean values and standard deviations in the above table.

Major Constituents

In comparing the total solid content of the samples collected on the 5th, 15th, and 55th day post partum, the 15th day sample contained the lowest percentage of total solids, protein, and carbohydrate. The fat content decreased throughout lactation, while the ash increased from 0.9% on the 5th to 1.3% on the 55th day. The composition of the milk compared closely with that reported by Braude _et al._ ('47). The protein values were slightly lower than those reported by Bowland _et al._ ('49b).

The mean fat values of the milk were slightly higher than the values reported by Bowland _et al._ ('49a) and Hughes and Hart ('35).

The values reported by the latter workers were based on the Minnesota Babcock method of analysis, whereas the Mojonnier fat extraction method was used in this study. Bowland et al. ('49a) reported that the Mojonnier method resulted in slightly higher fat values than the Babcock method of analysis.

Carotene

Carotene analyses were made only during Experiment 1, 1948. The quantity of ether-soluble yellow pigment (as B-carotene) varied from 0 to 8.9 mcg. per 100 ml. In a majority of milk samples no measurable amount of pigment was present.

Vitamin A

The vitamin A content of the sows' colostrum was high; a marked decrease occurred, however, by the 5th day of lactation and a gradual decrease was noted from the 5th to the 55th days of lactation. The vitamin A value for colostrum from sows in the spring (Experiment 1), 117 mcg. per 100 ml, was lower than during the fall (experiment 2), 145 mcg. per 100 ml. This is of interest because the sows in the fall (experiment 2) received a crude carotene concentrate at the level of 6,000 I.U. per pound of feed. However, for the milk, the values found in the spring and fall were not consistently different.

The vitamin A content of colostrum and milk found by us was similar to that reported by Braude et al. ('46, '47) and by Bowland et al. ('49a,c).

Supplementation of the basal ration with carotene concentrates and vitamin A during Experiment 3 afforded an opportunity to study the effect of such supplementation on the vitamin A content of colostrum and milk. The animals were fed, in addition to the carotene in the basal ration, 6,000 I.U. of either vitamin A (high-potency fish liver oil) or carotene (crude carotene concentrate prepared from alfalfa) per pound of feed. The results of the analyses are presented in Table 2. Supplementation with either carotene or vitamin A was without effect on survival or weaning weights of young from these sows.

TABLE 2

The Effect of Carotene and Vitamin A Supplementation of the Ration on the Vitamin A Content of Sow's Milk

Lot No.	Ration	No. of Samples	Vitamin A 5th day Mean	Vitamin A 5th day St.Dev.	Vitamin A 25th day Mean	Vitamin A 25th day St.Dev.
			mcg/100 ml			
	Gilts--1st lactation					
1	Basal	5	19	4.7	13	0.9
2	Basal ≠ iodine	3	15	2.7	14	2.6
3	Basal ≠ iodine ≠ Vitamin A	5	43	8.0	30	7.1
	Sows--2nd and 3rd lactations					
4	Basal ≠ iodine ≠ Vitamin A	4	58	20.7	28	8.2
5	Basal ≠ iodine ≠ carotene	4	30	7.1	20	6.2
6	Basal ≠ iodine ≠ Vitamin A ≠ fish solubles	3	37	5.1	35	9.7
7	Basal ≠ iodine ≠ Vitamin A ≠ Merck's APF supplements 1 and 2	4	60	15.3	34	8.3
	Average for all gilts and sows					
	No Vitamin A supplementation	8	18	4.6	13	1.7
	Vitamin A supplementation	16	50	15.7	31	7.7
	Carotene supplementation	4	30	7.1	20	6.2

Milk from gilts and sows fed additional vitamin A was approximately three times higher in vitamin A on the 5th day, and twice as high on the 25th day, than milk from sows fed the unsupplmented rations. Milk from sows fed carotene was higher in vitamin A than milk from sows fed only a basal ration but lower than that of sows fed the preformed vitamin. Bowland et al. ('49c) reported that sows on pasture produced milk higher in vitamin A than sows in dry lot. Schofield et al. ('42) reported that the feeding of massive doses of vitamin A to sows late in pregnancy increased the vitamin A content of the colostrum.

Ascorbic Acid

Swine colostrum was found to contain very large quantities of ascorbic acid, 19 mg/100 ml. The vitamin C content had declined by the 5th day of lactation to 13 and was stabilized at 11 in subsequent collections. These concentrations are greatly in excess of those found in the colostrum or milk of other domestic animals. They are, however, in close agreement with the values reported by Braude et al. ('47).

Effect of Ration, Breed, and Age

It was not possible to demonstrate any correlation between the rations fed and the total solids, solids-not-fat, fat, protein, ash or ascorbic acid content of the milk. Considerable individual variation existed between animals within a given treatment, however, and this may have obscured such effects. Supplementation with either vitamin A or carotene increased the vitamin A content of both colostrum and milk. No consistent differences in composition with respect to breed were found; but again, considerable individual variation within a given breed was noted.

Gilts and sows of one and two years of age were used in these studies. Examination of the data failed to reveal any correlation between the composition of the milk and age or number of previous lactations.

Summary

Samples of swine colostrum and milk were collected and analyzed for total solid, solids-not-fat, protein, ash, carotene, vitamin A, fat, and ascorbic acid content. The mean values for the principal constituents on the 5th, 15th, and 55th days of lactation, respectively, were, in percentage figures: total solids, 20, 19, 20; solids-not-fat, 11, 11, 13; fat, 9, 8, 7; protein, 6, 5, 7; ash, 0.9, 0.9, 1.3. The mean vitamin A content was, in micrograms per 100 ml: colostrum, 132; milk 5th day, 33; 15th day, 22; and 55th day, 19. Swine colostrum and milk contained essentially no carotene. The mean ascorbic acid content was, in milligrams per 100 ml: colostrum, 19; milk 5th day, 13; 15th day, 11; and 55th day, 11.

No correlation between the composition of milk and breed or age was found. Supplementation of the ration with materials presumably containing unknown factors was without effect. Addition of vitamin A or carotene, however, produced an increase in the vitamin A content of colostrum and milk.

PART II

B. Thiamine, riboflavin, niacin and pantothenic acid content.

Recent studies of the composition of milk have provided information concerning the B-complex vitamin content of the colostrum and milk of dairy cattle (Lawrence, Herrington and Maynard, '46; Pearson and Darnell, '46), goats (Holmes et al., '45), sheep (Pearson and Darnell, '46) and humans (Coryell et al., '45; Roderuck, Williams and Macy, '45; and Roderuck, Coryell, Williams and Macy, '45). Only fragmentary data concerning the composition of swine milk were available prior to the extensive investigations of Braude et al. ('47).

In the course of investigations in progress at this station (Heidebrecht et al., '50) samples of colostrum and milk from sows and gilts were collected. Advantage was taken of this opportunity to determine the thiamine, riboflavin, niacin and pantothenic acid content of swine milk. A summary of the principal results of these analyses for two successive lactations (spring and fall) is presented in the present paper.

Experimental

Materials

The methods of management and feeding of the experimental animals have been previously described (Heidebrecht et al., '51b). The methods of collecting the samples of colostrum and milk were those described in the previous paper of this series (Heidebrecht et al., '51a). A portion of each milking was frozen and maintained at $-14^{o}C.$ until analyzed.

Methods

Total thiamine was determined essentially as described by Hodson ('45). A 10 ml sample of milk was digested with takadiastase at pH 4.5 for three hours at 50°C., clarified with trichloroacetic acid and filtered. The thiamine was oxidized to thiochrome, extracted with isobutanol and fluorescence measured with a Coleman photofluorometer using an internal standard. Riboflavin was determined microbiologically by the method of Snell and Strong ('39), with minor modifications in the composition of the basal medium. The samples were not subjected to acidic or enzymatic hydrolysis since, in our experience, no material increase in the riboflavin content is observed following such treatment. Nicotinic acid was determined on whole milk by the microbiological procedures of Snell and Wright ('41). Pantothenic acid determinations were made by the methods of Barton-Wright ('45). In accord with the findings of Lawrence, Herrington and Maynard ('46) with cow's milk, enzymatic hydrolysis of samples of swine milk did not result in consistently higher values, indicating that only a small portion of the pantothenic acid is unavailable to Lactobacillus casei.

Results and Discussion

The average thiamine, riboflavin, niacin and pantothenic acid content of colostrum and 5-, 15- and 55-day milk is presented in figures 1 through 4, respectively. In the interpretation of these results, the limitations of microbiological assay procedures should be kept in mind. In such determinations the error is usually assumed to be as high as 10%. In our experience with milk, the deviation between replicate analyses of the same sample assayed at different levels was usually less than this figure for riboflavin and niacin. The photofluorometric

