THE EFFECT OF ANTIBIOTICS UPON FEED UTILIZATION BY FATTENING SWINE

by

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INTRODUCTION

Since the discovery that antibiotics will increase the rate of gain of pigs being fed a fattening ration, a tremendous increase in the use of antibiotics in commercial pig supplements has occurred. It has been observed that pigs fed antibiotics apparently consume greater amounts of water than normal. It has also been postulated that antibiotics increase digestibility of the entire ration and reduce the protein requirement. Antibiotics in the pig ration usually increase the average daily gain and reduce the feed required per pound of gain.

Recommendations have been made by some of the experiment stations as to the level and kind of antibiotic to add to swine rations. These recommendations are based on results of their experimental work with fattening rations.

There is a need for some work to actually evaluate the effect of antibiotics upon water consumption and feed utilization.

REVIEW OF LITERATURE

Aureomycin in Rations for Swine

The articles contained in this review of literature cover primarily the major work that has been done in feeding antibiotics to growing and fattening swine. The mode of action of antibiotics is over the research that has been accomplished with swine, but work that is pertinent which has been completed with small animals is included.

Jukes et al (28) found that aureomycin would increase pig gains on a diet consisting mainly of yellow corn, peanut meal and a supplement containing B12. Since this experiment much work has been done on the response of antibiotics when fed to growing and fattening swine. This review of literature will cover work which is applicable to the present study.

Working with healthy weanling pigs, Brigg and Beeson (9) fed various combinations of aureomycin in an all plant protein ration composed of yellow corn, soybean meal, alfalfa meal, cod liver oil and essential minerals. Pigs fed the basal ration gained 1.62 pound per head daily on a feed requirement of 392 pounds per 100 pound gain. The addition of 10 milligrams of pure aureomycin per pound significantly increased the average daily gain 12 percent and increased the feed efficiency 15 percent. The antibiotic provided some protection against bloody dysentery which infected the basal fed pigs during the last four weeks of the experiment. Burnside et al (11) also found the addition of aureomycin helped in the control of bloody dysentery among swine and reduced death losses due to this disease. Catron et al (19) working with an all plant protein ration found that aureomycin fed pigs had higher average daily gains than the basal ration pigs. The incidence of scouring after the first week was less than those lots receiving aureomycin. Terrell et al (54) feeding the same type of ration to growing-fattening pigs found a 27 percent increase in weight gain with the addition of 5 milligrams aureomycin per pound of feed. This is in agreement with work done by Luecke et al (35).

In feeding varying levels of aureomycin, Wallace et al (56) found while using a corn peanut meal ration, gains were not influenced by reducing the level of aureomycin from 20 grams to 10 grams per ton, and from 36 to 18 grams per ton. However, animals on the lower levels ate more feed per day, indicating that appetites may have been improved with a reduction in the amount of antibiotics. Nevertheless, in both tests feed utilization figures were in favor of the groups that remained on the high level of antibiotics. Complete withdrawal of the aureomycin caused slowing of gains, lower feed consumption, and poorer feed conversion in these two tests. In two other experiments involving a corn-soybean meal ration, the effects of withdrawing aureomycin were less pronounced but still apparent. The antibiotic supplementation should not be discontinued during the growing fattening period of the pig if optimum gains are to be obtained.

Using a ration containing fish meal as a source of animal protein, Braude et al (6) found aureomycin supplemented pigs grew at a faster rate than the controls. Lepley et al (30) using meat scraps as animal protein obtained a definite response with the addition of aureomycin as compared to the basal pigs.

Bowland et al (10) fed an APF supplement containing residual aureomycin which caused marked increases in rate and efficiency of gain when added to basal rations containing protein of either vegetable or mixed animal vegetable origin. Unthrifty weanling pigs gave a very great response in increased rate and efficiency of gain with the APF supplement. Pigs responded to aureomycin whether straight plant protein, or a combination of plant and animal protein was added to the ration.

Aureomycin does not appear to alter the composition of blood in swine. Squibb et al (53) found aureomycin increased the growth of pigs fed either corn or banana rations as well as the efficiency of their feed utilization. Aureomycin did not have any apparent effect on serum proteins, riboflavin, ascorbic acid, carotenoids, vitamin A, tocopherols, red cell count, hemoglobin and hematocrit in the blood of young growing pigs.

The antibiotic aureomycin does not effect litter size when it is fed to sows before parturition as found by Carpenter (12). In further experimental work Carpenter (15) found that feeding aureomycin to swine from weaning through two gestation and lactation periods did not have a harmful or beneficial effect on reproduction. Neither aureomycin nor penicillin was observed to be transferred across the placental tissues of the sow. Aureomycin can be detected in the milk of sows given the antibiotic orally but the amount is small and variable, and does not influence the growth rate of suckling pigs. Depape et al (21) found the addition of 0.5 percent APF for brood sows during pre-breeding, gestation and lactation resulted in no significant improvement with regard to number of pigs farrowed, number of pigs farrowed alive, average birth weights, and number of pigs weaned per sow.

Some experimental work indicates that the greatest response with aureomycin is with unthrifty pigs. Blight et al (4) gave weanling pigs of various degrees of unthriftness a well balanced ration supplemented with aureomycin. The supplemented pigs grew at a significantly faster rate, were more uniform in size and more thrifty in appearance than the controls. Based on differences in initial weight, the response to aureomycin was attributed primarily to its effect on the lighter more unthrifty pigs.

Several workers did not receive a response with aureomycin in healthy animals. Speer et al (52) fed 5 and 10 milligrams of aureomycin per pound of basal ration to pigs from weaning to approximately 100 pounds of final weight. This ration failed to increase daily gains or improve feed efficiency. The failure of aureomycin to improve gains or improve feed efficiency was explained by the disease level theory. Pigs managed under disease free conditions may not respond to aureomycin feedings as would unthrifty pigs fed in unsanitary surroundings.

Terramycin in Rations for Swine

Huang et al (26) found that terramycin stimulated the growth of pigs fed a corn soybean basal ration. It also improved feed utilization from weaning to market weight. This antibiotic improved digestibility, especially of dry matter and protein at an early age. This is in agreement with the work done by Lehrer et al (29), Carpenter (13) and Hoefer et al (25) who found that terramycin was effective in inducing gains. In another experiment Huang (27), obtained a faster rate of growth and more efficient feed utilization with the addition of terramycin. He observed that the pigs receiving the antibiotic did not scour, while scouring was prevalent in the controls.

Antibiotic Mode of Action

The mode of action of antibiotics is not clearly understood. The mechanisms of antibiotics are extremely complex and no concise picture of how they react in the animal is known. The experiments given below fall into a pattern which gives an indication of the changes in the body due to antibiotics.

Antibiotics Alter Intestinal Flora. Huang et al (27) found that in terramycin supplemented pigs there was no scouring while it was prevalent in the controls. There was a total absence of toxin producing bacteria, Clostridium perfrigens which were abundant in the feces of the other pigs. This suggests that terramycin has an antibacterial effect in the intestinal tract. March and Biely (38) found in feeding practical levels of aureomycin to chicks caused a depression in the number of Lactobacilli present in the feces. The antibiotic may cause a reduction in the number of microorganisms competing with the host for certain nutrients. Romocer et al (47) using penicillin as the antibiotic found that it controlled organisms which may have been competing with the host for nutrients. Smith and Robinson (51) working with mice and using streptomycin as the antibiotic found that it markedly alters the intestinal flora of mice. Huang et al (27) found that terramycin eliminated scouring in pigs. He assumed that the absence of the toxin producing bacteria, Clostridium perfringens present in the control pigs was the reason the scouring ceased.

Wasserman et al (57) studied the effects of penicillin, streptomycin, neomycin, and chloromycetin or invitro cellulose digestion. In the concentration used, penicillin stimulated the cellulolytic rumen microorganisms at the lower concentrations, neomycin was slightly stimulatory in the lowest concentrations and chloromycetin adversely affected the microorganisms.

Catron et al (17) found that the inclusion of aureomycin at practical feeding levels in the ration of growing pigs indicated a greater increase in blood glucose after an oral glucose administration than when no antibiotic is fed. Quinn et al (43) found that the feeding of 5 milligrams of aureomycin per pound of corn soybean oil meal basal ration to swine caused an increase in the number of glucose fermenters in the intestinal tract. These additional glucose fermenters may be responsible for the apparently lower concentration of blood glucose found in fasted animals from aureomycin treatments compared to basal treatment when both lots of pigs are given glucose by stomach tube. This effect is apparently reversed when aureomycin is present in the ration of unfasted animals and is believed that this is due to inhibition of glycolytic enzymes of potential glucose fermenters. A mixture of antibiotics fed for the purpose of sterilizing the intestinal tract failed to do so, but rather caused an increase of several groups of intestinal microflora although streptocci were decreased.

Antibiotics Exhibit Sparing Action

Antibiotics appear to lower the required levels of protein for swine. They may influence the intake of water excretion of urine and the levels of vitamins and minerals needed for the well being of the animal. Lih and Baumann (32) showed that various antibiotics stimulated the growth of rats receiving limiting amounts of thiamine, riboflavin and pantothenic acid as fed in his assays for these vitamins. Richardson et al (44) suggested a reduced dietary vitamin B12 requirement for weanling pigs as a result of feeding an antibiotic combination. While working on pantothenic acid requirements of growing fattening swine, Catron et al (16) found that aureomycin appears to "spare" both vitamin B12 and pantothenic acid. Migecovsky et al (39) fed penicillin to chicks and found that it enhanced calcium absorption. This evidence may support the theory that the antibiotic causes a change in the structure of the absorptive tissue of the gastro intestinal tract or in the P.H. of the contents of the tract with subsequent effect on the calcium absorption.

