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THE USE OF ANTIBIOTICS IN POULTRY RATIONS

by

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UNIVERSITY OF ALBERTA

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THE UNIVERSITY OF ALBERTA

THE USE OF ANTIBIOTICS IN POULTRY RATIONS

A DISSERTATION

SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES
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BY

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ABSTRACT

Three experiments, designed to study the effect of the addition of antibiotics to rations of breeders, chicks and broilers, were conducted.

The study with breeding hens indicated that the addition of penicillin to three breeding rations which varied in protein and energy content, had no effect on the productive and reproductive performance of birds fed the rations. The riboflavin content of the livers of the treated birds was not affected.

Three trials were conducted on the use of antibiotics in chick rations. The addition of antibiotics resulted in a variable response which appeared to be related to the ration fed and the type of chicks employed. The addition of vitamin B₁₂, penicillin or aureomycin to chick rations did not affect the storage of riboflavin in the liver of the chick.

A series of three trials was conducted to study the effect of the addition of penicillin to broiler rations, which varied in energy and protein content. The results obtained indicated that the addition of penicillin to a low energy type broiler ration or a corn-soybean oil meal ration caused an increase in the rate of growth of chicks. No growth response to penicillin supplementation was noted when a high energy; high energy, low protein; low energy, low protein or a corn-soybean oil meal, low protein diet was employed.

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INTRODUCTION

Poultry producers have known for many years that protein concentrates of animal origin contained something which was lacking in protein concentrates of plant origin. Producers have preferred to feed some animal protein supplement in their rations because, in most cases, the birds grew faster and made more efficient gains.

As a result of wartime conditions, however, animal protein concentrates were in short supply and the amount available was not adequate to meet the needs of all the producers. This lack of concentrates of animal origin had the effect of stimulating the use of plant proteins in poultry rations.

It soon became apparent that there was present in animal protein concentrates a factor(s) which was essential for maximum growth and which was lacking in concentrates of plant origin. The factor was commonly called the "Animal Protein Factor". Eventually in 1948 the factor was isolated in pure form and called vitamin B₁₂.

Following the isolation of vitamin B₁₂, it was found that a number of organisms isolated from soil produced this vitamin when grown in pure culture. Similarly organisms which are used in the production of antibiotics such as aureomycin, streptomycin and penicillin were shown to be

producers of the factor in question. As a result vitamin B₁₂ supplements (by-products from aureomycin, streptomycin and other fermentation processes) began to appear on the market, and were sold as Animal Protein Factor Supplements (APF Supplements).

It soon became apparent that certain of the APF Supplements contained a growth factor(s) other than vitamin B₁₂. In feeding trials it was noted that, on certain rations, the addition of an APF Supplement resulted in a marked increase in growth rate of chicks while no growth response was obtained from the addition of crystalline vitamin B₁₂. It was later shown that the factor(s) responsible for the increased growth rate was an antibiotic.

In view of the possible economic importance of the above observations, trials were initiated at the University of Alberta in 1950 to study certain aspects of the use of antibiotics in poultry rations.

REVIEW OF LITERATURE

Following the isolation of vitamin B₁₂ by Rickes and coworkers (1948) reports appeared in the literature suggesting that the growth promoting activity of certain "Animal Protein Factor Supplements" could not be explained on the basis of the vitamin B₁₂ content of such supplements.

Stokstad et al. (1949) reported that the Animal Protein Factor was multiple in nature and presented results which indicated that a fermentation product, obtained from the culture of Streptomyces aureofaciens promoted better chick growth than that obtained from pure vitamin B₁₂. In studies with pigs Cunha et al. (1949) noted that an "Animal Protein Factor Supplement" resulted in a twenty-six percent increase in the rate of gain of pigs while the addition of a vitamin B₁₂ concentrate had no apparent effect.