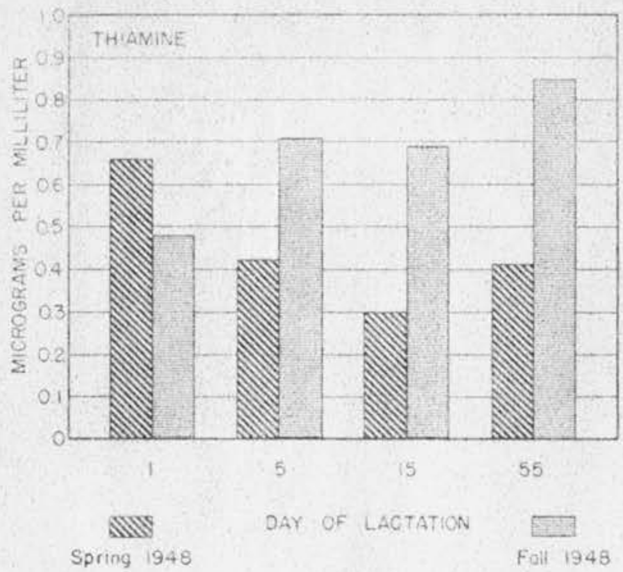

Figure 1

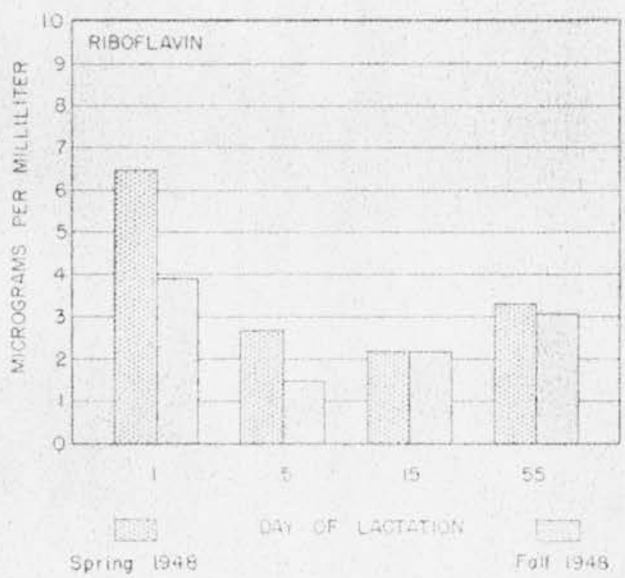

Figure 2

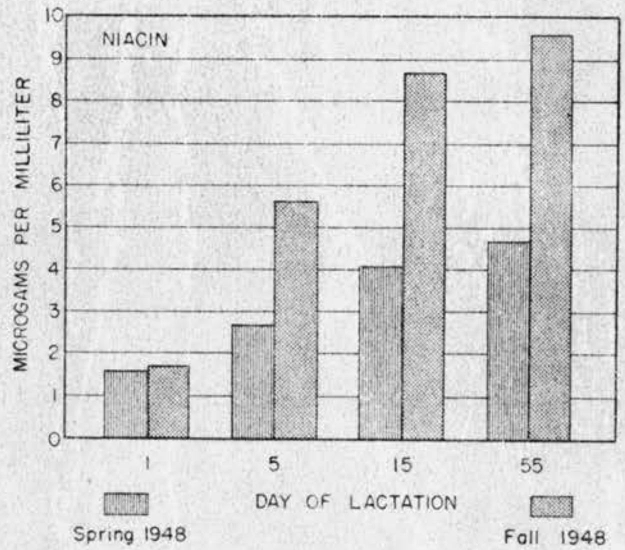

Figure 3

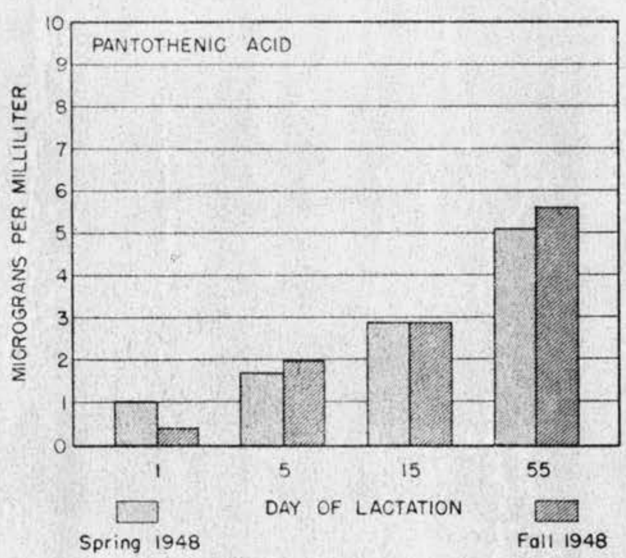

Figure 4

analysis for thiamine was also more accurate than 10%, but this will provide a conservative basis for comparison of the values presented.

Thiamine

The thiamine content of colostrum in the spring experiment was higher than that of the subsequent milk; this trend was similar to that observed by Braude et al. ('47) but the values obtained by these workers were considerably higher for both colostrum and milk. In the fall experiment, the reverse was true. No explanation is presently available for this anomolous observation; ration composition and management practices were essentially the same in both instances. Repeated checks were made in an attempt to rule out procedural analytical errors, with no change in results. Variations in the thiamine content of colostrum of a similar though less extreme nature were noted by Braude et al. ('47), who likewise were unable to account for such changes. In our observations, most of the values fall into the lower range, or below that of 0.52 to 1.01 mcg per milliliter observed by Leucke, Duncan and Ely ('47). The ration fed by these workers, however, was definitely superior to the basal ration used in our studies, and the animals were allowed access to rye pasture prior to farrowing.

The thiamine in the milk showed no marked change after the 5th day, the following content, in micrograms per milliliter, being found: 5th day, $0.6 \neq 0.28$; 15th day, $0.6 \neq 0.28$; and 55th day, $0.7 \neq 0.33$. The values obtained in the fall experiment are comparable to those reported as total thiamine by Braude et al. ('47). The thiamine content of the fall milk was definitely superior to that observed in the previous experiment; again we are unable to present any reason for such a wide difference in composition. It is of interest, however, that these low thiamine and, as will be discussed later, low niacin values were associated with an outbreak of a severe gastroenteritis of unknown etiology which affected the suckling young. No explanation can be advanced for these observations; changes in the vitamin content of the ration were minimized by the fact that all ingredients came from a common lot in the spring and fall.

Riboflavin

The riboflavin content of swine colostrum was higher than that of the subsequent milk in both lactations, averaging 5.0 $\pm$ 2.7 mcg per milliliter as compared with values of from 2 to 3 mcg per milliliter for milk. In this respect the sow resembles the cow and the ewe (Pearson and Darnell, '46), whose colostrum contains appreciably more riboflavin than does the subsequent milk. The values observed in this study are similar to that (4.00 mcg per milliliter) reported by Leucke and co-workers ('47) but much higher than those reported by the English group.

Subsequent to the first few days of lactation, the riboflavin content of milk appears to become stabilized and then rises somewhat throughout the remainder of the lactation period. Average values for all samples were, in micrograms per milliliter, as follows: 5th day, 2.1 $\pm$ 0.9: 15th day, 2.2 $\pm$ 0.9: 55th day, 3.1 $\pm$ 0.7. Again, these values are much greater than those reported by the group at Reading. In an attempt to resolve this obvious conflict in results, collaboration between the two groups of workers was undertaken. The results of these cooperative studies have been previously presented (Davis _et al._, '50) and require only brief comment here. It appears that riboflavin exists in swine milk in a somewhat different form than in cow's milk. Extraction procedures which removed riboflavin from cow's milk failed to effect more than a partial extraction from swine milk. Following incubation of the milk with proteolytic enzymes (clarase and takadiastase), however, determination of the riboflavin in 10 representative samples of milk by a modification of the Conner and Straub ('41) procedure gave an average of 2.2 mcg per milliliter, compared with a value of 2.6 by microbiological assay. Enzymatic treatment of a sample of cow's milk, however, did not result in any material increase in the apparent quantity of riboflavin, as evidenced by little change in the intensity of fluorescence.

Niacin

The niacin content of colostrum was 1.7 ± 0.5 mcg per milliliter. This value was distinctly less than that of milk at any subsequent period during lactation. In this respect the sow resembles the ewe, the milk of which was found by Pearson and Darnell ('46) to contain about twice as much niacin as the colostrum. The only available data on the niacin content of swine milk is that of Leucke et al. ('47), who analyzed the colostrum of 6 sows and found a range of 1.14 to 1.85 mcg per milliliter, with an average of 1.43.

The niacin content of milk was found to increase rapidly during the first few days. Values toward the end of lactation were only slightly higher than those for the 15-day milk. The following niacin content, in micrograms per milliliter, was found: 5th day, 4.3 ± 2.6; 15th day, 7.0 ± 3.9; 55th day, 8.0 ± 4.3. The content of this vitamin in the fall milk was nearly twice as high as that observed in the previous spring, although essentially the same basal ration and the same management practices were being used. In the fall farrowing, however, the enteric disturbance in the pigs which prevailed in the spring was not observed. In order to obtain additional data on the possible relationship between the niacin content of the milk and the growth of the young, samples of milk were collected during the spring farrowing, 1949, on the 5th and 25th day post partum, from 15 sows and 13 gilts, and analyzed for this vitamin. The following results, in micrograms per milliliter, were obtained: 5th day, sows, 4.4 $\pm$ 1.9; gilts, 2.7 $\pm$ 1.9; 25th day, sows, 6.9 $\pm$ 2.9; gilts, 6.7 $\pm$ 2.9. It will thus be seen that milk collected during the spring farrowing of 1949 resembled that of the preceding fall with respect to niacin content. During this spring season the herd was again relatively free of the enteric infection that had persisted throughout the farrowing period the preceding spring. Whether the lower niacin and thiamine content of the milk during this earlier lactation contributed in any way to the incidence of enteritis in the young pigs is unknown.

Pantothenic acid

Examination of the data presented in figure 4 shows that swine colostrum contained only a small amount of pantothenic acid, averaging 0.7 $\pm$ 0.49 mcg per milliliter. This was slightly less than the 1.05 (0.60 to 1.70) found by Leucke et al. ('47). Swine colostrum was found to be lower in this nutrient than the values reported for either bovine or sheep colostrum.

There was a steady increase in the content of this vitamin throughout the whole period, so that near the termination of lactation swine milk contained more pantothenic acid than has been reported in cow's milk. The values observed were, in micrograms per milliliter: 5th day, 1.9 $\pm$ 0.79; 15th day, 2.9 $\pm$ 1.80; and 55th day, 5.4 $\neq$ 3.04.

Effect of ration

Since these studies were conducted incident to the more general problem of unknown nutritive requirements for reproduction and lactation in swine, the basal rations employed were presumably adequate with respect to known vitamins but deficient in some unknown factor or factors. Supplements were added primarily as a source of this factor, although they doubtlessly supplied limited amounts of the members of B-complex for which analyses were made. Careful scrutiny of the data failed to reveal any correlation between the various supplements fed and milk composition. This should not be construed as suggesting that the vitamin content of swine milk is unaffected by ration, but rather that the particular supplements used in these experiments had so little effect that it was obscured by the rather great variability within treatments.