Cunha et al (20) suggested that the accepted values for the protein requirement of swine may need to be evaluated by using adequate amounts of vitamin B12 plus other factors present in Lederle APF supplement. Catron et al (18) used a total of 128 Duroc pigs which were fed a corn soybean oil meal ration supplemented with minerals and vitamins, including vitamin B12, from weaning to 200 pounds in drylot. Without antibiotics, the rate of gain for the entire feeding period varied significantly among the several sets of protein levels. The results suggest that in the absence of an antibiotic the 16-13-10 percent protein level combination supplied the pigs needs for protein from weaning to market, whereas in the presence of the antibiotic, the 14-11-8 percent level combination produced gains equivalent to higher levels of protein. Contrary to previous recommendations, higher levels of protein, are in excess of the pig's needs if rations are balanced with respect to non protein dietary factors. Aureomycin added at the rate of 10 milligrams per pound of ration appeared to exhert a protein "sparing" effect on the lower protein levels. Pigs receiving antibiotics in their ration gained an average of 0.12 pound more per day and consumed 23 pounds less feed per 100 pounds of gain than those pigs not receiving the antibiotics. Using eighty 25 pound pigs to study the effect of terramycin on the growth of pigs fed different levels of protein, Hoefer found that terramycin at 5 milligram per pound of total ration had a highly significant effect on rate of gain and also improved efficiency of gain. It did not seem to affect the requirement of the pigs for protein. The pigs receiving the 15 percent protein ration which was reduced to 12 percent at 100 pounds did just as well as the pigs receiving the 18 percent protein ration which was reduced to 15 at 100 pounds. It was suggested that our present standards for protein for pigs may be higher than they need to be, and that the higher level of B vitamins used in this study may be related to an increased efficiency of protein utilization.

Robinson et al (45) studied the growth promoting effects of procaine penicillin on nine week old pigs on a restricted feeding program.

Supplemented pigs gained faster than the corresponding controls. Feed consumption was increased, and the efficiency of feed conversion was greater. Restricted feeding limited the increase in rate of live weight gain obtainable with antibiotic supplements. In continuation of this work (46) nitrogen, calcium digestibility and water economy were studied with pigs receiving a supplement of procaine penicillin. All animals gained satisfactorily, but only when water was given free choice did those on procaine penicillin gain more than the corresponding controls. The antibiotic appeared to lessen the desire for water, the intake on free choice being reduced when the supplement was given. No effect of procaine penicillin on nitrogen retention was observed. Calcium retention was greater in controls. There was a slight but consistent improvement in nitrogen digestibility due to antibiotics. Digestibility of the other proximate feed constituents was not affected. Braude et al (5) using a purified diet in the feeding of young pigs found the addition of aureomycin at the level of 20 milligrams per 1 kilogram of ration brought about expected improvement in rate growth and increase in efficiency of food utilization. However, no effect on nitrogen retention was observed, even though there was an increase in efficiency of food utilization. Considerable higher urinary excretion was observed with animals receiving antibiotics.

Antibiotics Influence Parasite Levels

Parasitic infestation appears to be increased or decreased by the addition of various antibiotics. Huang and McCoy (26) found that the feeding of terramycin seemed to favor the infestation of swine by ascarids. Hansen et al (22) did experimental work to determine the effect of aureomycin and vitamin B12 on the resistance of chicks to introduced doses of Ascaridia galli. All chicks received the same all plant protein basal ration; however, half of them had their basal ration supplemented with 0.9 grams of aureomycin and 0.9 milligrams of vitamins B12 per 100 pounds of feed. The chicks receiving the supplemented ration had the least mortality. Parasitosis, whether in the chicks receiving basal ration only, or the supplemented ration increased the mortality. Fewer chicks became infected in the supplemented group than in the non-supplemented group when exposed to a measured dose of embryonated ova of Angalli.

EXPERIMENT I

Experimental Procedure

With the increased use of antibiotics in pig rations, much has yet to be learned of how antibiotics actually function in the animal body. These experiments were designed primarily to study the influence of antibiotics upon water consumption, nitrogen balance, and feed utilization.

On November 11, 1952 fifteen Duroc Jersey male weanling pigs were started on the experiment. These were five litters of three pigs each from sows fed a good ration without antibiotics during gestation-lactation. All pigs were wormed with 1/2 pound of sodium fluoride, per 100 pounds of feed. The pigs had access to the treated feed for 48 hours. Sodium fluoride reduced the palatability of feed and pigs sometimes refused the feed for a short time. By leaving the feed before them for 48 hours, there is more liklihood of the feed being eaten and the pigs properly wormed. Littermate pigs were randomly allotted to each lot. This put a littermate in each of the three lots and thereby reduced the experimental error due to breeding.

Lot I, the control lot, received a practical basal ration including animal protein. Lot II received the basal ration plus 10 milligrams of aureomycin-hydrochloride per pound of total feed from Aurofac 2A, and Lot III received the basal ration plus 10 milligrams of terramycin-hydrochloride per pound of total ration from Bi-Con TM 5. The basal ration is given in Table 1, along with the calculated and chemical analysis. The pigs were individually self fed from weaning to market weight in concrete floored pens. The pens were 212 by 36 inches. One-half of the pen was on the outside of the building, allowing the pigs access to sunshine at all times. The pigs were removed from the pens only for weighing and when they were placed in metabolism crates. Individual self feeders, 12 by 22 by 42 inches were used to supply feed. Fresh water was supplied twice daily in a small trough. The building in which the pigs were kept was not heated.

The feed was mixed and fed as a complete ration. Three levels of protein were used. The pigs were fed an 18 percent protein ration until they weighed approximately 75 pounds. At this time, they were changed to a 15 percent protein ration. This ration was fed until the pigs had completed one week in a metabolism crate. They weighed about 120 pounds when placed on a 12 percent protein ration. This ration was fed until the pigs reached market weight of approximately 225 pounds.

The pigs were weighed at weekly intervals. They were also weighed the day of slaughter, which usually did not fall on the official weighing day. The feed was weighed back every two weeks and a record made of the feed that had been added in that two week period. This gave the amount of feed consumed by the pig for a two week period.

At approximately 100 pounds the pigs were placed in metabolism crates for one week to collect urine and feces for digestion, nitrogen

Table 1. Composition of basal feed.

Ingredients	Percent protein ration 18%	15%	12%
Yellow corn	73.5	80.5	87.5
Soybean oil meal	11.0	7.0	5.0
Tankage	10.0	7.0	4.0
Alfalfa meal	3.0	3.0	2.0
Vitamin D2 (premix soybean oil meal)	1.0	1.0	
Steamed bone meal	.5	.5	.5
Ground limestone	.5	.5	.5
Salt	.5	.5	.5
CALCULATED ANALYSIS			
Protein	18.04	15.07	12.73
Fat	3.49	3.71	3.87
Fiber	3.79	3.41	2.88
CA	.998	.835	.62
P	.651	.601	.444
Mg. Carotene per lb.	1.635	1.705	1.48
Ribo. Mg./lb.	.82	.77	.58
Niacin Mg./lb.	9.67	9.32	894
Panto. Acid mg/lb.	2.72	2.59	2.87
Cholene Mg./lb.	427	347	288
Vit. D2 units/lb.	50	50	50
CHEMICAL ANALYSIS of 15% Protein Ration			
Protein	16.69	16.31	17.19
Ether extract	3.99	4.08	4.15
Crude fiber	2.70	2.49	2.57
Moisture	9.97	9.44	10.05
Ash	5.12	4.79	5.00
N-free extract	61.53	62.89	61.04

balance and water balance studies. A picture of the type of metabolism crate used is shown in plate I. An accurate measurement of feed and water consumed and urine and feces excreted was kept. A 10 percent sample of urine and feces was collected daily. Toluene was used as a preservative for the urine and the feces were dried in an oven. The addition of feed and water was made once daily. The pigs were checked several times per day to make sure feed and water was available. When the pigs were slaughtered, a blood sample was taken.

Results and Discussion

Pigs in this trial were exposed to low temperatures over a period of time. One litter made extremely poor progress as compared to the other pigs on experiment. It was felt that the environment may have been instrumental in the poor performance of these pigs. Therefore the data from this litter was not included in the experiment.

There was a large difference in the growth curves of all lots as seen in Fig. 1. The aureomycin fed pigs grew at a much faster rate than the other two lots. The terramycin fed pigs had a slower growth rate than either Lot I or Lot II pigs. The Lot III pigs average daily gain was 1.29 pounds as compared to 1.59 pounds for the aureomycin fed pigs and 1.38 pounds for the basal fed pigs. This low rate of gain may partially be explained by the Lot III pigs apparent dislike of the terramycin supplement in the feed. This was evident by an effort of the pig to sort the corn from the ration, thus leaving the fine material. Waste feed deposited from the pigs mouth apparently imparted a disagreeable flavor to the water. They would drink larger quantities of water if the

EXPLANATION OF PLATE I

Top figure is a close up of a metabolism crate used in Experiment 1.