It was soon established that the increased rate of growth was caused by the presence of aureomycin in the APF Supplement. The concept that an antibiotic could stimulate the growth rate of chicks was not entirely new, for Moore et al. (1946) showed that feeding streptomycin to chicks on a purified diet resulted in an increased rate of growth. Stokstad and Jukes (1950) showed that the addition of crystalline aureomycin enhanced the growth of chicks on diets adequate in vitamin B₁₂ to almost the same extent as concentrated cultures of Streptomyces aureofaciens. A response in growth rate was also obtained from the addition of streptomycin to the basal diets. The effectiveness of aureomycin and streptomycin as growth promoting substances was confirmed by Groschke and Evans (1950).

Subsequently it was shown that in addition to aureomycin and streptomycin, penicillin and terramycin were

effective in stimulating the growth rate in turkeys; McGinnis, Stern, Wilcox and Carver (1951). Penicillin was found to be the most effective of the antibiotics tested.

In trials conducted at the University of Alberta to be reported herein, only penicillin and aureomycin were used. It would therefore seem advisable to deal with each in turn.

Penicillin

A number of investigators have found that the addition of penicillin to rations stimulates the growth of chicks and turkey poults. McGinnis et al. (1951) reported that the addition of penicillin to a turkey starter was effective in increasing the rate of growth of poults. When compared to aureomycin, streptomycin and terramycin, penicillin appeared to be the most effective antibiotic. Combinations of other antibiotics with penicillin were no more effective than penicillin alone. The response to antibiotics was greater on the basal diet which contained ten percent fishmeal than on the basal diet in which soybean oil meal was used as the only protein supplement. Penicillin was found to be effective when added to the basal diet at a level of 5 milligrams per kilogram of ration. Patrick (1951) studied the effect of penicillin supplementation on turkey poults fed a corn-soybean oil meal ration adequately supplemented with vitamin B₁₂. Penicillin was added to the

basal ration at levels of 22, 44, and 88 milligrams per kilogram of ration. The greatest response was obtained on the higher level (88 milligrams per kilogram) whereas the least response was obtained on the basal ration supplemented with 44 milligrams of penicillin per kilogram of ration. The response as a result of the addition of penicillin, however, was irregular and could not be attributed to the amount of the antibiotic consumed. Somewhat similar results were reported by Davis and Briggs (1951). These workers obtained an increased rate of growth of chicks when a corn-soybean oil meal ration adequate in vitamin B₁₂ was supplemented with either penicillin, aureomycin, terramycin or streptomycin. The results indicated that a level of 25 milligrams of penicillin per kilogram of ration appeared to be as effective as did a level of 50 milligrams. The degree of response, however was irregular and stimulation of growth did not occur in all cases. When stimulation did occur, equal effects were obtained by the addition of either penicillin, bacitracin, aureomycin, or terramycin. Streptomycin, however, did not appear to be as active as the others. The results of feed efficiency data indicated that the addition of each antibiotic resulted in improved feed utilization.

Branion and Hill (1951) studied the effect of the addition of penicillin at a level of 25 milligrams per kilogram of ration to two basal rations, one containing animal protein and the other a soybean oil meal - cereal grain diet. The addition of penicillin resulted in improved growth of turkey poults, when added to either of the above rations. The addition of penicillin to the ration containing animal protein did not improve feed efficiency, but an improvement was evident when penicillin was added to the plant protein ration.

Although most of the reports which have appeared in the literature have dealt with the effect of the addition of penicillin to chick or poult rations, a few studies have been conducted on the effect of the addition of penicillin to broiler, laying and breeding rations. Reynolds, Runnels and Waller (1951) fed a practical type mash containing five percent fishmeal, two and one-half percent dried whey and no vitamin B₁₂ supplement to broilers grown in batteries. The mash was supplemented with penicillin at levels of 2.2, and 4.4 milligrams per kilogram of ration respectively. A level of 2.2 milligrams of penicillin per kilogram of ration appeared to be near the optimum level for maximum growth response. In a further experiment Runnels, Reynolds and Waller (1951) obtained data on the influence of various

levels of penicillin and streptomycin on the rate of growth and feed efficiency in broiler diets. A complete practical type mash containing five percent meat scraps but no APF Supplement was fed as the basal diet. Penicillin or streptomycin were added to the basal ration at varying levels. Analysis of the results showed that 2.2 milligrams of penicillin per kilogram of ration produced the greatest gains and most efficient feed utilization.