Effect of Breed

Sows and gilts of Duroc, Chester White, Hampshire and crossbred breeding were used in these studies. Examination of the data failed to reveal any obvious correlations between breed and the vitamin composition of colostrum and milk with respect to any of the 4 B-complex vitamins studied. Only a limited number of animals of each breed was available for study, however, and more extensive investigation will be necessary to eliminate the possibility of minor breed differences.

Effect of Age

Both gilts and sows (from one to two years of age) were used in this study. Careful scrutiny of the raw data failed to reveal any consistent differences in the colostrum or milk of gilts or sows. Again, however, the number of animals was limited and small differences may actually exist.

Summary

Colostrum and milk were obtained during two successive farrowing seasons from a total of 35 sows and gilts, and analyzed for thiamine, riboflavin, niacin and pantothenic acid. The average values from all samples of colostrum, in micrograms per milliliter, were: thiamine, 0.6; riboflavin, 5.0; niacin, 1.7; and pantothenic acid, 0.7. The average values for milk at the 5th, 15th and 55th days post partum, respectively, in micrograms per milliliter, were: thiamine, 0.6, 0.6 and 0.7; riboflavin, 2.1, 2.2 and 3.2; niacin, 4.3, 7.0 and 8.0; pantothenic acid, 1.9, 2.9 and 5.4. It was not possible to correlate the composition of colostrum or milk with respect to these vitamins and such factors as age, breed or supplementation of an all-vegetable ration with various materials presumably containing still unknown factors.

PART III

THE VALUE OF ANTIBIOTICS FOR GROWING-FATTENING PIGS

A. The effect of antibiotics, combinations of antibiotics, and vitamin B_{12} and sulfathalidine on unthrifty pigs.

Observations

In experiments in progress, during the spring of 1950, it was observed that pigs allowed access to feed to which was added 1 percent of a supplement containing vitamin B_{12} and aureomycin were much thriftier and healthier in appearance than pigs fed the unsupplemented ration. It was thought that aureomycin in the supplement was beneficial in preventing the occurrence of a non-specific type of enteritis. Cunha, et al. (1949) suggested that Lederle APF supplement contained some growth factor or factors other than vitamin B_{12} which resulted in a marked growth response in young pigs fed a corn-peanut meal basal ration. Later, Jukes et al. (1950) reported data indicating that the antibiotic aureomycin was a constituent of Lederle APF supplement, and that crystalline aureomycin would produce a growth response in pigs. Because of these reports and our observations, an experiment was designed in 1950 to determine the value of feeding certain antibiotics, combinations of antibiotics, and vitamin B_{12} and sulfathalidine to unthrifty pigs.

Experimental

Forty-two unthrifty, weaning spring pigs weighing from 15 to 50 pounds were used in this experiment. They had a persistent type of diarrhea, rough hair coat, and lacked vigor. They were divided into seven lots with respect to weight, age, and physical condition. All were treated with benzene hexachloride for control of lice and mange. All pigs were kept on concrete floors which were washed daily. They were self-fed the various rations shown in Table 1 and had access to automatic waterers. The animals were observed closely throughout the experimental period of 56 days. Only those animals surviving throughout the experimental period were used in calculating the average daily gains. Mortality during the experiment and average daily gains of the survivors are also presented in Table 1.

TABLE 1

Experimental Rations Fed and Results

Lot No.	Rations	No. Pigs per Lot	Mortality	Av. Daily Gain Pigs Completing Exp. (56 da.) Lbs.
1	Basal (Control)	6	5	0.54
2	Basal + 2.5 gms. aureomycin per 100 lbs. feed	6	3	0.87
3	Basal + 2.5 gms. streptomycin per 100 lbs. feed	6	1	1.25
4	Basal + 1.25 gms. procaine penicillin G per 100 lbs. feed	6	2	1.37
5	Basal + 0.75 gms. procaine penicillin G per 100 lbs. feed + 0.625 mg. vitamin B_{12} per 100 lbs feed	6	3	1.06
6	Basal + 1.4% Lederle's APF No. 5 containing vitamin B_{12} and aureomycin	6	1	1.23
7	Basal + 0.2% sulfathalidine	6	3	0.91

BASAL RATION	Percent
Ground yellow corn	69.5
Expeller soybean meal	7.0
Tankage (60% protein)	10.0
Fish meal	2.0
Cottonseed meal	5.0
Alfalfa meal (17% dehydrated)	5.0
Trace mineralized salt (Barton's)	0.5
Steamed bone meal	1.0
	100.0

Results and Discussion

It is apparent from the number of pigs living at the end of the experiment that the addition of each of the drugs used was helpful in promoting survival. Although the number of animals in each lot is insufficient to draw definite conclusions as to the relative merits of any one of the drugs, differences were observed. Most of the deaths in the lots fed the antibiotics or sulfathalidine occurred very early in the experimental period, in many cases within a few days after feeding was begun. It was thought that many of these deaths occurred before the drugs afforded any protection. It would appear desirable to initiate treatment of such unthrifty pigs by administering the drugs in such a manner that the animals would be assured of receiving an adequate dosage until such time as they began to consume the supplemented ration in adequate amounts.

All pigs fed the basal ration had a chronic diarrhea during the entire course of the experiment; many became weak and emaciated and finally died. Pigs that regularly consumed feed containing the various supplements recovered from the enteritis and responded with a marked increase in rate of gain and vigor. Hair coat and general appearance also improved. Pigs fed rations containing antibiotics or sulfathalidine that failed to eat continued to have a chronic diarrhea, became weak, emaciated, and finally died. On the basis of this trial, it would appear that any agent capable of controlling the infection will be helpful in improving weight gains, livability, and general health and vigor.

These data were substantiated later by numerous workers as reviewed

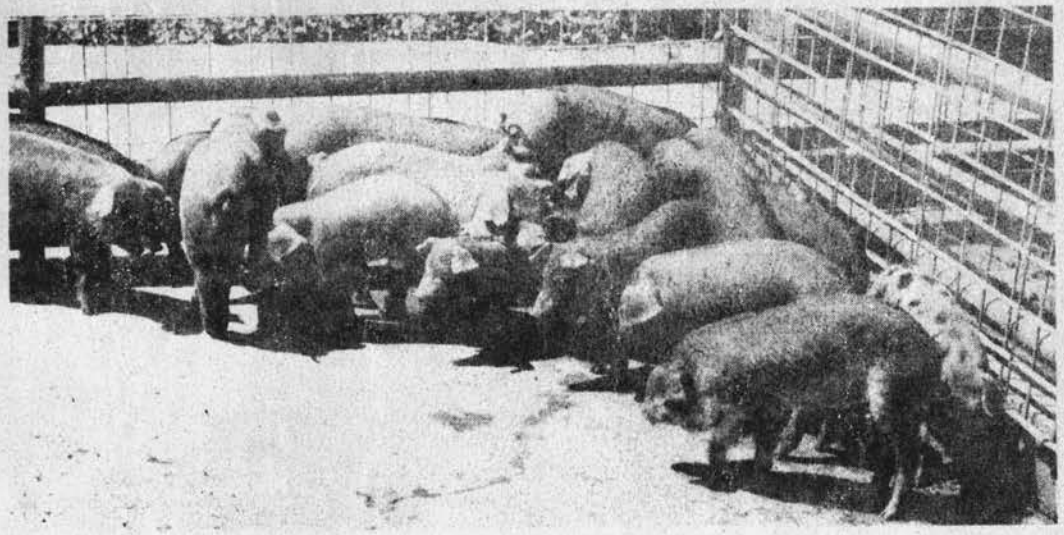

Fig. 1. This group of pigs all had a chronic type of diarrhea. They are typical of experimental pigs in lots 1 and 7. Note the humped back, gauntness, droopy ears, and dry, rough haircoat. Their appetite was poor.

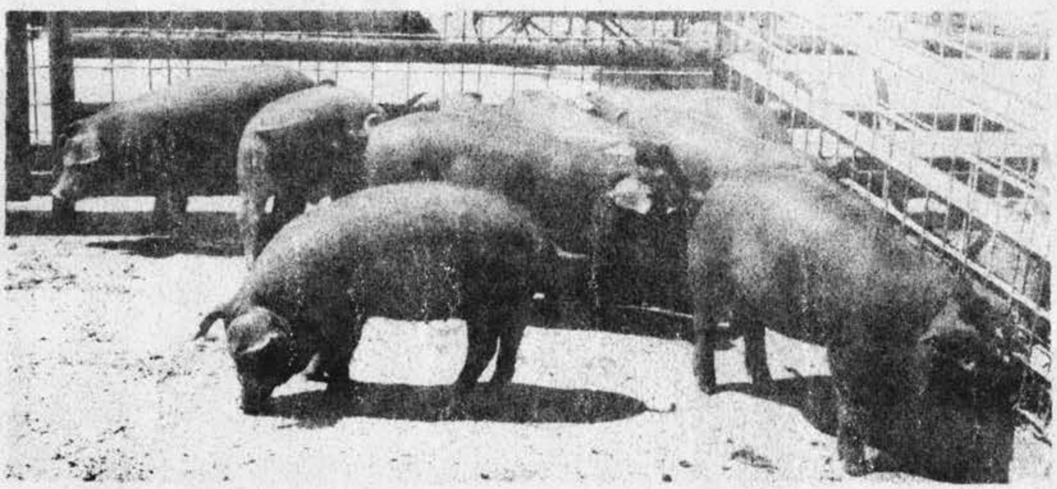

Fig. 2. Group of pigs typical of those fed antibiotic drugs. These pigs were the same age as the pigs shown in fig. 1. Note the healthy haircoat and skin.

by Braude et al. (1953).

Summary

Aureomycin, streptomycin, penicillin, and sulfathalidine had a beneficial effect in the treatment of digestive disturbances in unthrifty pigs. Growth rate increased and the general appearance of the pigs improved.

PART III

B. The effect of various levels of penicillin upon growth of pigs.

Observations

Since it was observed in a previous experiment that procaine penicillin G, when included in a well-balanced ration at levels of 0.75 and 1.25 grams per 100 pounds of ration, afforded some protection against intestinal disturbances in pigs, an experiment was designed to measure the effect of adding various levels of penicillin to a corn-soybean meal ration on growth and efficiency of feed utilization of pigs.