Lower figure is a close up of a pig operating the self-feeder used in both experiments.

PLATE I

trough was cleaned daily. This problem was not observed in the other two lots. The Lot III pigs were not as efficient in feed utilization and took longer to reach market weight of two hundred and twenty five pounds. The aureomycin pigs gained faster and were more efficient in feed utilization than either Lot I or Lot II. A summary of growth and feed results are given in Table 2.

Blood samples were taken at the time of slaughter. The blood data as seen in Table 3 showed no outstanding differences between treatments and exhibited normal variations found in swine. The animals were also checked for parasites at slaughter. Ascaris found in the intestinal tract were counted. Variations were large within Lots. Average worm counts showed Lot III had the greatest number of ascaris as seen in Table 4. Lot II had the smallest number of worms followed by Lot I animals.

The water balance study as seen in Table 5 shows the aureomycin supplemented animals drank more water and excreted a larger volume of urine than either of the other Lots. The terramycin supplemented pigs drank less water and had the lowest urine volume. The basal pigs drank slightly more water and their urine volume was greater than the pigs fed terramycin.

Four pigs from each treatment were placed in metabolism crates as they reached 100 pounds liveweight. The Lot II pigs digested less protein. There was very little difference between the other two Lots. There was a small variation in fat utilization in all three Lots with the aureomycin pigs utilizing the greatest percentage of fat. The antibiotic supplemented lots digested less fiber than the basal pigs. There was very little

Table 2. Summary of growth and feed results.

Lot I Basal	Initial weight	Final weight	Total gain	Total days	Average daily gain	Total feed	Feed/average gain
72	25	224	199	141	1.41	777	390
97	28	218	190	150	1.27	731	385
86	29	221	192	130	1.48	657	342
43	40	234	194	141	1.38	806	415
Total	122	897	775	562		2971	
Average	30.5	224.25	193.75	140.5	1.38	743	383
Lot II Basal and 10 mg. Aureo.							
71	26	224	198	121	1.64	689	348
94	30	220	190	130	1.46	710	374
79	32	227	195	113	1.73	655	336
48	33	225	192	121	1.59	769	400
Total	121	896	775	485		2823	
Average	30.25	224	193.75	121.25	1.60	704	364
Lot III Basal and 10 mg. Terra.							
69	29	220	191	150	1.27	731	383
93	31	225	194	141	1.38	711	366
82	32	218	186	150	1.24	737	396
49	35	224	189	150	1.26	796	421
Total	127	887	760	591		2975	
Average	31.75	221.75	190	147.75	1.29	744	391

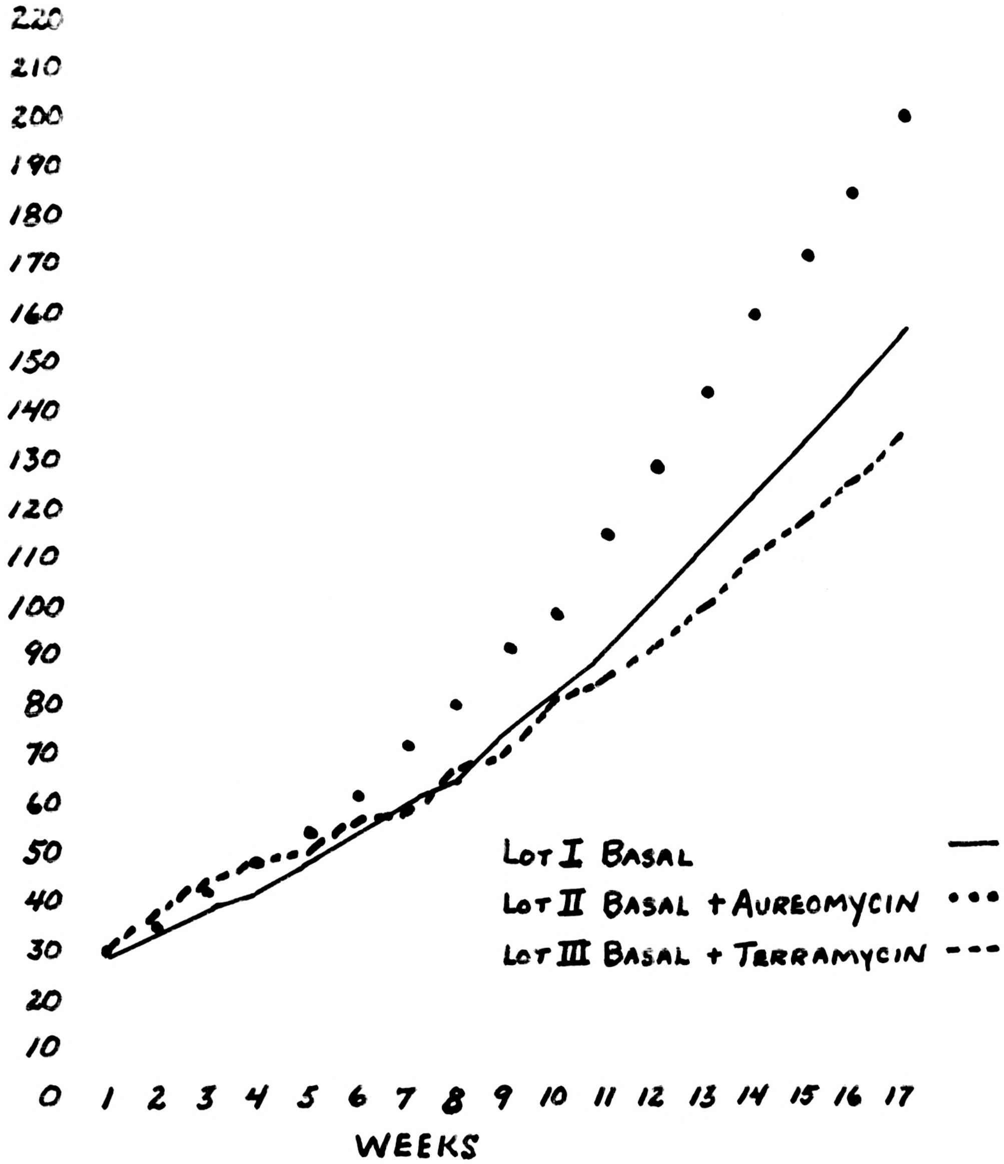


Fig. I Growth Curves of Lot Mean Weights- Experiment I

Table 3. Summary of blood data.

Pig No.	Treatment	Total R.B.C.	Hb gm/ 100 ml	Hemato- crit	MCV	MCH	MCHC	Total W.B.C.
72	Basal	7,985,000	19.5	46.0	57.61	24.42	42.39	16,250
97	"	8.890,000	17.3	44.0	49.49	19.46	39.32	25,900
86	"	13,150,000	20.9	47.0	35.74	15.89	44.47	16,750
43	"	7,175,000	20.1	46.5	64.81	28.01	43.23	15,250
Average		9,300,000	19.5	45.88	51.91	21.95	42.35	18,538
	Basal & 10 mg Aureo./							
71	lb. of feed	7,960,000	19.0	46.0	57.79	23.87	41.30	20,400
79	"		BLOOD COAGULATED					
94	"	7,300,000	17.0	44.0	60.27	23.29	38.64	25,000
48	"	10,230,000	19.9	46.0	44.97	19.45	43.26	12,875
Average		8,496,666	18.6	45.33	54.34	22.20	41.07	19,425
	Basal & 10 mg Terra./							
69	lb. of feed	7,525,000	16.5	41.5	55.15	21.93	39.76	24,325
93	"	8,215,000	18.3	46.5	56.60	22.28	39.35	16,375
82	"	6,522,000	18.1	47.0	72.06	27.75	38.51	24,375
49	"	6,735,000	18.3	45.0	66.82	27.17	40.67	14,125
Average		7,226,875	17.8	45.0	62.66	24.78	39.57	19,800
Overall Average		8,341,217	18.6	45.40	56.30	22.98	41.00	19,254

R.B.C. - - - - red blood cell
Hb - - - - - - Hemoglobin
M.C.V. - - - - Mean Corpuscular volume
M.C.H. - - - - Mean Corpuscular hemoglobin
M.C.H.C. - - - Mean Corpuscular hemoglobin concentration
W.B.C. - - - - White blood cell

Table 4. Ascaris numbers found on autopsy.

Lot I Pig No.-Ascaris No.		Lot II Pig No.-Ascaris No.		Lot III Pig No.-Ascaris No.	
72- 1		71- 6		69-22	
97- 8		94- 9		93-15	
86-25		79-12		82-64	
43-18		48- 7		49-27	
52	Total	34	Total	128	Total
13	Average	8.5	Average	32	Average

variation in the nitrogen free extract digestion. The total digestive nutrients were the same for all three lots. A summary of the digestion results are given in Table 6.

The nitrogen balance studies showed that the aureomycin fed pigs retained a smaller percentage of nitrogen in the body than either the basal or terramycin fed group. The basal ration pigs retained the greatest percentage. A summary of the nitrogen balance results is given in Table 7.