In experiments with laying hens, Halick and Couch (1951) studied the effect of additions of aureomycin, penicillin and streptomycin to a purified diet deficient in vitamin B₁₂. It was observed that the addition of either penicillin or aureomycin appeared to stimulate the hatchability of eggs in the early part of the trial. In a later report Elam, Gee and Couch (1951) noted that the addition of penicillin resulted in an increase in hatchability of eggs from hens fed a vitamin B₁₂ deficient diet. It was also observed that production rate was improved when penicillin was added to the diet of pullets injected with vitamin B₁₂.

Aureomycin

Aureomycin has been shown to be effective in stimulating the rate of growth of chicks and turkey poults. The initial studies, which led to the establishment of the effectiveness of aureomycin, in this regard were conducted

using a vitamin B₁₂ fermentation product (APF Supplement) which also contained aureomycin. Stokstad et al. (1949) reported that such a product contained an unidentified growth factor(s) since the growth response was greater than that produced by vitamin B₁₂ alone. Similar results were reported by Singsen and Matterson (1949) in studies with chicks, and by Cunha et al. (1949) in studies with pigs. In a further report Stokstad and Jukes (1950) showed that the unidentified chick growth factor(s) present in the APF Supplement was probably aureomycin since the addition of pure aureomycin to a vitamin B₁₂ adequate diet stimulated the rate of growth of chicks to the same extent as the APF Supplement. Chemical fractionation of the APF Supplement showed some similarity between the distribution of aureomycin and the unidentified growth factor.

The effectiveness of aureomycin in stimulating rate of growth of chicks was confirmed by Groschke and Evans (1950). Aureomycin was added to the basal diet at a level of 100 milligrams per kilogram of diet and the APF Supplement (Lederle) was used at a level of one percent of the diet.

The results of a number of studies on the use of pure aureomycin soon appeared and further confirmed the effectiveness of the antibiotic in stimulating growth of chicks and poults. Whitehill, Oleson and Hutchings (1950)

reported that aureomycin at a level of 25 milligrams per kilogram of ration was as effective as a whole Streptomyces aureofaciens mash in increasing rate of growth of chicks. The growth promoting effect was not limited to vitamin B₁₂ deficient chicks or to chicks fed a corn-soybean oil meal diet since chicks obtained from a commercial hatchery and fed several diets responded to the addition of aureomycin.

McGinnis et al. (1951) reported that a level of 25 milligrams of aureomycin per kilogram of ration stimulated the growth of poults from vitamin B₁₂ deficient breeders when fed either a corn-soybean oil meal diet or a corn-fishmeal diet. Branion and Hill (1951) found the same level (25 milligrams per kilogram of ration) was effective in promoting the growth of turkey poults from breeders fed a diet adequate in vitamin B₁₂.

A number of studies have been conducted using an APF Supplement (Lederle) which contained aureomycin. Reed and Couch (1950) found that the addition of an APF Supplement (Lederle) at levels of 0.25, 0.50 and 1 percent of the diet resulted in a decided increase in the weight of chicks with each level fed. Biely et al. (1951) reported that the addition of an APF Supplement (Lederle) at levels of 0.3 and 0.5 percent to either an all vegetable ration or to a ration containing fishmeal resulted in a marked increase in the rate of growth of chicks as compared to chicks fed

an APF Supplement containing only vitamin B₁₂ (Merck APF-3). Similar evidence of a growth promoting effect has been reported by Johnson (1950); Peterson et al. (1950); Couch and German (1950); and McGinnis et al. (1950).