Experimental

Experiment 1

This experiment involved 32 weanling Hampshire pigs farrowed late in the spring of 1950. The pigs were obtained from a herd with no previous history of digestive disturbance or infectious disease. All pigs were wormed with sodium fluoride and treated with benzene hexachloride to control lice and mange before they were placed on test. The pigs were divided into four equal lots. Each pig was placed in a small individual concrete pen and self-fed. The feeding period was the 56 days following weaning; Table 2 gives the experimental rations.

Experiment 2

Twenty Duroc barrows weighing an average of 80 pounds were obtained from a healthy herd for this experiment. The pigs were divided into four equal groups. Each pig was placed in an individual pen and self-fed the rations as indicated in Table 3. Each pig remained on test until a weight of about 225 pounds was reached; the animal was then slaughtered at the college meat laboratory to determine effects of penicillin supplementation on dressing percentage and quality of carcass.

TABLE 2

Rations Fed in Experiment No. 1

Lot No.	Rations
1	Basal ration
2	Basal + 0.125 gms. procaine penicillin G per 100 lbs. ration
3	Basal + 0.250 gms. procaine penicillin G per 100 lbs. ration
4	Basal + 0.500 gms. procaine penicillin G per 100 lbs. ration

BASAL RATION

Ingredients	Percent
Ground yellow corn	70.1
Soybean meal (expeller type)	23.0
Dehydrated alfalfa meal (17% protein)	5.0
Steamed bone meal	1.2
Trace mineralized salt (Barton's)	0.5
Cod liver oil	0.2

TABLE 3

Rations Fed in Experiment No. 2

Lot No.	Rations
1	Basal ration
2	Basal + 0.25 gms. procaine penicillin G per 100 lbs. ration
3	Basal + 0.75 gms. procaine penicillin G per 100 lbs. ration
4	Basal + 1.25 gms. procaine penicillin G per 100 lbs. ration

BASAL RATION

Ingredients	80 to 150 lb. Hogs Percent	150 to 225 lb. Hogs Percent
Ground yellow corn	77.3	83.3
Soybean meal (expeller type)	16.0	10.0
Dehydrated alfalfa meal	5.0	5.0
Steamed bone meal	1.2	1.2
Trace mineralized salt (Barton's)	0.5	0.5
Delsterol (vitamin D_3)	9 grams per 100 lbs. ration to all lots	

Results and Discussion

Experiment 1

A mild chronic type of diarrhea was observed among pigs of all lots; however, it was less severe in pigs fed the higher levels of penicillin. All pigs continued to eat and appeared thrifty regardless of the digestive disturbance.

Pigs fed the basal ration supplemented with 0.125, 0.25, and 0.50 grams of procaine penicillin G gained faster, consumed more feed, and required less feed per unit of gain than pigs fed the basal ration. Pigs fed the highest level (0.5 grams of penicillin per 100 pounds of feed) made slightly more efficient and faster gains than the pigs fed the low and medium levels of penicillin.

TABLE 4

Results of Experiment No. 1

Factor	Lot Number			
	1	2	3	4
Penicillin, gms./100 lbs. feed	0	0.125	0.25	0.50
Pigs per lot	8	8	8	8
Av. No. days on test	56	56	56	56
Av. initial wt., lbs.	36.2	36.4	36.4	36.0
Av. final wt., lbs.	89.1	100.8	101.2	107.1
Av. daily gain, lbs.[1]	0.94	1.15	1.16	1.27
Av. daily feed per pig, lbs.[1]	3.29	3.74	3.62	3.88
Feed required per cwt. gain, lbs.[1]	358.00	316.00	313.00	306.00

[1] The differences among lots with respect to rate of gain, feed consumption, and feed required per unit of gain were not statistically significant at the 5 percent level of probability.

Experiment 2

A diarrhea was noted among some of the pigs fed the basal ration (Lot 1) and the pigs fed the low level of penicillin (Lot 2). Two pigs in Lot 1 and one pig in Lot 2 went "off-feed" and were subsequently treated by oral administration of one gram of streptomycin per pig (one treatment). No digestive disturbances were observed in pigs fed the basal retion supplemented with either 0.75 or 1.25 grams of penicillin per 100 pounds of ration (Lots 3 and 4, respectively).

No appreciable difference was noted in the rate of gain between pigs fed the basal ration (Lot 1) and pigs fed the basal ration supplemented with 0.25 grams of penicillin per 100 pounds of feed (Lot 2). This is contrary to the results obtained in Experiment 1 with the same level of penicillin supplementation. Pigs fed the basal ration in Experiment 2, supplemented with 0.75 grams of penicillin per 100 pounds of feed (Lot 3), gained approximately 0.25 pounds more per day than pigs fed the unsupplemented ration (Lot 1). Further increase in the level of penicillin supplementation to 1.25 grams per 100 pounds in Lot 4 did not result in any further increase in the rate of gain, although the efficiency of feed utilization continued to improve.

The amount of feed required per unit of gain was decreased as the level of penicillin supplementation was increased. The economic value of penicillin supplementation in this experiment could not be estimated because commercial penicillin prices were not available at the time.

There were no noticeable differences among pigs from the four lots with respect to carcass yield and carcass quality. All carcasses were of choice quality.

TABLE 5

Results of Experiment No. 2

Factor	Lot Number			
	1	2	3	4
Penicillin, gms./100 lbs. feed	0	0.25	0.75	1.25
Pigs per lot	5	5	5	5
Av. No. days on test	79	84	71	70
Av. initial wt., lbs.	80.9	80.0	80.7	80.9
Av. final wt., lbs.	221.6	224.2	224.8	224.2
Av. daily gain, lbs.[1]	1.79	1.72	2.03	2.05
Av. daily feed per pig, lbs.[2]	7.20	6.50	7.60	7.30
Feed required per cwt. gains, lbs.	402.00	381.00	376.00	358.00
Dressing percentage	74.00	73.00	73.40	73.20

[1] The differences among lots were statistically significant at the one percent level of probability.

[2] The differences among lots with respect to daily consumption and feed required per unit of gain were not statistically significant.

Summary

Procaine penicillin G added to a ration composed of ground yellow corn, expeller soybean meal, alfalfa meal, trace mineralized salt, steamed bone meal, and a vitamin D supplement tended to increase the rate of growth and the efficiency of feed utilization under the conditions of this experiment. The optimal level of penicillin for growth appeared to be approximately 0.75 grams per 100 pounds of a corn-soybean meal ration when fed to pigs.

PART III

C. The value of adding aureomycin to a good ration for growing pigs.

Considerable concern had been expressed by swine producers as to the practicability of adding antibiotics to well-balanced swine rations fed to healthy growing pigs. The objectives of this study were: (1) to determine the value of adding aureomycin to a good ration for 10-week-old pigs fed to market weight of 225 pounds, and (2) to determine the effect of removal of aureomycin from a good ration to which it had been added until the pigs reached an average weight of 125 pounds.

Experimental

For this experiment, 18 Duroc barrows, about 10 weeks of age and weighing an average of approximately 50 pounds, were obtained from a herd that had no previous history of digestive disturbances. The pigs were divided into three lots. Each pig was self-fed in an individual concrete pen. Table 6 shows the basal rations fed and the supplements are indicated in Table 7.

TABLE 6

Basal Rations

Ingredients	Weight of Hogs - Lbs. 50-100	100-150	150-225
	Percent	Percent	Percent
Ground yellow corn	73.25	78.25	83.25
Tankage	5.00	3.75	2.50
Expeller soybean meal	5.00	3.75	2.50
Cottonseed meal	5.00	3.75	2.50
Fish meal	3.00	2.25	1.50
Dried skim milk	2.00	1.50	1.00
Dehydrated alfalfa meal	5.00	5.00	5.00
Brewer's yeast	0.25	0.25	0.25
Trace mineralized salt	0.50	0.50	0.50
Steamed bone meal	1.00	1.00	1.00
Delsterol (vitamin D_3)	9 grams per 100 lbs. of feed		

Each pig remained in the experiment until a weight of about 225 pounds was reached. The pig was then slaughtered to determine effects of aureomycin supplementation on dressing percentage and carcass quality.

Results and Discussion

The results of this study are given in Table 7.

TABLE 7

Summary of Results

Factors	Lot Number		
	1	2	3
	Basal	Basal + Aureomycin	Basal + Aureomycin until Pigs Weighed 125 lbs.[1]
No. pigs per lot	6	6	6
Av. days on test	91	95	89
Av. initial wt., lbs.	53.1	52.8	53.4
Av. final wt., lbs	224.7	226.2	226.5
Av. daily gain to 125 lbs.	1.64	1.52	1.70
Av. daily gain from 125 lbs. to end of exp.	2.13	2.52	2.17
Av. daily gain. entire exp.[2]	1.89	1.83	1.94
Av. daily feed cons., lbs.[2]	6.50	6.50	6.60
Feed required per cwt. gain, lbs.[2]	345.00	359.00	342.00
Dressing percentage[2]	74.20	75.00	74.20

[1] Basal ration for the remainder of the experiment.

[2] The differences between lots with respect to rate of gain, feed consumption, feed required per unit of gain, and dressing percentage was not statistically significant.

Excellent performance was observed in all lots. No appreciable differences were obtained with respect to daily consumption, feed required per unit of gain, rate of gain, carcass grade, and carcass quality. There were no noticeable differences between lots with respect to vigor or genaral appearance. These results are contrary to those obtained previously when antibiotics were fed to unthrifty pigs with digestive disturbances. According to a review presented by Braude et al. (1953), numerous experiment stations have obtained similar results. Antibiotics have also been shown to improve growth of healthy pigs fed an all-plant ration. It is suggested, therefore, that the response of pigs to antibiotics depends upon the health of the animal and the adequacy of the ration with respect to various nutrients.

Summary

The addition of 0.75 grams of aureomycin per 100 pounds of an adequate ration for healthy pigs during growth to 125 pounds, or during growth and fattening to 225 pounds, did not significantly improve performance.