As the trial progressed, what appeared to be a calcium or phosphorus deficiency became evident in the pigs. Typical ricket like symptoms developed in the legs of the pigs. This was particularly evident in the terramycin pigs as shown in Plate IV. An analysis of feed was made to determine calcium and phosphorus amount in the feed. This was done to find out whether or not rickets were caused by low calcium or phosphorus content or imbalance between calcium and phosphorus. Results of analysis as shown in Table 8 indicate that the cause of ricket symptoms was being caused by something other than a deficiency or imbalance of calcium and

Table 5. Results of water balance study.

Lot I Basal	Gms. feed consumed	Ml. H_2O	Ml. urine	% urine of H_2O intake	Ml-H_2O in feces	% of HOH in feces of total intake	Total Ml. in urine and feces	Total percent in urine and feces of intake
72	15515	21800	12605	57.82	3098.5	14.21	15703	72.03
97	12869	15100	7000	46.36	3140.3	20.80	10140	67.15
86	14935	22455	12976	57.79	3152.5	14.04	16128	71.82
43	9997	16810	10933	65.04	1608.7	9.57	12542	74.61
Total		76165	43514	57.13	10999	14.44	54513	71.57
Lot II Basal and Aureomycin								
71	14548	22670	11450	50.51	3139.3	13.85	14589	64.35
94	13168	21130	12195	57.71	2857.7	13.52	15053	71.24
79	12996	21300	12784	60.02	2655.1	12.46	15439	72.48
48	9943	22050	12534	56.84	3345.1	15.17	15879	72.01
Total		87150	48963	56.18	11997	13.77	60960	69.95
Lot III Basal and Terramycin								
69	10240	14360	6750	47.00	3082.0	21.46	9832	68.47
93	13666	24600	16885	68.64	3990.1	16.22	20875	84.86
82	11007	16460	9145	55.56	1536.3	9.33	10681	64.89
49	10980	18600	9235	49.65	1982.4	10.66	11217	60.31
Total		74020	42015	56.76	10590	14.31	52645	71.12

Table 6. Summary of digestion results.

Lot I	Total grams feed consumed	Total feces voided dm basis	% Protein	Grams crude protein	% Ether extract	Grams ether extract	Ether extract x 2.25	% Crude fiber	Grams crude fiber	% N.F.E.	Grams N.F.E.	Total Dig.	% TDN
Pig (72)	15515		17.19	2667.028	4.15	643.872	1448.712	2.57	398.735	61.04	9470.356		
		1585.347	22.19	351.778	9.93	157.425		9.81	155.522	42.53	674.248		
Amount digested				2315.250		75.55	1094.506		243.213		8796.108	12449.077	
Dig. coef.				86.81					60.0		92.88		80.24
(97)	12869		17.19	2212.181	4.15	534.063	1201.642	2.57	330.733	61.04	7855.238		
		1625.778	26.69	433.920	8.29	134.777		9.04	146.970	39.72	645.759		
Amount digested				1778.261		399.286	898.393		183.803		7209.479	10069.936	
Dig. coef.				80.38		74.76			55.57		91.78		78.25
(86)	14935		17.19	2567.326	4.15	619.802	1394.554	2.57	383.829	61.04	6102.169		
		1555.711	24.75	385.038	7.87	122.484		10.35	161.016	40.16	624.773		
Amount digested				2182.288		497.368	1119.078		222.813		8491.551	12015.730	
Dig. coef.				85.00		80.25			58.05		93.15		80.45
(43)	9997		17.19	1718.484	4.15	414.875	933.469	2.57	256.923	61.04	6102.169		
		1102.401	24.19	266.671	6.97	76.837		9.73	107.264	42.53	468.851		
Amount digested				1451.813		338.038	760.585		149.659		5633.318	7995.375	
Dig. coef.				84.48		82.04			58.25		92.32		79.98
Total	53316			9165.019			4978.377		1370.220		32544.087		
Amount digested				7727.612			3872.562		799.488		30130.456	42530.118	
Dig. coef.				84.32					58.35		92.58		79.77
Lot II													
Pig (71)	14548		16.31	2372.779	4.08	593.558	1335.505	2.49	362.245	62.89	9149.237		
		1934.615	23.69	458.310	6.29	121.687	273.796	9.94	192.300	43.04	832.658		
Amount digested				1914.469		471.871	1061.709		169.945		8316.579	11462.702	
Dig. coef.				80.68		79.50			46.91		90.90		78.79
(94)	13168		16.31	2147.700	4.08	537.254	1208.821	2.49	327.883	62.89	8281.355		
		1596.492	24.06	384.116	7.72	123.249	277.310	9.15	146.079	42.51	678.669		
Amount digested				1763.584		414.005	931.511		181.804		7602.686	10479.585	
Dig. coef.				82.11		77.06			55.45		91.80		79.58
(79)	12996		16.31	2119.648	4.08	530.237	1193.033	2.49	323.600	62.89	8173.184		
		1384.791	20.75	287.344	7.14	98.874	222.466	10.30	142.633	43.23	598.645		
Amount digested				1832.304		431.363	970.567		180.967		7574.539	10558.377	
Dig. coef.				86.44		81.35			55.92		92.67		81.24

Table 6 (concl.).

	Total grams feed consumed	Total feces voided dm basis	% Protein	Grams crude protein	% Ether extract	Grams ether extract	Ether extract x 2.25	% Crude fiber	Grams crude fiber	% N.F.E.	Grams N.F.E.	Total Dig.	% TDN
(48)	9943		16.31	1621.703	4.08	405.674	912.766	2.49	247.580	62.89	6253.153		
		1481.841	24.94	369.571	5.14	76.167	171.376	10.14	150.259	42.73	633.191		
Amount digested				1252.132		329.507	741.390		97.321		5619.962	7710.805	
Dig. coef.				77.21		81.22			39.31		89.87		77.55
Total	50655			8261.830			4650.125		1261.308		31856.929		
Amount digested				6762.489			3705.177		630.037		29113.766	40211.469	
Dig. coef.				81.85		79.68			49.95		91.39		79.38
<u>Lot III</u>													
Pig (69)	10240		16.69	1709.056	3.99	408.576	919.296	2.70	276.480	61.73	6321.152		
		1422.759	24.69	351.279	7.62	108.414	243.931	11.02	156.788	38.88	553.169		
Amount digested				1357.777		300.162	675.365		119.692		5767.983	7920.817	
Dig. coef.				79.45		73.46			43.29		91.25		77.42
(93)	13666		16.69	2280.855	3.99	545.273	1226.864	2.70	368.982	61.73	8436.022		
		1888.805	21.94	414.404	8.43	159.226	358.258	10.08	190.391	42.15	796.131		
Amount digested				1866.451		386.047	868.606		178.591		7639.891	10551.539	
Dig. coef.				81.83		70.80			48.40		90.56		77.21
(82)	11007		16.69	1837.068	3.99	439.179	988.153	2.70	297.189	61.73	6794.621		
		927.745	23.81	220.896	7.46	69.210	155.722	11.09	102.887	40.05	371.562		
Amount digested				1616.172		369.969	832.431		194.302		6423.059	9065.964	
Dig. coef.				87.97		84.24			65.38		94.53		82.36
(49)	10980		16.69	1832.562	3.99	438.102	985.729	2.70	296.460	61.73	6777.954		
		1198.474	20.69	247.964	7.22	86.530	194.692	12.35	148.011	42.99	515.224		
Amount digested				1584.598		351.572	791.037		148.449		6262.730	8786.814	
Dig. coef.				86.47		80.25			50.07		92.40		80.02
Total	45893			7659.541			4120.042		1239.111		28329.749		
Amount digested				6424.998			3167.439		641.034		26093.663	36327.134	
Dig. coef.				83.88		76.88			51.73		92.11		79.16

Table 7. Summary of nitrogen balance studies.

Pig	Total grams feed consumed	% N in feed	Total grams N consumed	Total Ml urine	Grams N per Ml urine	Total grams N in urine	% N voided in urine	Grams feces dry basis	% N in feces	Total grams N in feces	% N voided in feces	Total N voided urine & feces	% N voided in urine & feces	% retained by pig
Lot I														
72	15515	2.75	426.66	12605	.0120	151.26	35.45	1585.34	3.55	56.280	13.19	207.54	48.64	51.36
97	12869	2.75	353.89	7000	.0130	91.00	25.71	1625.77	4.27	69.421	19.62	160.421	45.33	54.67
86	14935	2.75	410.71	12976	.0111	144.03	34.53	1555.71	3.96	61.606	14.77	205.640	49.30	50.70
43	9997	2.75	274.91	10933	.0116	126.82	46.13	1102.40	3.87	42.663	15.52	169.486	61.65	38.35
Total			1466.18			513.11				219.970		733.087		
Average							35.00				15.00		50.00	50.00
Lot II														
71	14548	2.61	379.70	11450	.0142	162.59	42.82	1934.61	3.79	73.322	19.33	235.912	62.20	37.80
94	13168	2.61	343.68	12195	.0111	135.36	39.39	1596.49	3.85	61.465	17.88	196.829	57.27	42.73
79	12996	2.61	339.19	12784	.0124	158.52	46.73	1384.79	3.32	45.975	13.55	204.497	60.29	39.71
48	9943	2.61	259.51	12534	.0092	115.31	44.43	1481.84	3.99	59.125	22.78	174.438	67.22	32.78
Total			1322.09			571.78				239.887		811.676		
Average							43.25				18.14		61.39	38.61
Lot III														
69	10240	2.67	273.40	6750	.0131	88.42	32.34	1422.75	3.95	56.195	20.55	144.620	52.89	47.11
93	13666	2.67	364.88	16885	.0098	165.47	45.35	1888.80	3.51	66.297	18.17	231.770	63.52	36.48
82	11007	2.67	293.88	9145	.0103	94.19	32.05	927.74	3.81	35.347	12.03	129.540	44.08	55.92
49	10980	2.67	293.16	9235	.0121	111.74	38.11	1198.47	3.31	39.669	13.53	151.412	51.65	48.35
Total			1225.34			459.83				197.508		657.342		
Average							37.53				16.12		53.65	46.35

Table 8. Calcium and phosphorus content of ration.