While most of the reports in the literature indicate that aureomycin or APF Supplements containing aureomycin result in an improved rate of growth there are some indications that a growth response is not always obtained. Sherwood and Couch (1950) found that when a corn-soybean oil meal basal diet was supplemented with 1 percent of an APF Supplement (Lederle) the growth rate obtained was only comparable to that obtained when the basal diet was supplemented with 4 percent fish solubles. Scott and Glista (1950) obtained excellent growth of chicks when fed a corn-soybean oil meal ration fortified with the known vitamins including crystalline vitamin B₁₂. The addition of aureomycin at a level of 30 milligrams per kilogram of ration did not improve its ability to promote chick growth. A slight response in growth rate was obtained during the first few weeks with ad libitum feeding but none was obtained when the feed intake was equated. Patrick (1951) reported that feeding of antibiotics can result in growth stimulation; however the degree of stimulation cannot be accurately predicted. Similar results were reported by Davis and Briggs (1951). These workers

obtained growth stimulation in most cases, but not in all, when a practical corn-soybean oil meal ration was supplemented with aureomycin at levels of 10 and 25 milligrams per kilogram of ration. No better results were obtained by adding aureomycin plus another antibiotic over that obtained with aureomycin alone.

Little information is available in the literature to indicate the effect on the growth rate of broilers of feeding aureomycin or APF Supplements containing aureomycin. Berg et al., however, (1950) noted that the addition of an APF Supplement (Lederle) to a high energy ration resulted in a significant increase in rate of growth of fryers. The APF Supplement was added to the ration at a level of 0.25 percent.

A few studies have been conducted on the effect of aureomycin supplementation on egg production and hatchability. Reid et al. (1951) noted that the egg production of Single Comb White Leghorn hens was increased when either an APF Supplement (Lederle) containing aureomycin (1 percent of the ration) or crystalline aureomycin (66 milligrams per kilogram of ration) was added to a corn-soybean oil meal ration. On the other hand, Carver et al. (1951) reported that the addition of aureomycin (10 milligrams per kilogram of ration) resulted in no improvement in rate of egg production.

In studies with breeding birds Carlson et al. (1951) noted no improvement in hatchability of turkey eggs from breeders fed a ration supplemented with crystalline aureomycin. Peterson et al. (1952) reported that the feeding of pure streptomycin or aureomycin did not improve hatchability when fed to Single Comb White Leghorn hens receiving a sub-optimal level of vitamin B₁₂.

Mode of Action of Antibiotics

Several theories have been advanced as possible explanations of the mechanism by which antibiotics produce their growth promoting effects. It has been widely assumed, primarily as a result of failure to obtain a growth response from the injection of antibiotics (Groschke and Evans, 1950; McGinnis et al. 1950; Whitehill et al. 1950), that the growth response obtained from the ingestion of antibiotics was a result of the action of the antibiotic upon the intestinal microflora. Groschke (1950) stated that "It is believed that antibiotics stimulate growth indirectly by changing the intestinal microflora from "undesirable" to "desirable" types and that unknown factors synthesized by the desirable types are responsible for the growth effect". McGinnis (1950) suggested three possible methods by which antibiotics may exert their influences: "(a) stimulation of intestinal synthesis of vitamins by bacteria, (b) reduction in total numbers of bacteria in the tract with a

lowering of competition between microorganisms and host animal for nutrients and (c) the inhibition of harmful bacteria which may be mildly pathogenic or toxin producing." The work of Groschke and Evans (1950) supports the first proposal, since the addition of known vitamins at a high level to the diet reduced the response to antibiotics. Further support for the theory that antibiotics affect vitamin synthesis was presented by Biely and March (1951), who found that the addition of aureomycin to rations containing sub-optimal amounts of riboflavin, niacin or folic acid resulted in growth comparable to that obtained when optimum levels of the vitamins were used. McGinnis (1950) reported data which supports the theory that antibiotics inhibit harmful bacteria. They found that the addition of either penicillin or terramycin completely prevented the growth of Clostridium (probably welchii) in the intestinal tract of turkeys.