PART III

GENERAL DISCUSSION

Since 1949, when it was first reported that products derived from antibiotic fermentation promoted growth of pigs, antibiotics have been used extensively in swine rations. There seems to be uniform agreement that antibiotics are of value as demonstrated by a 10 to 20 percent increase in growth and a 2 to 5 percent increase in feed efficiency. These effects are not so marked when fed to strictly healthy swine. Antibiotics have been especially effective under stress conditions, such as infectious diseases, especially digestive disorders, and inadequate rations. On the other hand, Thompson et al. (1952) found that pigs taken by Caesarian operation, raised and maintained in an environment entirely isolated from other swine-raising operations, did not benefit from aureomycin feeding. Limited studies have indicated that antibiotics are ineffective in the ration of chicks raised under germ-free conditions. These recent findings explain and corroborate the results obtained in the experiments involving the study of antibiotics reported herein. The discrepancy in results found in these experiments is undoubtedly due to the "disease level" in the pigs and the type rations fed. Most of the evidence at present indicates antibiotics function in the control of miscellaneous infectious diseases. Whether these substances are true "growth-promoting" factors or whether they allow "normal-growth" by suppressing the growth of pathogenic agents is a question for further study.

Braude et al. (1953), in reviewing the literature on the use of antibiotics, reported that aureomycin, penicillin, streptomycin, terramycin, and bacitracin are effective as growth promoting supplements in swine rations. Under similar conditions aureomycin and terramycin are approximately 30 percent more effective on the average than penicillin, streptomycin, and bacitracin. Antibiotics such as neomycin, subtilin, riniocidin, polymyxin, and chloromycetin have been tested with generally negative results.

A level of 5 to 10 milligrams of antibiotic per pound of total ration is the recommended amount under average swine raising conditions. This level may vary widely depending on the degree of infection existing in the herd and the type of ration fed.

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APPENDIX

TABLE 1

Reproduction and Lactation Performance of Individual Sows
Experiment 1, Spring, 1948

Lot No.	Sow No.	Breed	No. Pigs Born Alive	No. Pigs Born Dead	Average Birth Wt. (Lbs.)	No. Pigs Weaned	Percent Pigs Weaned Born Alive	Average Weaning Wt. (Lbs.)
1	76	Hampshire	9	0	2.8	3	33.3	19.8
	90	Hampshire	6	0	2.4	0	0.0	--
	82	Hampshire	3	0	2.7	0	0.0	--
	80	Hampshire	Failed to conceive					
	94	Hampshire	Failed to conceive					
2	83	Hampshire	7	0	2.9	7	100.0	24.1
	77	Hampshire	1	12	2.6	1	100.0	41.5
	93	Hampshire	7	1	2.5	2	28.6	28.0
	78	Hampshire	Failed to conceive					
3	81	Hampshire	11	0	2.9	2	18.2	16.0
	88	Hampshire	7	0	2.9	0	0.0	--
	91	Hampshire	4	0	3.1	4	100.0	24.2
	84	Hampshire	Failed to conceive					
4	89	Hampshire	8	4	--	0	0.0	--
	86	Hampshire	8	0	2.6	0	0.0	--
	87	Hampshire	10	0	2.6	0	0.0	--
	85	Hampshire	5	0	3.2	0	0.0	--
5	92	Hampshire	7	1	2.7	5	71.4	20.6
	95	Hampshire	11	0	2.5	2	18.2	31.5
6	96	Hampshire	6	0	3.2	1	16.7	7.5

TABLE 2

Reproduction and Lactation Performance of Individual Sows
Experiment 2, Fall, 1948

Lot No.	Sow No.	Breed	No. Pigs Born Alive	No. Pigs Born Dead	Average Birth Wt. (Lbs.)	No. Pigs Weaned	Percent Pigs Weaned Born Alive	Average Weaning Wt. (Lbs.)
Gilts								
1	1	Ch. White	6	0	2.3	3	50.0	30.7
	14	Duroc	10	0	2.5	10	100.0	17.9
	24	Duroc	10	0	2.6	9	90.0	18.3
	12	Duroc	Failed to conceive					
2	22	Ch. White	9	3	2.5	9	100.0	21.7
	70	Duroc	7	0	2.7	7	100.0	26.3
	21	Duroc	9	0	1.7	8	88.9	21.1
	11	Duroc	7	0	3.0	7	100.0	22.9
3	20	Ch. White	11	0	2.6	8	72.7	22.0
	10	Duroc	11	0	2.2	8	72.7	19.8
	13	Duroc	Failed to conceive					
	25	Duroc	Failed to conceive					
4	21	Ch. White	11	1	2.6	6	54.5	18.6
	23	Duroc	9	0	2.3	9	100.0	21.2
	15	Duroc	Failed to conceive					
5	55[1]	Ch. White	8	1	2.7	8[1]	100.0	20.0
	2	Duroc	8	1	2.6	8	100.0	22.4
6	32	Duroc	7	0	2.8	7	100.0	22.1
Sows								
7	90	Hampshire	9	0	2.7	5	55.6	22.4
	93	Hampshire	11	0	2.8	10	90.9	19.0
	76	Hampshire	7	0	2.7	7	100.0	24.5
8	95	Hampshire	6	0	3.2	5	83.3	31.4
	91	Hampshire	9	0	2.8	9	100.0	22.9
	82	Hampshire	Failed to conceive					

[1] Died due to injury of vertebrae. Pigs removed from gilt 7 days prior to weaning date.

TABLE 3

Reproduction and Lactation Performance of Individual Sows
Experiment 3, Spring, 1949

Lot No.	Sow No.	Breed	No. Pigs Born Alive	No. Pigs Born Dead	Average Birth Wt. (Lbs.)	No. Pigs Weaned	Percent Pigs Weaned Born Alive	Average Weaning Wt. (Lbs.)
Gilts								
1	124	Ch. White x Hamp.	9	0	2.5	7	87.5	25.2
	52	Ch. White x Hamp.	11	0	2.7	7	87.5	23.6
	17	Duroc	12	0	2.2	8	100.0	18.9
	60	Duroc	12	0	2.7	7	87.5	20.5
	79	Duroc	13	0	2.4	8	100.0	23.3
	51	Duroc	Failed to conceive					
2	125	Ch. White x Hamp.	Failed to conceive					
	90	Duroc	9	3	2.3	8	100.0	16.5
	305	Duroc	6	0	2.4	5	83.3	25.6
	63	Duroc	10	0	2.7	8	100.0	23.3
	64	Duroc	Failed to conceive					
3	147	Ch. White x Hamp.	6	0	2.6	5	83.3	24.4
	11	Duroc	11	0	2.6	8	100.0	21.3
	10	Duroc	8	0	2.6	7	87.5	19.7
	55	Duroc	9	0	2.5	8	100.0	19.6
	80	Duroc	9	2	2.3	7	87.5	24.5
Sows								
4	76	Hampshire	9	3	3.0	8	100.0	27.2
	21	Duroc	10	1	2.2	8	100.0	23.0
	10	Duroc	13	0	2.8	8	100.0	16.1
	22	Chester White	9	0	2.8	7	87.5	27.7

Table 3, Cont'd.

Lot No.	Sow No.	Breed	No. Pigs Born Alive	No. Pigs Born Dead	Average Birth Wt. (Lbs.)	No. Pigs Weaned	Percent Pigs Weaned Born Alive	Average Weaning Wt. (Lbs.)
Sows								
5	95	Hampshire	9	0	3.3	7	87.5	30.6
	23	Duroc	11	1	2.3	7	87.5	21.9
	24	Duroc	9	0	3.1	7	87.5	29.0
	1	Chester White	13	0	2.5	7	87.5	26.1
6	93	Hampshire	8	0	3.4	8	100.0	22.9
	2	Duroc	11	0	2.3	8	100.0	21.9
	70	Duroc	10	1	2.7	7	87.5	30.6
	21	Chester White	12	2	2.5	Sow died 4th day after farrowing. Pigs died.		
7	91	Hampshire	8	0	3.0	8	100.0	25.1
	32	Duroc	6	1	3.3	6	100.0	28.7
	11	Duroc	10	0	3.1	8	100.0	22.2
	20	Chester White	6	0	2.9	6	100.0	16.2

TABLE 4

Reproduction and Lactation Performance of Individual Sows
Experiment 4, Fall, 1949

Lot No.	Sow No.	Breed	No. Pigs Born Alive	No. Pigs Born Dead	Average Birth Wt. (Lbs.)	No. Pigs Weaned	Percent Pigs Weaned Born Alive	Average Weaning Wt. (Lbs.)
1	10	Duroc	Failed to conceive					
	52	Ch. White x Hamp.	10	0	2.9	8	100.0	21.8
	147	Ch. White x Hamp.	Failed to conceive					
	56	Pol. China x Duroc	6	0	2.5	5	83.3	19.2
	98	Pol. China x Duroc	11	0	2.6	8	100.0	28.5
	64	Pol. China x Duroc	9	0	2.0	6	75.0	24.3
	106	Pol. China x Duroc	8	1	2.8	6	75.0	24.5
	92	Pol. China x Duroc	9	1	2.4	5	62.5	26.4
2	80	Duroc	6	1	3.3	4	66.7	23.3
	124	Ch. White x Hamp.	5	0	3.3	4	80.0	27.0
	115	Pol. China x Duroc	10	1	2.3	8	100.0	18.8
	33	Pol. China x Duroc	8	1	2.9	5	62.5	19.4
	117	Pol. China x Duroc	7	0	2.6	0	0.0	—
	112	Pol. China x Duroc	7	0	2.7	5	71.4	29.2
	175	Pol. China x Duroc	8	1	2.7	3	37.5	13.7
3	79	Duroc	Failed to conceive					
	305	Duroc	Failed to conceive					
	65	Pol. China x Duroc	12	0	2.1	8	100.0	26.1
	62	Pol. China x Duroc	6	0	3.3	5	83.3	23.4
	104	Pol. China x Duroc	8	0	2.8	7	87.5	22.3
	14	Pol. China x Duroc	9	0	2.4	8	100.0	13.1
	32	Pol. China x Duroc	9	0	2.4	8	100.0	13.1
4	17	Duroc	No estrus observed					
	55	Duroc	No estrus observed					
	103	Pol. China x Duroc	4	0	3.1	3	75.0	31.7
	38	Pol. China x Duroc	9	0	3.2	8	100.0	23.9
	95	Pol. China x Duroc	6	0	1.8	6	100.0	33.3
	168	Pol. China x Duroc	8	0	2.6	8	100.0	29.0