	Calcium Percent (calculated)	Calcium Percent (chem. analysis)	Phosphorus Percent (calculated)	Phosphorus Percent (chem. analysis)
Sample 1 - 15% protein ration:	.90	.75	.6	.59
Sample II - 18% protein ration:	.928	1.00	.76	.711
Sample III - 18% protein ration:	.928	1.08	.711	.78

phosphorus. Apparently the rickets were caused by lack of vitamin D. Delsterol was added to the mouth of the self feeder, a teaspoonful at a time. This arrested ricket-appearing symptoms. Upon autopsy no evidence of rickets could be found in the bones.

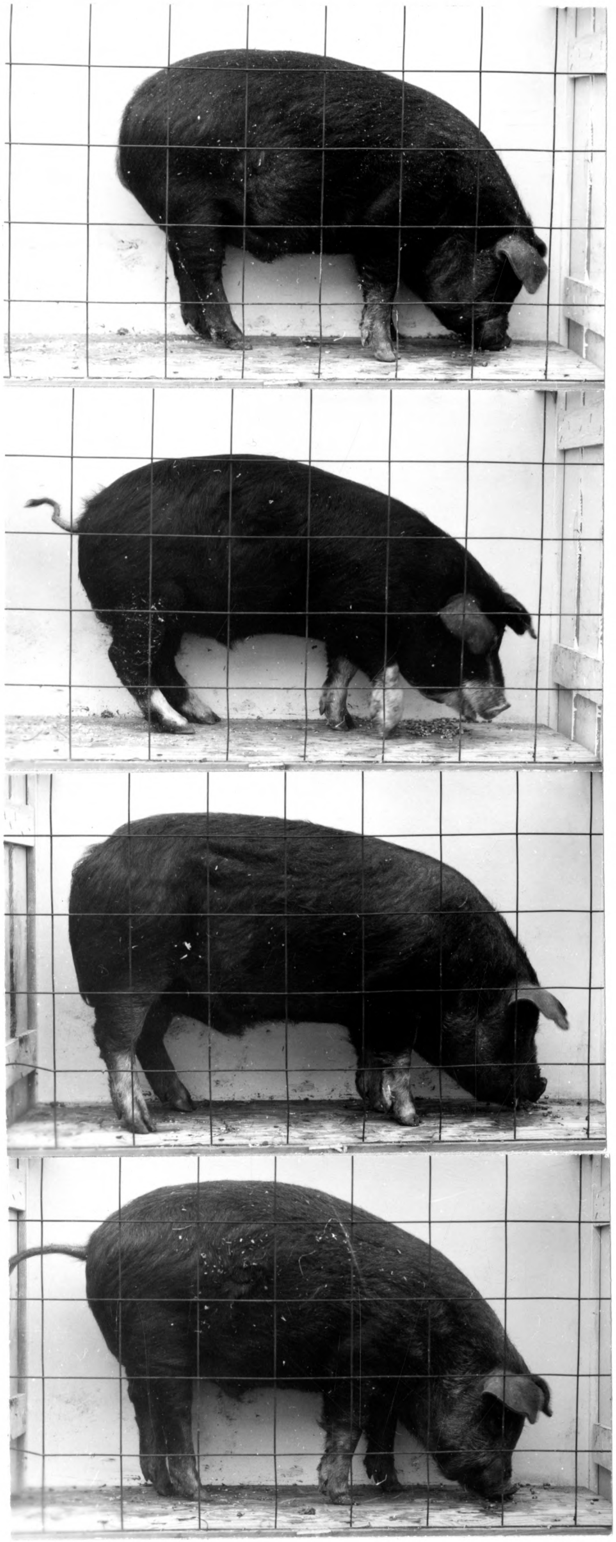
Summary

Five Duroc Jersey litters of 3 male weanling pigs each were randomly alloted to three lots. A littermate was placed in each lot. The first lot was the control, receiving a practical basal ration consisting of yellow corn, soybean oilmeal, tankage, alfalfa meal, and minerals. The ingredients were balanced to give 18, 15, and 12 percent protein rations. The second lot received the basal ration plus 10 milligrams aureomycin per pound total feed, and the third lot received the basal ration plus 10 milligrams terramycin per pound total feed. The aureomycin supplemented pigs had a greater rate of gain and were more efficient in the utilization of feed than either of the other two lots. Terramycin fed pigs had a lower rate of gain and were less efficient in the utilization of feed.

EXPLANATION OF PLATE II

Four basal ration pigs numbering one through four consecutively from the top. Each pig is a littermate of the corresponding number in the other two treatments.

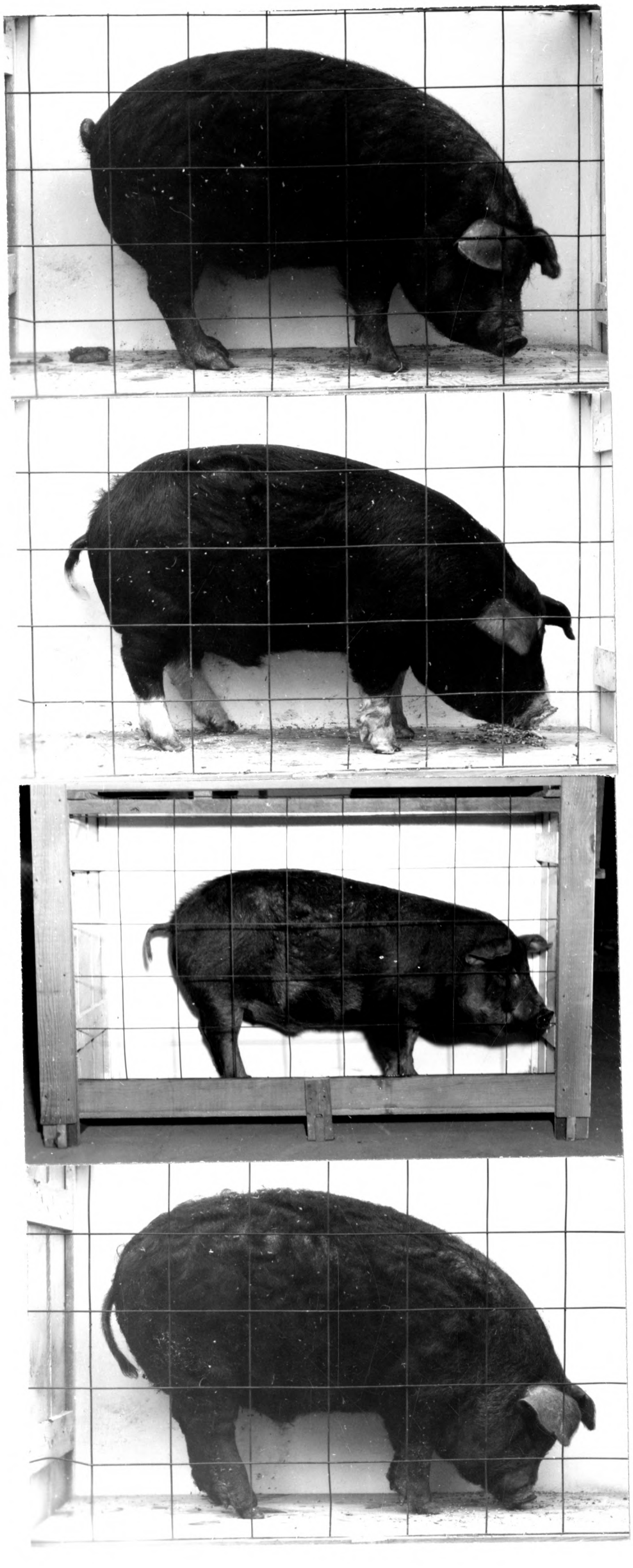
PLATE II



EXPLANATION OF PLATE III

Four aureomycin ration pigs numbering one through four consecutively from the top. Each pig is a littermate of the corresponding number in the other two treatments.