Branion and Hill (1951) presented evidence that the mode of action of antibiotics is more complex than the theories, mentioned above, would indicate. In experiments conducted with turkey poults fed a corn-soybean oil meal ration, the addition of chloromycetin failed to initiate a growth response or improve feed efficiency. According to these workers there are at least three possible explanations why chloromycetin failed to influence growth

or feed efficiency: "(1) some antibiotics have no effect on intestinal flora, (2) some antibiotics are too general in their action destroying all microorganisms both beneficial and harmful, or (3) the action of antibiotics is more specific than has been thought." An explanation of this kind is necessary if the theory that antibiotics bring about the beneficial response by some effect upon the intestinal microflora is to be accepted.

While a number of possible ways by which antibiotics exert their growth promoting effect have been advanced, the actual mode of action of the antibiotics in growing rations is not clear.

EXPERIMENTS AT THE UNIVERSITY OF ALBERTA

Experiments were designed to study:

- I. The use of an antibiotic (penicillin) in breeding rations.
- II. The use of antibiotics in chick rations.
- III. The use of antibiotics in broiler rations.

I. The Use of an Antibiotic (penicillin) in Breeding Rations.

Status of the Problem

A limited number of studies have been published on the use of penicillin in laying and breeding rations. Results of these trials have indicated that the addition of penicillin to certain types of rations may stimulate both production and hatchability (see "Review of Literature"). However the reports have provided no information on the effect of the addition of penicillin to breeding rations of the type commonly used in Alberta, nor on rations containing adequate levels of vitamin B₁₂. Further, there was no indication of what the effect might be on a ration in which the energy or protein content was varied. Consequently a trial was initiated to study the effect of the addition of penicillin to diets adequate in vitamin B₁₂ but varying in protein and energy content.

Experimental

Single Comb White Leghorn pullets were used in the present study. For five weeks preceding the start of the experiment the birds were fed a practical all-mash ration. At the end of the pre-experimental period one hundred and ninety-eight pullets were selected, weighed individually and divided into six comparable lots of thirty-three pullets each. The birds were placed in floor pens with straw litter. The litter was changed every two weeks. The birds were handled and weighed every twenty-eight days. Feed and water were supplied ad libitum. The experiment was terminated at the end of three hundred and thirty-six days.

At the end of the experiment two hens were killed from each group and the livers were removed for riboflavin assay. The livers were prepared for assay in the same manner as reported by Clandinin (1946). The microbiological assay method was the same as that used by Clandinin (1949) but adapted for riboflavin assay. The test organism used was Lactobacillus casei.

Records were kept throughout the experimental period on mortality, production, feed consumption, body weight, fertility and hatchability. Rate of production was calculated on both a hen-day basis and on a hen-housed basis.

Table 1.- Composition of breeding rations

17.

Ingredients	1	2	3	4	5	6
	%	%	%	%	%	%
Ground wheat	31.75	31.75	36.75	36.75	11.75	11.75
Ground oats	10	10	10	10	20	20
Ground barley	10	10	10	10	20	20
Ground corn	20	20	20	20	10	10
Dehydrated alfalfa meal	5	5	5	5	5	5
Wheat bran	5	5	5	5	10	10
Fish oil (2400A-400D)	.25	.25	.25	.25	.25	.25
Wheat shorts	5	5	5	5	10	10
Herring meal	2	2	2	2	2	2
Meat meal	5	5	0	0	5	5
Soybean oil meal	2	2	0	0	2	2
Ground limestone	2.50	2.50	2.50	2.50	2.50	2.50
Bone meal	1	1	3	3	1	1
Iodized salt	.50	.50	.50	.50	.50	.50
MnSO ₄ .H ₂ O, lb./ton	.50	.50	.50	.50	.50	.50
Riboflavin, gm./ton	2.50	2.50	2.50	2.50	2.50	2.50
Calcium pantothenate, gm./ton	7.50	7.50	7.50	7.50	7.50	7.50
Niacin, gm./ton	12.50	12.50	12.50	12.50	12.50	12.50
Irradiated animal sterol supplement (1,000,000D/lb.), lb./ton	1	1	1	1	1	1
*APF Supplement, lb./ton	1		1		1	
**APF Supplement and penicillin, lb./ton		1		1		1
Protein (calculated)	15.5	15.5	13.0	13.0	15.5	15.5