TABLE 5

Reproduction and Lactation Performances of Individual Sows
Experiment 5, Spring, 1950

Lot No.	Sow No.	Breed	No. Pigs Born Alive	No. Pigs Born Dead	Average Birth Wt. (Lbs.)	No. Pigs Weaned	Percent Weaned of Pigs Given to Raise	Average Weaning Wt. (Lbs.)
1	56	Pol. China x Duroc	6	0	2.5	0	0	--
	52	Ch. White x Hamp.	11	2	3.0	1	12.5	21.5
	114	Duroc	10	0	1.5	3	37.5	13.0
	52	Duroc	11	0	2.2	0	0	---
	161	Duroc	5	0	2.2	4	50.0	17.5
	11	Duroc	9	0	2.5	4	50.0	18.8
	75	Duroc	9	1	2.9	8	100.0	18.9
	83	Duroc	No estrus observed					
2	104	Pol. China x Duroc	7	0	3.0	7	100.0	22.3
	33	Pol. China x Duroc	7	0	3.1	6	85.7	20.6
	115	Duroc	8	0	2.4	3	37.5	13.7
	44	Duroc	6	0	2.5	5	83.3	18.2
	86	Duroc	6	1	2.8	5	83.3	17.2
	28	Duroc	10	0	2.4	5	62.5	17.4
	168	Duroc	No estrus observed					
		Duroc	Failed to conceive					

Table 5, Cont'd.

Lot No.	Sow No.	Breed	No. Pigs Born Alive	No. Pigs Born Dead	Average Birth Wt. (Lbs.)	No. Pigs Weaned	Percent Weaned of Pigs Given to Raise	Average Weaning Wt. (Lbs.)
3	98	Pol. China x Duroc	2	8	3.5	0	0	--
	106	Pol. China x Duroc	Failed to conceive					
	88	Duroc	6	0	2.9	6	100.0	27.5
	79	Duroc	15	0	2.4	1	12.5	8.0
	18	Duroc	11	2	2.3	2	25.0	17.3
	512	Duroc	2	0	2.1	0	0	--
	287	Duroc	No estrus observed					
	12	Duroc	Failed to conceive					
4	112	Pol. China x Duroc	9	0	2.6	4	50.0	28.4
	32	Pol. China x Duroc	11	0	2.4	6	75.0	32.0
	17	Duroc	10	4	2.4	8	100.0	25.8
	91	Duroc	14	0	1.9	6	75.0	18.4
	73	Duroc	10	0	2.0	6	75.0	20.5
	276	Duroc	9	0	2.7	6	75.0	32.5
	65	Duroc	8	3	2.4	4	50.0	20.0
	92	Duroc	8	1	2.8	7	87.5	38.0

TABLE 6

Major Constituents in Gilts' Milk
5th Day of Lactation
Experiment 1, Spring, 1948

Lot No.	Gilt No.	Breed	Solids Percent	Solids Not Fat Percent	Fat Percent	Protein Percent	Ash Percent
1	76	Hampshire	19.60	11.46	8.14	5.93	0.83
	80	Hampshire	--	--	--	--	--
	82	Hampshire	--	--	--	--	--
	90	Hampshire	21.50	--	--	7.04	1.20
2	78	Hampshire	--	--	--	--	--
	77	Hampshire	18.51	--	--	5.28	0.84
	83	Hampshire	19.00	11.51	7.49	5.79	0.87
	93	Hampshire	23.53	13.02	10.51	7.31	1.01
3	81	Hampshire	19.75	--	--	6.12	0.88
	84	Hampshire	--	--	--	--	--
	88	Hampshire	26.96	12.07	14.89	6.63	0.93
	91	Hampshire	21.68	12.51	9.17	6.94	0.84
4	86	Hampshire	20.94	11.99	8.95	7.06	0.95
	85	Hampshire	--	--	--	--	--
	89	Hampshire	--	--	--	--	--
	87	Hampshire	25.21	13.67	11.54	8.38	1.12
5	92	Hampshire	18.52	--	--	4.66	0.92
	95	Hampshire	21.35	12.46	8.89	6.47	0.94
6	94	Hampshire	--	--	--	--	--
	96	Hampshire	18.69	11.55	7.14	5.93	0.86

TABLE 7

Major Constituents in Gilts' Milk
15th Day of Lactation
Experiment 1, Spring, 1948

Lot No.	Gilt No.	Breed	Solids Percent	Solids Not Fat Percent	Fat Percent	Protein Percent	Ash Percent
1	76	Hampshire	20.39	10.83	9.56	6.11	0.96
	80	Hampshire	--	--	--	--	--
	82	Hampshire	--	--	--	--	--
	90	Hampshire	--	--	--	--	--
2	78	Hampshire	--	--	--	--	--
	77	Hampshire	--	--	--	--	--
	83	Hampshire	16.95	--	--	5.00	0.87
	93	Hampshire	19.33	11.75	7.58	5.75	0.86
3	81	Hampshire	--	--	--	--	--
	84	Hampshire	--	--	--	--	--
	88	Hampshire	--	--	--	--	--
	91	Hampshire	19.38	--	--	5.93	0.91
4	86	Hampshire	--	--	--	--	--
	85	Hampshire	--	--	--	--	--
	89	Hampshire	--	--	--	--	--
	87	Hampshire	--	--	--	--	--
5	92	Hampshire	17.53	11.47	6.06	5.12	0.98
	95	Hampshire	--	--	--	--	--
6	94	Hampshire	--	--	--	--	--
	96	Hampshire	24.06	12.90	11.16	6.80	1.14

TABLE 8

Major Constituents in Gilts' Milk
55th Day of Lactation
Experiment 1, Spring, 1948

Lot No.	Gilt No.	Breed	Solids Percent	Solids Not Fat Percent	Fat Percent	Protein Percent	Ash Percent
1	76	Hampshire	18.40	12.00	6.40	5.80	1.09
	80	Hampshire	--	--	--	--	--
	82	Hampshire	--	--	--	--	--
	90	Hampshire	--	--	--	--	--
2	78	Hampshire	--	--	--	--	--
	77	Hampshire	19.80	12.30	7.50	6.58	1.03
	83	Hampshire	21.60	13.90	7.70	7.78	1.30
	93	Hampshire	19.50	12.07	7.43	6.66	1.22
3	81	Hampshire	--	--	--	--	--
	84	Hampshire	--	--	--	--	--
	88	Hampshire	--	--	--	--	--
	91	Hampshire	22.57	13.49	9.08	7.60	1.25
4	86	Hampshire	--	--	--	--	--
	85	Hampshire	--	--	--	--	--
	89	Hampshire	--	--	--	--	--
	87	Hampshire	--	--	--	--	--
5	92	Hampshire	--	--	--	--	--
	95	Hampshire	17.70	10.57	7.13	5.77	0.95
6	94	Hampshire	--	--	--	--	--
	96	Hampshire	--	--	--	--	--

TABLE 9

Vitamin Content of Gilts' Colostrum
Experiment 1, Spring, 1948

Lot No.	Gilt No.	Breed	Riboflavin mcg/ml	Nicotinic Acid mcg/ml	Pantothenic Acid mcg/ml	Thiamin mcg/ml	Ascorbic Acid mg/100 ml	Vitamin A mcg/100 ml	Carotene mcg/100 ml
1	76	Hampshire	6.00	1.00	1.70	—	35.1	95	1.4
	80	Hampshire	—	—	—	—	—	—	—
	82	Hampshire	2.50	1.50	2.10	0.75	17.8	93	3.0
	90	Hampshire	5.20	1.20	0.90	0.95	16.7	242	2.2
2	78	Hampshire	—	—	—	—	—	—	—
	77	Hampshire	3.80	0.90	0.60	—	27.7	154	0.8
	83	Hampshire	10.70	1.00	0.70	—	21.8	168	1.4
	93	Hampshire	—	—	—	—	10.0	83	3.3
3	81	Hampshire	12.80	1.60	0.70	0.75	13.2	64	3.6
	84	Hampshire	—	—	—	—	—	—	—
	88	Hampshire	5.40	1.40	0.50	—	20.0	67	7.0
	91	Hampshire	6.60	1.80	0.80	0.60	16.9	76	8.9
4	86	Hampshire	—	—	—	—	19.8	68	0.0
	85	Hampshire	5.40	3.20	0.40	0.63	20.0	259	0.0
	89	Hampshire	—	—	—	—	—	—	—
	87	Hampshire	8.90	—	1.60	—	6.8	—	—
5	92	Hampshire	—	—	—	—	—	—	—
	95	Hampshire	4.00	2.30	1.20	0.34	25.6	110	3.9
6	94	Hampshire	—	—	—	—	—	—	—
	96	Hampshire	—	1.70	0.00	0.62	22.6	54	0.0

TABLE 10

Vitamin Content of Gilts' Milk
5th Day of Lactation
Experiment 1, Spring, 1948

Lot No.	Gilt No.	Breed	Riboflavin mcg/ml	Nicotinic Acid mcg/ml	Pantothenic Acid mcg/ml	Thiamin mcg/ml	Ascorbic Acid mg/100 ml	Vitamin A mcg/100 ml	Carotene mcg/100 ml
1	76	Hampshire	2.10	1.30	1.10	0.21	16.4	16	3.7
	80	Hampshire	--	--	--	--	--	--	--
	82	Hampshire	--	--	--	--	--	--	--
	90	Hampshire	2.60	1.60	0.90	--	11.1	91	0.0
2	78	Hampshire	--	--	--	--	--	--	--
	77	Hampshire	2.30	1.80	1.80	--	11.4	22	7.5
	83	Hampshire	1.80	1.40	1.50	--	15.2	20	1.8
	93	Hampshire	3.20	2.00	2.80	0.16	16.5	43	5.1
3	81	Hampshire	2.50	2.50	0.90	0.69	5.5	18	0.0
	84	Hampshire	--	--	--	--	--	--	--
	88	Hampshire	3.60	1.70	1.40	0.37	9.4	53	2.5
	91	Hampshire	2.60	2.90	1.40	0.45	13.2	39	0.0
4	86	Hampshire	3.40	1.80	1.20	0.62	16.9	76	2.0
	85	Hampshire	3.30	4.30	2.10	0.34	8.7	52	0.0
	89	Hampshire	--	--	--	--	--	--	--
	87	Hampshire	5.6	1.70	1.60	0.56	8.1	57	0.0
5	92	Hampshire	2.00	2.40	2.10	0.45	12.3	15	2.4
	95	Hampshire	1.10	1.10	2.30	0.39	6.6	22	0.6
6	94	Hampshire	--	--	--	--	--	--	--
	96	Hampshire	2.80	2.10	3.20	--	20.0	21	5.6