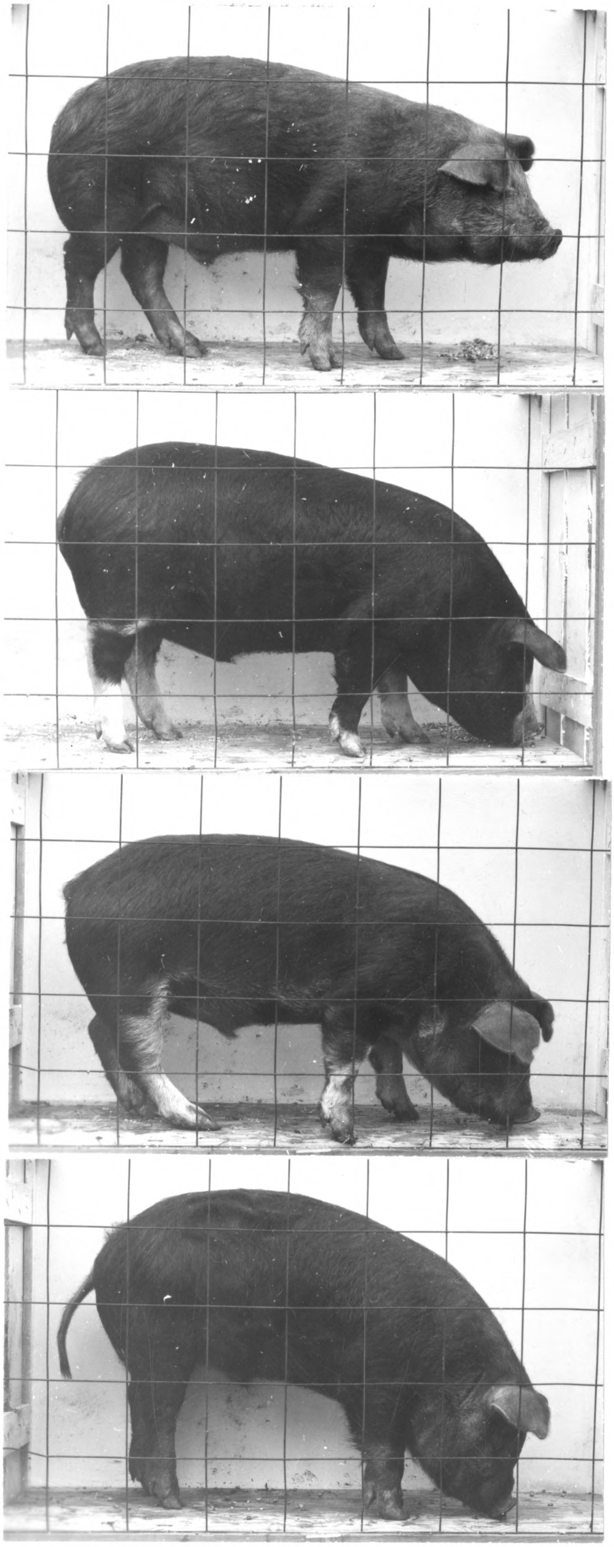
PLATE III



EXPLANATION OF PLATE IV

Four terramycin ration pigs numbering one through four consecutively from the top. Each pig is a littermate of the corresponding number in the other two treatments.

PLATE IV



Analysis of blood data showed normal variations for pigs between all three lots. Parasite infestation was greatest in Lot III pigs. The Lot II pigs had the lowest concentration of worms followed by the Lot I animals.

Water balance studies showed that pigs receiving aureomycin drank a larger volume of water and had larger urinary losses than the other lots. In the digestion trial the aureomycin pigs digested less protein than either of the other two lots which closely parallel each other. The Lot II pigs utilized a higher percentage of fat than the other two lots, and both Lot II and Lot III pigs digested a lower percentage of fiber than the basal ration pigs. The aureomycin pigs retained a smaller percentage of nitrogen in the body than the other two lots.

EXPERIMENT II

Experimental Procedure

The experimental procedure in Experiment II was essentially the same as for Experiment I. The only variations being the use of Poland China female weanling pigs. Spring litters were used in this experiment. Metabolism studies were not conducted due to extremely warm weather.

Results and Discussion

Pigs in Experiment II were exposed to extremely warm temperatures during the summer months. Temperatures of 110 F degrees were not unusual. Water troughs were checked two to three times daily and the pigs were sprayed with a hose twice daily. The average daily gains were considerably higher for all Lots in Experiment II as compared to Experiment I. At approximately 165 pounds, the 5th pig in Lot II broke the latch that held open the door to the outside. In doing so, he closed the door, leaving himself on the outside. All pigs had been checked at 10 a.m. and by 1 o'clock the pig was found dead. It is assumed that he became excited upon not being able to return to the inside of the building where shade could be found. Temperatures were over 100° F and the pig succumbed to the heat.

When the first three pigs reached 100 pounds, they were placed in the metabolism crates, as was done in the first trial. The metabolism crate construction limits the circulation of air that can reach the animal readily in the crate. At approximately 11 o'clock the animals were placed in the crates. at 2 o'clock one pig had already died from the heat, and the other two animals were suffering acutely. They were quickly removed to their pens and sprinkled with water. They were fully recovered two hours later. It was felt, due to the lack of facilities for handling animals in metabolism crates during warm weather, no metabolism work would be run in Experiment II.

No evidence or indication of rickets appeared in this experiment. At approximately 170 pounds, the first pig in Lot I as seen in Plate V, started refusing the corn in his ration, eating only the fine material. At 200 pounds the pig refused all feed. Gradually the animal went back on feed and reached market weight. The pig at all times appeared well. The gilts mouths was checked with a spectulum. Visual inspection showed no abnormality. Though upon autopsy, advanced decay was found in all molars.

There was a large difference in the rate of gain of Lot II pigs as compared to the other lots as shown in Fig. II. Aureomycin supplemented animals not only grew at a faster rate, but were more efficient in

EXPLANATION OF PLATE V

Five basal ration pigs numbering one through five consecutively from the top. Each pig is a littermate of the corresponding number in the other two treatments.

PLATE V

EXPLANATION OF PLATE VI

Four aureomycin ration pigs numbering one through four consecutively from the top. Each pig is a littermate of the corresponding number in the other two treatments.

PLATE VI

EXPLANATION OF PLATE VII

Four terramycin ration pigs numbering 1, 2, 4, and 5 consecutively from the top. Each pig is a littermate of the corresponding number in the other two treatments.

PLATE VII

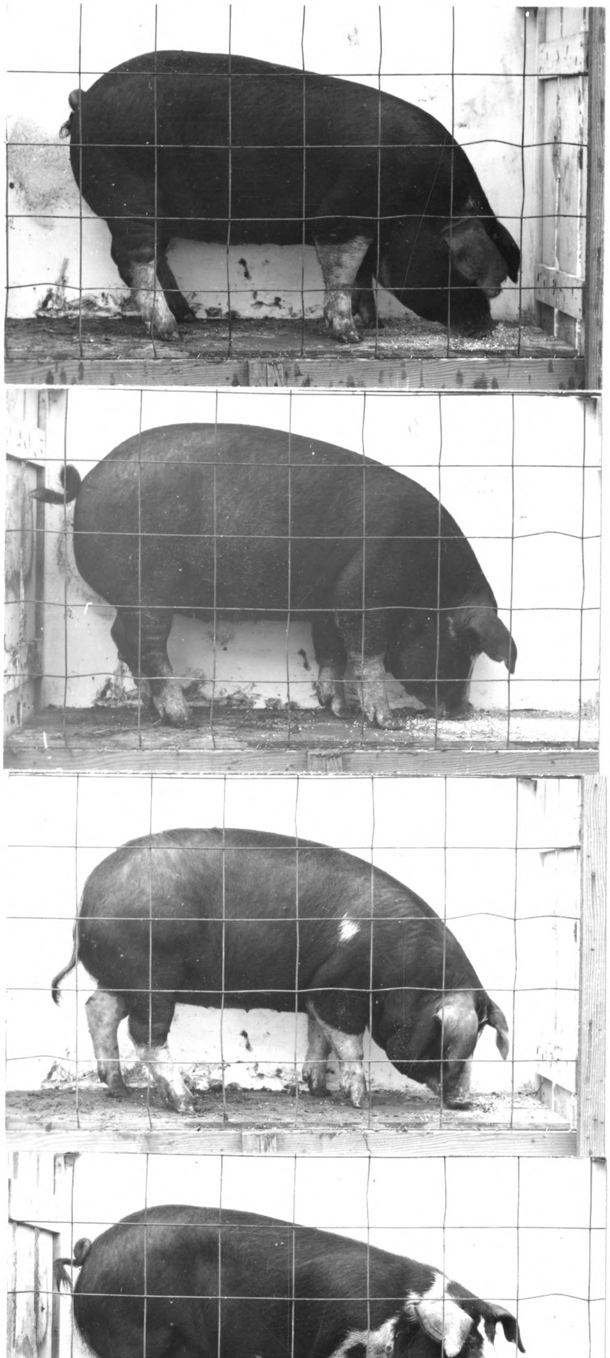


Table 9. Summary of growth and feed results.

Lot I Basal	Initial weight	Final weight	Total gain	Total days	Average daily gain	Total feed	Feed per 100 pounds gain
63*	41	235	194	147	1.32	796	410
9	38	243	205	122	1.65	580	283
8	48	235	187	96	1.95	588	312
39	38	229	191	147	1.30	669	350
54	40	238	198	122	1.62	697	351
Total	205	1180	975	634	7.87	3330	1706
Average	41	236	195	127	1.57	666	341
Lot II Basal and 10 mg. Aureo.							
A5 died							
59	45	232	187	103	1.81	599	320
3	49	245	196	96	2.20	679	348
12	42	249	207	103	2.00	640	310
44	36	229	193	122	1.58	677	350
Total	172	955	783	424	7.59	2595	1328
Average	43	239	196	106	1.90	649	332
Lot III Basal and 10 mg. Terra.							
T3 died							
58	49	228	179	103	1.74	604	339
5	49	235	186	103	1.80	631	340
45	40	237	197	131	1.50	785	399
51	34	233	199	147	1.35	633	319
Total	172	933	761	484	6.39	2653	1397
Average	43	234	190	121	1.60	663	349

*Pig number 63 at 170# started refusing the corn in the ration, at 200" went completely off feed. Gradually went back on feed. Autopsy showed advanced decay in all molars.