* Merck APF-3 Supplement

** Merck APF-8 Supplement and Antibiotic (contains 2 grams of penicillin per pound)

The rations fed the experimental lots are shown in Table 1. Ration 1 represents a type of breeding ration commonly used in Alberta. Ration 3 was similar to ration 1 except that the level of protein was reduced to thirteen percent. Ration 5 was modified by increasing the level oats, barley, bran and shorts and decreasing the level of wheat and corn to give a low energy type ration. Rations 2, 4 and 6 are the same as rations 1, 3 and 5 respectively except that an APF Supplement (Merck APF-8) containing penicillin was added to each in place of the APF Supplement (Merck APF-3) containing no penicillin.

Results and Discussion

The effect of penicillin supplementation on percentage mortality, rate of production, feed efficiency and average weight is presented in Table 2.

It is evident from the results that the use of penicillin had no effect on percent mortality, rate of production, feed efficiency or average body weight of the different lots. These results are not in agreement with those reported by Elam et al. (1951). However, the experimental conditions differed widely in that the above workers added a higher level of penicillin (thirty-three milligrams per kilogram) to the diet, and in addition sub-optimal levels of vitamin B₁₂ were fed.

Table 2.- Percentage mortality, rate of production, feed efficiency and average body weight.

Ration Fed	Number Birds	Mortality	Rate of Production		Efficiency Feed per Dozen Eggs	Average Body Weight	
			Hen-Days	Hen-Housed		Initial	Final
		%	%	%	lb.	lb.	lb.
1	33	12.1	57.7	54.4	5.6	3.9	4.5
2	33	3.0	56.2	54.3	5.6	3.9	4.4
3	33	24.2	55.5	49.4	6.0	3.9	4.4
4	33	21.2	58.5	52.8	5.7	3.9	4.3
5	33	18.2	59.3	52.9	5.7	3.9	4.4
6	33	15.2	56.6	50.7	5.9	3.9	4.4

Under the conditions of the experiment, no effect on percent mortality, rate of production, feed efficiency or average body weight was obtained as a result of variations in protein and energy levels of the ration.

The results presented in Table 3, show the effect of additions of penicillin to the ration on apparent fertility and hatchability. No differences in apparent fertility or hatchability were noted as a result of supplementing the diet with penicillin or varying the protein or energy level of the ration. The results differ from those of Halick et al. (1951) and Elam, Gee and Couch (1951) who reported a stimulation in hatchability as a result of penicillin

supplementation. However, in the present study the level of hatchability was high in all the experimental lots as compared to a low level of hatchability reported by the above workers.

Table 3.- Apparent fertility, hatchability and riboflavin content of livers

Ration fed	Apparent Fertility		Hatchability		Riboflavin Content of Livers
	Initial	Final	Initial	Final	
	%	%	%	%	mg./gm.
1	92	88	93	85	22.0
2	86	91	93	87	18.9
3	90	93	94	85	18.7
4	83	91	98	88	18.8
5	76	84	97	87	18.6
6	91	82	93	84	19.4

On the basis of the results obtained it would appear that the addition of a low level of penicillin to rations adequate in vitamin B₁₂ and other vitamins did not result in an improved level of egg production, feed efficiency, fertility or hatchability.

The results of the riboflavin assays (Table 3) indicate that the various treatments had no effect on riboflavin storage. The riboflavin content of the livers compare very favorably with those reported by Stamburg et al. (1947) for Single Comb White Leghorn hens fed an all mash diet.