TABLE 11

**Vitamin Content of Gilts' Milk
15th Day of Lactation
Experiment 1, Spring, 1948**

Lot No.	Gilt No.	Breed	Riboflavin mcg/ml	Nicotinic Acid mcg/ml	Pantothenic Acid mcg/ml	Thiamin mcg/ml	Ascorbic Acid mg/100 ml	Vitamin A mcg/100 ml	Carotene mcg/100 ml
1	76	Hampshire	1.80	2.60	1.50	0.31	14.1	15	1.40
	80	Hampshire	—	—	—	—	—	—	—
	82	Hampshire	—	—	—	—	—	—	—
	90	Hampshire	—	—	—	—	—	—	—
2	78	Hampshire	—	—	—	—	—	—	—
	77	Hampshire	2.40	5.30	1.40	—	9.7	21	1.2
	83	Hampshire	2.60	2.00	1.60	0.05	10.3	19	1.1
	93	Hampshire	3.70	1.80	2.40	—	11.7	18	4.0
3	81	Hampshire	2.80	3.00	3.20	—	8.5	31	0.0
	84	Hampshire	—	—	—	—	—	—	—
	88	Hampshire	1.00	1.30	2.30	0.58	7.6	38	0.0
	91	Hampshire	—	—	—	—	—	—	—
4	86	Hampshire	—	—	—	—	—	—	—
	85	Hampshire	2.10	6.80	3.00	—	10.2	25	2.0
	89	Hampshire	—	—	—	—	—	—	—
	87	Hampshire	—	—	—	—	—	—	—
5	92	Hampshire	1.30	3.50	3.00	—	11.0	14	1.1
	95	Hampshire	2.60	1.10	4.20	0.51	11.7	20	2.0
6	94	Hampshire	—	—	—	—	—	—	—
	96	Hampshire	2.40	4.70	4.30	0.25	7.1	23	1.1

TABLE 12

Vitamin Content of Gilts' Milk
55th Day of Lactation
Experiment 1, Spring, 1948

Lot No.	Gilt No.	Breed	Riboflavin mcg/ml	Nicotinic Acid mcg/ml	Pantothenic Acid mcg/ml	Thiamin mcg/ml	Ascorbic Acid mg/100 ml	Vitamin A mcg/100 ml	Carotene mcg/100 ml
1	76	Hampshire	3.40	5.10	2.50	0.26	7.7	19	1.80
	80	Hampshire	—	—	—	—	—	—	—
	82	Hampshire	—	—	—	—	—	—	—
	90	Hampshire	—	—	—	—	—	—	—
2	78	Hampshire	—	—	—	—	—	—	—
	77	Hampshire	3.30	3.60	3.20	—	6.2	21	2.3
	83	Hampshire	3.00	5.50	2.80	0.26	8.0	22	6.0
	93	Hampshire	2.60	3.60	5.30	0.18	8.8	6	1.3
3	81	Hampshire	4.60	4.00	5.00	1.05	15.4	18	1.7
	84	Hampshire	—	—	—	—	—	—	—
	88	Hampshire	—	—	—	—	—	—	—
	91	Hampshire	3.90	3.40	4.70	0.42	11.5	14	1.7
4	86	Hampshire	—	—	—	—	—	—	—
	85	Hampshire	—	—	—	—	—	—	—
	89	Hampshire	—	—	—	—	—	—	—
	87	Hampshire	—	—	—	—	—	—	—
5	92	Hampshire	—	—	—	—	—	—	—
	95	Hampshire	2.70	2.00	7.50	0.41	7.8	5	1.4
6	94	Hampshire	—	—	—	—	—	—	—
	96	Hampshire	—	—	—	—	—	—	—

TABLE 13

Major Constituents in Gilts' and Sows' Milk
5th Day of Lactation
Experiment 2, Fall, 1948

Lot No.	Sow No.	Breed	Solids Percent	Solids Not Fat Percent	Fat Percent	Protein Percent	Ash Percent
Gilts							
1	1	Chester White	21.16	11.54	9.62	6.62	0.90
	24	Duroc	18.65	11.47	7.18	5.47	0.85
	14	Duroc	19.90	10.95	8.95	5.96	0.85
2	22	Chester White	20.52	11.80	8.72	6.27	0.79
	70	Duroc	20.62	12.26	8.36	7.24	0.88
	21	Duroc	20.94	10.97	9.97	6.14	0.86
	11	Duroc	17.51	11.53	5.98	5.98	0.79
3	20	Chester White	21.81	11.56	10.25	6.39	0.96
	10	Duroc	--	--	--	--	--
4	21	Chester White	21.20	10.55	10.65	6.05	0.89
	23	Duroc	23.04	11.92	11.12	6.03	0.89
5	55	Chester White	18.96	9.85	9.11	5.50	0.93
	2	Duroc	19.18	11.16	8.02	5.53	0.75
6	32	Duroc	20.72	11.70	9.02	5.68	0.84
Sows							
7	76	Hampshire	21.75	11.07	10.68	6.61	0.90
	93	Hampshire	19.31	11.32	7.99	6.21	0.88
	90	Hampshire	17.86	10.96	6.90	7.51	0.89
8	95	Hampshire	21.34	11.85	9.49	6.36	0.93
	91	Hampshire	19.49	10.72	8.77	6.17	0.79

TABLE 14

Major Constituents in Gilts' and Sow's Milk
15th Day of Lactation
Experiment 2, Fall, 1943

Lot No.	Gilt No.	Breed	Solids Percent	Solids Not Fat Percent	Fat Percent	Protein Percent	Ash Percent
Gilts							
1	1	Chester White	19.24	12.36	6.88	5.90	0.92
	24	Duroc	--	--	--	--	--
	14	Duroc	18.72	11.32	7.40	5.35	0.92
2	22	Chester White	19.68	11.06	8.62	5.08	0.92
	70	Duroc	17.21	10.32	6.89	4.81	0.75
	21	Duroc	19.24	8.98	10.26	5.13	0.80
	11	Duroc	17.70	10.45	7.25	4.90	0.80
3	20	Chester White	19.81	11.17	8.64	4.76	0.93
	10	Duroc	23.05	15.61	7.44	5.54	0.95
4	21	Chester White	19.33	12.43	6.90	5.28	0.86
	23	Duroc	20.52	10.13	10.39	5.23	0.95
5	55	Chester White	15.89	10.21	5.68	4.06	0.88
	2	Duroc	18.36	10.49	7.87	4.92	0.76
6	32	Duroc	19.72	13.22	6.50	5.32	0.82
Sows							
7	76	Hampshire	20.22	12.47	7.75	5.72	0.84
	93	Hampshire	19.25	11.65	7.60	5.90	0.89
	90	Hampshire	18.30	10.40	7.90	5.19	0.88
8	95	Hampshire	15.45	10.49	4.96	4.09	0.80
	91	Hampshire	18.90	11.37	7.53	5.25	0.78

TABLE 15

Major Constituents in Gilts' and Sows' Milk
55th Day of Lactation
Experiment 2, Fall, 1948

Lot No.	Sow No.	Breed	Solids Percent	Solids Not Fat Percent	Fat Percent	Protein Percent	Ash Percent
Gilts							
1	1	Chester White	21.50	14.22	7.28	7.56	1.14
	24	Duroc	26.04	18.34	7.70	8.01	1.48
	14	Duroc	--	--	--	--	--
2	22	Chester White	23.63	16.73	6.90	7.70	1.37
	70	Duroc	22.48	14.97	7.51	7.62	1.36
	21	Duroc	19.72	11.86	7.86	5.87	1.18
	11	Duroc	19.97	13.76	6.21	7.60	1.32
3	20	Chester White	22.24	16.00	6.24	6.70	1.41
	10	Duroc	--	--	--	--	--
4	21	Chester White	19.08	11.22	7.86	5.32	1.72
	23	Duroc	18.95	12.38	6.57	6.68	1.34
5	55	Chester White	--	--	--	--	--
	2	Duroc	18.26	11.18	7.08	6.65	1.16
6	32	Duroc	18.44	12.00	6.44	6.54	1.27
Sows							
7	76	Hampshire	21.71	14.20	7.51	7.61	1.20
	93	Hampshire	--	--	7.58	8.19	--
	90	Hampshire	19.44	12.70	7.24	7.05	1.40
8	95	Hampshire	17.98	10.89	7.09	5.89	1.20
	91	Hampshire	18.38	12.44	5.94	--	1.25