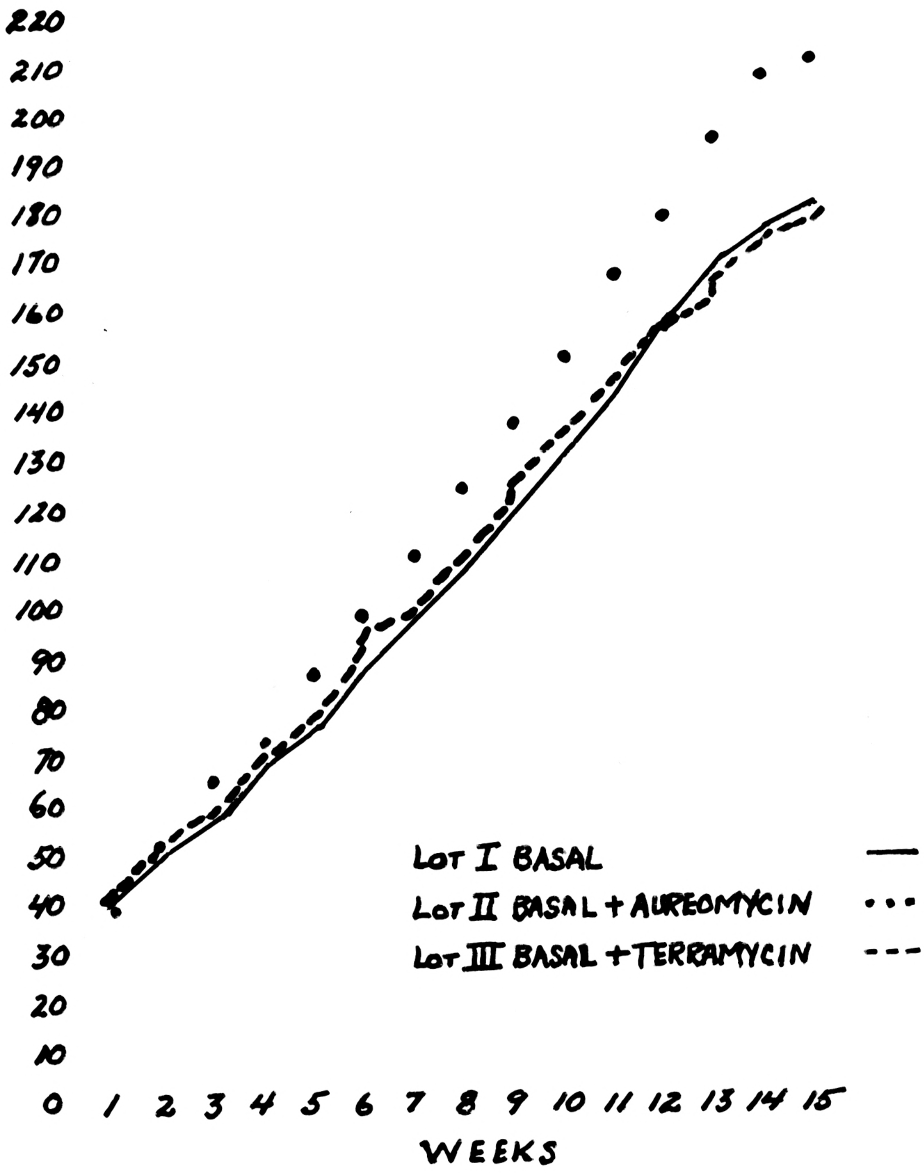


Fig. II Growth Curves of Lot Mean Weights - Experiment II

Table 10. Blood data Experiment II.

Pig No.	Treatment	Total R.B.C.	Hb gm/ 100 ml	Hematocrit	MCV	MCH	MCHC
63	Basal	8,965,000	17.5	47.8	53.32	19.52	36.61
9	"	11,410,000	21.3	50.0	43.82	18.67	42.60
8	"	7,833,000	18.4	44.0	56.17	23.49	41.82
39	"	7,485,000	18.0	46.5	62.12	24.05	38.71
54	"	11,080,000	21.3	50.5	45.58	19.22	42.18
Average		9,354,000	19.3	47.8	52.22	20.99	40.38
59	Basal and aureomycin	8,750,000	20.1	46.0	52.57	22.97	43.70
3	"	8,633,000	18.8	46.0	53.28	21.78	40.87
12	"	Blood Coagulated					
44	"	Blood Coagulated					
56	"	Died					
Average		8,692,000	19.5	46.0	52.93	22.38	42.29
58	Basal and terramycin	8,670,000	21.7	48.0	55.36	25.03	45.21
5	"	9,010,000	21.2	47.0	52.16	23.53	45.11
6	"	Died					
45	"	9,240,000	17.9	50.0	54.11	19.37	35.80
51	"	11,060,000	15.2	50.1	45.30	13.74	30.34
Average		9,495,000	19.0	48.8	51.73	20.42	39.12
Overall Average		9,180,000	19.3	47.5	52.29	21.26	40.57

Table 11. Ascaris numbers found on autopsy: Experiment II.

Lot I Pig No.-Ascaris No.		Lot II Pig No.-Ascaris No.		Lot III Pig No.-Ascaris No.	
63-5		59-24		58-38	
9-3		3- 6		5-12	
8-12		12-14		6-died	
39-6		44- 8		45-4	
54-55		56-died		51-4	
81	Total	52	Total	58	Total
16	Average	13	Average	14.5	Average

utilizing feed than the other lots as seen in Table 9. Growth rate and feed utilization was about the same for Lot I and Lot III pigs. Animals used in the experiment are shown in Plates V, VI and VII.

As the pigs reached market weight, blood samples were taken. The blood data as seen in Table 10 showed no outstanding differences between treatments and exhibited normal variations found in swine. White blood cell counts were not included due to an error in technique when the count was made.

The animals were checked for parasites at slaughter. Ascaris found in the intestinal tract were counted. Variations were large within lots, as seen in Table 11. Averages of the three lots showed less ascaris in Lot II and Lot III as compared to Lot I, though the variation was small in all lots.

Summary

Three lots of five Poland China weanling gilts each were bed in the same manner as was done in the first experiment. The same ration was fed and the same antibiotic supplements were used. No digestion trial was run due to the extremely warm weather which caused the death of two pigs. Aureomycin supplemented swine made faster gains over the other two lots. Feed utilization was more efficient with the aureomycin pigs. Terramycin pigs closely paralleled the rate of gain and feed efficiency of the basal ration pigs. Blood data on all three lots showed no deviation from the normal values found in swine. Upon autopsy both antibiotic lots showed a lower parasite infestation than the controls. The aureomycin supplemented swine showed a greater decrease in parasite infestation, while terramycin decreased infestation only slightly.

GENERAL DISCUSSION

The observation that aureomycin can increase growth, (Jukes et al, 28), in swine has been followed by numerous studies on the nutritional effect of antibiotics, with emphasis on vitamin B12 and unknown growth factors. Swine as a class of livestock have made the most striking increases due to antibiotics. Response is markedly influenced by the environment and the diet. In some cases (Burnside et al, 11) where very large increases were observed, diarrhea and enteritis were present. The increase in growth was due to combined nutritional and therapeutic effects. This response has been noted by other investigators, (19, 3, 4, 27 and 12). The two experiments conducted showed no evidence at any time of diarrhea except for a few days at the start of the first experiment. All pigs that started the experiment were in a healthy and thrifty condition.

The antibiotic growth response is confined solely to the growth rate and does not affect the final size of the animal. The effect was most marked during the early growing period. Antibiotics have no effect on reproduction in swine. There is no effect on gestation, no increase in size of litter, or the average birth rate of pigs. This work was shown by DePape et al, (21), and Mirone (40) working with mice. Antibiotics do not seem to have any effect on the blood values of hemoglobin, erythrocytes and leukocytes, or the differential count. Mirone (40), and Squibb et al (53) working with mice and swine respectively have found the former to be true. Blood analysis on these experiments showed no deviation from the established norms on swine blood.

A great deal of work has been done to determine the mechanism of the action of antibiotics. The available evidence indicates that the effect is on the intestinal bacteria, and not directly on the animal.

Antibiotics change the intestinal microflora and some of the theories on how this improves the growth of the animal are, first, elimination of the bacteria that produces harmful substances, second, elimination of bacteria which absorb dietary substances and thus prevent their absorption by the host, and third, improvement of bacterial synthesis of essential growth factors.

Evidence to support the first possibility that antibiotics eliminate bacteria which produce harmful substances have been shown. Bridges et al (7) found a significant correlation between rates of gain and the coliform groups of bacteria when penicillin was fed to swine. This work does not directly agree with Speer et al (52), who failed to obtain an increase in the rate of gain with aureomycin fed to pigs under disease free conditions. Pigs in these experiments were raised under sanitary conditions. No evidence of disease was present in any of the lots; however, the pigs receiving aureomycin made a much greater rate of gain than either the control or terramycin group.

There is some evidence to support the second possibility that antibiotics may prevent competition for essential nutrients between the animal and the intestinal bacteria. Romocer (47), indicated an apparent decrease in unidentified branch rods present in the cecal content of chicks when penicillin was fed. This microorganism has been suggested as a competitor with the host for certain nutrients. March and Ruby (38), by feeding aureomycin to chicks caused a depression in the number lactobacilli present in the feces. The authors state that the antibiotics may cause a reduction in the number of microorganisms competing with the host for nutrients. Richardson et al (44), hypothesized that feeding a high level of a combination of antibiotics to weanling pigs affected the intestinal flora in such a manner as to reduce the number of organisms competing with the host for vitamin B12.

The third possible mechanism of action is the enhancement of bacterial synthesis of essential growth factors. There have been experiments indicating that antibiotics decrease requirements for certain water soluble vitamins. Lih et al (32), show that various antibiotics stimulated the growth of rats receiving limiting amounts of thiamine, riboflavin, and pantothenic acid as fed in his assays for these vitamins. Catron and Baumann (16) found aureomycin appeared to "spare" both vitamin B12 and pantothenic acid. There is little doubt that under particular conditions antibiotics decrease the requirement for certain water soluble vitamins. It is difficult to decide whether this is the result of an increased synthesis or a decreased uptake of vitamin by the intestinal microflora.

Antibiotics appear to exhibit a "sparing" effect on the level of protein fed to swine. Catron et al (18) feeding a corn soybean oil-meal ration supplemented with minerals and vitamins, including vitamin B12, found that pigs gain normally from weaning to 200 pounds in drylot on a 16-13-10 percent protein ration without antibiotics. With the addition, of an antibiotic, swine on a 14-11-8 percent protein level produced gains equivalent to a higher level protein. Hoefer et al (25) using terramycin as the antibiotic found that pigs receiving a 15 percent protein ration reduced to 12 percent at 100 lbs. did just as well as pigs receiving the 18 percent protein ration reduced to 15 percent at 100 lbs. This is in agreement with the findings in these experiments. Aureomycin supplemented pigs while in the metabolism crates utilized less protein than either the basal or the terramycin lots. Terramycin supplemented swine, utilized more protein than the aureomycin swine and slightly less than the basal ration. These results suggest that antibiotic fed swine can utilize a lower level of protein in the ration to an advantage.

The antibiotic fed swine utilized in these experiments smaller amounts of crude fiber than the basal ration pigs. Wasserman et al (57), in working with antibiotics on invitro cellulose digestion found that penicillin stimulated cellulolytic rumen microorganisms, neomycin was slightly stimulatory, and chloromycetin adversely affected the microorganism. It may be assumed that different microorganisms respond differently to various antibiotics. More work has to be done before a definite conclusion on the mode of action of aureomycin and terramycin upon cellulose digestion can be determined.

The work in this experiment is unique in that it is not in agreement with the work done by Leher et al (29), Huang (26), (27), Carpenter (13), Hoefer et al (25) who found significant responses in the growth rate of pigs when fed terramycin. Terramycin when fed in these experiments appeared to lower the palatability of the ration fed. Terramycin when fed in these experiments appeared to lower the palatability of the ration fed. Terramycin supplemented swine made a lower rate of gain than the pigs fed the basal ration in the first experiment, and in the second experiment closely parallelled the rate of gain made by the basal ration pigs. While in the metabolism crates the terramycin pigs drank less water and correspondingly excreted less urine. Robinson et al (46) using procaine penicillin as a supplement found that the antibiotics appeared to lessen the desire for water. Just the opposite effect was found with the aureomycin supplemented swine. This agrees with Braude and Johnson (5), who found higher urinary excretion with aureomycin fed swine.

Braude and Johnson (5) found no effect on nitrogen relention when aureomycin was added to the ration. In these experiments aureomycin supplemented pigs retained considerably less nitrogen than either the basal or terramycin fed lots.

Robinson et al (45) studied the growth promoting effects of procaine penicillin on nine week old pigs on a restricted feeding program. He found that restricted feeding limited the increase in rate of live weight gain obtainable with antibiotic supplements. In these experiments aureomycin fed pigs though not on a restricted feeding program made a greater average daily gain at a more efficient feed conversion than any of the other lots on the experiment.

It has been suggested that antibiotics influence the level of parasite infestation of swine. Huang and McCoy (26) reported that terramycin seems to favor the infestation of swine by ascaris. His work is in agreement with the first experiment. In the second experiment terramycin supplemented pigs had less worms than the control, but more than the aureomycin supplemented pigs. Hansen et al (22) found that chicks fed aureomycin and vitamin B12 had less infestation of parasites. This is in agreement with Experiment I and II. Hansen, in experimental work that is in the process of publication, found that feeding aureomycin to chicks decreased the infestation of ascaris, while vitamin B12 increased the incidence of of ascaris. Shorb (50) using aureomycin and vitamin B12 in swine found the supplemented ration had no effect on parasitism. The pigs were infected with oesophagostomum and hyostrongylus. This would correspond with Hansens work that aureomycin and vitamin B12 together have a nullifying effect upon each other in regard to the degree of infestation by parasites. Separately, aureomycin decreases infestation while vitamin B12 enhances infestation by parasites.

SUMMARY

In two experiments conducted to study the effects of antibiotics, by fattening swine, it was evident at the close of the second experiment, that there was a definite correlation between experiments.

There were three lots of swine on experiment. The first lot was the control receiving a practical ration consisting of yellow corn, soybean oil meal, tankage, alfalfa meal, and minerals. The ingredients were balanced to give an 18, 15, and 12 percent protein ration. The second lot received the basal ration plus 10 milligrams aureomycin per pound of total feed, and the third lot received the basal ration plus 10 milligrams terramycin per pound of total feed.

Aureomycin supplemented pigs made significantly greater rates of gain and increased efficiency of feed utilization in both experiments over the controls, as well as the terramycin supplemented swine. Aureomycin supplemented pigs drank more water, excreted more urine, utilized less protein, retained less nitrogen, and digested less crude fiber than the other two lots.

Terramycin supplemented swine did not gain as well as the controls in the first experiment and only paralleled the controls in the second experiment. Feed utilization by the terramycin fed pigs were less than the controls in the first experiment and were approximately the same in the second experiment. Terramycin fed pigs drank less water, excreted less urine, utilized slightly less protein than the controls, and less fiber than the check lot. Blood data was normal for all lots in both experiments.

Aureomycin appeared to decrease the infestation of ascaris in both experiments, while terramycin appeared to increase the infestation in the first experiment, the ascaris level was slightly lower than the controls in the second experiment.

CONCLUSIONS

1. Terramycin did not increase the palatability of the feed used in these two experiments.

2. Terramycin did not increase the rate of gain over the basal ration in these experiments.

3. Aureomycin greatly increased the rate of gain over the basal ration in these feeding trials.

4. Aureomycin fed pigs digested less portein.

5. Aureomycin supplemented swine retained less nitrogen than the other lots.

6. Terramycin and aureomycin fed pigs did not digest crude fiber as well as pigs fed the basal ration.

7. The aureomycin pigs while in the metabolism crates drank more water, and excreted a larger volume of urine than either of the other two lots.

8. No significant differences were found in the blood values studied.

9. Aureomycin fed pigs were more efficient in feed utilization than either the basal or terramycin fed pigs.

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THE EFFECT OF ANTIBIOTICS UPON FEED UTILIZATION BY FATTENING SWINE

by

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Two feeding trials were conducted to study the influence of antibiotics upon water consumption, nitrogen balance, and feed utilization with fattening swine. Fifteen pigs were used in both experiments. Duroc Jersey barrows were used in the first experiment, and Poland China gilts in the second experiment. They were littermate pigs from sows fed a good ration without antibiotics during gestation-lactation. The animals were individually self fed from weaning to market weight in concrete floored pens.

Littermate pigs were randomly allotted to each lot. There were three lots. All pigs received a practical ration containing yellow corn, soybean oilmeal, tankage, alfalfa meal, and minerals. The various ingredients were balanced to give an 18 percent protein ration from weaning until they reached a weight of approximately 75 pounds. They were then changed to the 15 percent protein ration. At approximately 120 pounds they went on the 12 percent protein ration until they reached market weight. The first lot was fed the basal ration. The second lot received the basal ration plus 10 milligrams aureomycin per pound total feed, and the third lot received the basal ration plus 10 milligrams terramycin per pound total feed. Aureomycin supplemented swine made faster gains and was more efficient in utilization of feed. Terramycin supplemented pigs had lower rates of gain and lower feed utilization than the control lots in the first experiment. In the second experiment, terramycin supplemented swine closely paralleled the performance of the controls. Aureomycin supplemented pigs drank more water, excreted more urine and terramycin animals drank less water, excreted less urine than the basal pigs. Both antibiotics digested less protein and crude fiber than the controls. The aureomycin fed animals retained less nitrogen than either of the other groups. The terramycin supplement appeared to lower the palatability of the ration. The swine on this ration would make a point of eating only the corn in the mixed feed and leaving the fine material. The watering troughs were cleaned daily because waste feed from the pigs mouth seemed to impart a disagreeable flavor to the drinking water. Blood values for all lots were normal for swine. Aureomycin seemed to decrease parasitism in both experiments. Terramycin appeared to increase the incidence of parasites in the first experiment. This does not agree with the second experiment where the terramycin pigs had less worms than the controls.