TABLE 16

Vitamin Content of Gilts' and Sows' Colostrum
Experiment 2, Fall, 1948

Lot No.	Sow No.	Breed	Riboflavin mcg/ml	Nicotinic Acid mcg/ml	Pantothenic Acid mcg/ml	Thiamin mcg/ml	Ascorbic Acid mg/100 ml	Vitamin A mcg/100 ml
Gilts								
1	1	Chester White	2.43	1.23	0.94	0.34	16.7	44
	24	Duroc	1.89	1.87	0.44	0.16	21.3	154
	14	Duroc	2.13	2.50	0.43	0.44	7.9	161
2	22	Chester White	5.68	1.60	0.22	0.86	17.6	124
	70	Duroc	—	—	—	—	—	—
	21	Duroc	—	1.40	—	1.31	24.7	202
	11	Duroc	—	—	—	—	—	—
3	20	Chester White	—	—	—	—	—	—
	10	Duroc	2.80	2.60	0.19	0.21	28.4	25
4	21	Chester White	4.98	1.54	0.46	0.59	14.8	85
	23	Duroc	—	—	—	—	—	—
5	55	Chester White	2.17	1.57	0.25	0.29	13.7	—
	2	Duroc	3.53	1.44	0.25	0.21	20.7	127
6	32	Duroc	5.00	1.90	0.13	0.60	14.8	245
Sows								
7	76	Hampshire	6.13	1.20	0.52	0.32	30.8	189
	93	Hampshire	6.75	1.38	0.41	—	13.1	285
	90	Hampshire	3.71	1.71	0.35	—	8.9	76
8	95	Hampshire	3.81	1.74	0.38	0.44	25.9	153
	91	Hampshire	3.09	2.37	0.62	—	24.7	167

TABLE 17

Vitamin Content of Gilts' and Sows' Milk
5th Day of Lactation
Experiment 2, Fall, 1948

Lot No.	Sow No.	Breed	Riboflavin mcg/ml	Nicotinic Acid mcg/ml	Pantothenic Acid mcg/ml	Thiamin mcg/ml	Ascorbic Acid mg/100 ml	Vitamin A mcg/100 ml
Gilts								
1	1	Chester White	2.35	3.12	2.80	0.78	7.1	36
	24	Duroc	2.00	7.85	4.88	0.42	18.8	18
	14	Duroc	1.16	6.66	0.75	1.26	14.0	12
2	22	Chester White	1.65	5.03	2.01	0.62	10.7	16
	70	Duroc	1.94	5.87	2.34	0.62	18.8	26
	21	Duroc	1.12	7.26	2.26	1.10	18.4	24
	11	Duroc	2.01	4.54	2.35	0.45	18.9	22
3	20	Chester White	1.50	6.72	1.81	0.70	10.6	27
	10	Duroc	1.47	7.98	1.48	0.89	14.7	22
4	21	Chester White	1.54	6.05	1.88	0.79	16.9	62
	23	Duroc	1.26	6.80	2.01	0.44	15.1	26
5	55	Chester White	1.19	4.60	1.82	0.56	9.0	30
	2	Duroc	1.00	3.88	1.82	0.53	14.0	20
6	32	Duroc	1.30	4.83	2.01	1.00	11.1	11
Sows								
7	76	Hampshire	1.87	3.39	1.30	0.52	19.0	54
	93	Hampshire	1.86	3.01	1.00	0.59	16.8	47
	90	Hampshire	1.24	5.46	1.73	0.53	11.1	20
8	95	Hampshire	1.41	8.04	1.30	1.33	13.1	25
	91	Hampshire	1.58	4.82	2.30	0.37	14.5	29

TABLE 18

Vitamin Content of Gilts' and Sow' Milk
15th Day of Lactation
Experiment 2, Fall, 1948

Lot No.	Sow No.	Breed	Riboflavin mcg/ml	Nicotinic Acid mcg/ml	Pantothenic Acid mcg/ml	Thiamin mcg/ml	Ascorbic Acid mg/100 ml	Vitamin A mcg/100 ml
Gilts								
1	1	Chester White	2.34	4.19	9.90	1.20	8.5	18
	24	Duroc						
	14	Duroc	1.00	12.60	1.16	0.55	9.5	14
2	22	Chester White	4.39	12.88	3.25	0.74	9.8	26
	70	Duroc	0.83	7.77	2.05	0.71	13.3	18
	21	Duroc	1.82	11.54	2.30	1.00	12.8	31
	11	Duroc	1.72	8.41	2.08	0.55	7.8	23
3	20	Chester White	3.12	11.70	4.14	0.90	13.0	16
	10	Duroc	2.13	10.09	0.52	0.82	9.8	24
4	21	Chester White	3.70	9.82	3.21	0.69	13.5	26
	23	Duroc	1.96	12.41	4.86	0.75	11.1	14
5	55	Chester White	3.68	5.11	3.71	0.57	8.4	19
	2	Duroc	1.04	11.33	1.50	0.54	12.5	19
6	32	Duroc	1.26	6.94	2.21	1.10	11.6	22
Sows								
7	76	Hampshire	1.37	3.41	1.10	0.43	12.0	29
	93	Hampshire	1.34	5.73	0.90	0.49	11.7	19
	90	Hampshire	2.66	9.01	2.83	0.36	9.8	14
8	95	Hampshire	2.98	5.81	3.75	0.56	9.1	20
	91	Hampshire	2.72	8.15	3.03	0.40	10.7	17

TABLE 19

Vitamin Content of Gilts' and Sows' Milk
55th Day of Lactation
Experiment 2, Fall, 1948

Lot No.	Sow No.	Breed	Riboflavin mcg/ml	Nicotinic Acid mcg/ml	Pantothenic Acid mcg/ml	Thiamin mcg/ml	Ascorbic Acid mg/100 ml	Vitamin A mcg/100 ml
Gilts								
1	1	Chester White	2.17	5.05	2.11	0.82	5.9	24
	24	Duroc	3.15	15.25	2.85	0.84	9.3	24
	14	Duroc	—	—	—	—	—	—
2	22	Chester White	3.63	11.63	7.11	0.77	8.4	28
	70	Duroc	2.13	8.76	5.75	0.86	10.1	19
	21	Duroc	4.38	9.54	8.71	1.05	12.3	22
	11	Duroc	2.80	10.35	6.85	0.65	11.8	17
3	20	Chester White	3.98	16.02	7.99	1.02	10.8	16
	10	Duroc	2.38	7.85	1.41	—	11.4	17
4	21	Chester White	3.00	1.67	0.37	0.41	18.0	24
	23	Duroc	2.44	12.48	4.48	1.10	12.0	16
5	55	Chester White	—	—	—	—	—	—
	2	Duroc	3.05	8.77	7.61	1.25	12.0	23
6	32	Duroc	3.31	7.14	5.53	1.20	11.0	26
Sows								
7	76	Hampshire	2.53	4.71	3.28	0.47	10.8	23
	93	Hampshire	2.68	4.37	3.70	1.15	10.9	19
	90	Hampshire	3.10	15.00	11.97	0.73	11.4	25
8	95	Hampshire	3.78	11.48	3.88	0.67	8.8	17
	91	Hampshire	3.75	13.07	11.53	0.61	12.3	21

TABLE 20

Vitamin A Content of Gilts' and Sows' Milk
Experiment 3, Spring, 1949

Gilts					Sows				
Lot No.	Gilt No.	Breed	Vitamin A Content mcg/100 ml 5th day	Vitamin A Content mcg/100 ml 25th day	Lot No.	Sow No.	Breed	Vitamin A Content mcg/100 ml 5th day	Vitamin A Content mcg/100 ml 25th day
1	52	Hamp. x Ch. White	19	13	4	76	Hampshire	44	17
	124	Hamp. x Ch. White	28	12		22	Chester White	89	32
	79	Duroc	16	12		10	Duroc	50	36
	60	Duroc	19	13		21	Duroc	50	28
	17	Duroc	16	14	5	95	Hampshire	28	29
2	90	Duroc	12	17		1	Chester White	34	17
	63	Duroc	16	14		23	Duroc	37	17
	305	Duroc	17	12		24	Duroc	21	16
3	147	Hamp. x Ch. White	46	25	6	93	Hampshire	32	24
	55	Duroc	45	41		70	Duroc	42	43
	10	Duroc	42	33		2	Duroc	38	37
	80	Duroc	53	23	7	91	Hampshire	39	32
	11	Duroc	31	30		20	Chester White	75	25
						11	Duroc	61	32
						32	Duroc	66	45

TABLE 21

Nicotinic Acid Content of Gilts' and Sows' Milk
Experiment 3, Spring, 1949

Gilts					Sows				
Lot No.	Gilt No.	Breed	Nicotinic Acid Content mcg/ml 5th day	Nicotinic Acid Content mcg/ml 25th day	Lot No.	Sow No.	Breed	Nicotinic Acid Content mcg/ml 5th day	Nicotinic Acid Content mcg/ml 25th day
1	52	Hamp. x Ch. White	1.30	2.80	4	76	Hampshire	2.30	5.40
	124	Hamp. x Ch. White	3.30	6.00		22	Chester White	3.10	12.80
	79	Duroc	3.60	7.10		10	Duroc	6.00	4.70
	60	Duroc	2.20	4.60		21	Duroc	3.40	--
	17	Duroc	2.40	13.40	5	95	Hampshire	2.50	3.80
2	90	Duroc	1.50	5.20		1	Chester White	2.50	8.60
	63	Duroc	6.80	7.30		23	Duroc	4.30	6.00
	305	Duroc	7.00	9.50		24	Duroc	5.80	10.80
3	147	Hamp. x Ch. White	2.10	4.90	6	93	Hampshire	5.80	5.10
	55	Duroc	3.50	10.00		70	Duroc	5.10	9.60
	10	Duroc	1.50	3.90		2	Duroc	5.50	6.90
	80	Duroc	3.20	6.50	7	91	Hampshire	2.50	2.70
	11	Duroc	2.00	6.50		20	Chester White	9.30	9.30
						11	Duroc	4.30	5.80
						32	Duroc	3.50	4.90

TABLE 22

Composition of Milk from Sow
Which Raised 10 Healthy Pigs to Weaning
Spring, 1948

Breed	Day	Solids Percent	Solids Not Fat Percent	Fat Percent	Protein Percent	Ash Percent
Duroc	5	18.89	11.20	7.69	4.91	0.83
	15	17.80	11.46	6.34	4.96	0.82
	55	16.80	11.97	4.83	5.59	1.24

Day	Riboflavin mcg/ml	Nicotinic Acid mcg/ml	Pantothenic Acid mcg/ml	Thiamin mcg/ml	Ascorbic Acid mg/100 ml	Vitamin A mcg/100 ml
5	1.90	12.3	--	--	11.6	44
15	1.10	13.2	4.90	0.12	13.8	32
55	3.00	10.0	9.80	0.32	9.1	8

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