Summary

- (1) The addition of penicillin, to three practical type breeding rations which varied in protein or energy level had no effect on percent mortality, rate of production, feed efficiency or average body weight during a trial lasting for three hundred and thirty-six days.
- (2) Reproductive performance was not affected by the addition of penicillin to the rations.
- (3) The addition of penicillin had no effect on the liver storage of riboflavin.

II. The Use of Antibiotics in Chick Rations

Status of the Problem

The growth promoting effect usually obtained from the inclusion of antibiotics in chick rations has been indicated in the "Review of Literature". Their use in growing rations has been regarded by many as one of the major advances in poultry feeding. In the past few years, antibiotics were available both in the pure form and as APF Supplements containing antibiotic activity. It therefore seemed advisable to study the effect of additions of these supplements to chick starting rations.

Trial 1

Object

To study the relative efficacy of two APF Supplements, one of which contained penicillin (Merck APF-8) and the other aureomycin (Lederle APF-5).

Experimental

Six hundred and forty day-old Single Comb White Leghorn chicks were divided into sixteen lots of forty chicks each. The chicks were raised in electrically heated batteries with raised screen floors. Feed and water were supplied ad libitum. The experiments were terminated at twenty-eight days at which time the birds were weighed individually.

The basal rations used in the trial are shown in Table 4. The two basal rations differed in the source of protein and in the level of vitamin B₁₂. Basal 1 was a corn-soybean oil meal type of diet deficient in vitamin B₁₂, whereas Basal 2 contained five percent of fishmeal which

Table 4.- Composition of basal rations

Ingredients	1	2
	%	%
Ground yellow corn	39.5	44.5
Wheat bran	10	10
Wheat middlings	10	10
Dehydrated alfalfa meal	5	5
Soybean oil meal	30	21
Fish meal		5
Ground limestone	2	2
Insoluble grit	1	1
Bone meal	1.5	.5
Iodized salt	.5	.5
Fish oil (2400A-400D)	.5	.5
MnSO ₄ .H ₂ O, lb./ton	.5	.5
Riboflavin, gm./ton	2.0	2.0
Calcium pantothenate, gm./ton	6.0	6.0
Niacin, gm./ton	10.0	10.0

supplied sufficient vitamin B₁₂ for good growth and which might be expected to give a greater growth response from antibiotic supplementation since McGinnis et al. (1951) have reported that a greater growth response of poult to antibiotic supplementation was obtained when fish meal was included in the diet.

Results and Discussion

The APF Supplement used, level of supplementation, percentage mortality and average weights of the lots are shown in Table 5.

In the lots fed Basal 1 (Lots 1-8) the addition of an APF Supplement containing penicillin (Lots 4, 6 and 8) resulted in an increase in growth rate as compared to the basal ration supplemented with vitamin B₁₂ alone (Lot 2). The optimum level of supplementation appeared to be one pound of Supplement (Merck APF-8) per ton of ration (equivalent to two grams of penicillin per ton of ration).

The addition of an APF Supplement containing aureomycin gave similar results (Lots 3, 5 and 7). The optimum level in this case appeared to be five pounds of APF Supplement (Lederle APF-5) per ton of ration (equivalent to eight to nine grams of aureomycin per ton).

In the lots fed Basal 2 (Lots 9-16), however, the addition of the APF Supplement containing penicillin (Lots 12, 14 and 16) or the addition of a vitamin B₁₂ Supplement containing aureomycin (Lots 11, 13 and 15) did

not cause an appreciable increase in the rate of growth above that obtained on the basal ration supplemented with an APF Supplement alone (Lot 10).

Table 5.- The effect of supplementing chick rations with commercial APF Supplements

Lot Number	Basal Ration Fed	APF Supplement Used	Level of APF Supplement	Mortality	Average Weight 28 days
			lb./ton	%	gm.
1	1	None	-	7.5	236
2	1	Merck APF-3	1	2.5	260
3	1	Lederle APF-5	2.5	2.5	271
4	1	Merck APF-8	.5	-	280
5	1	Lederle APF-5	5	2.5	289
6	1	Merck APF-8	1	7.5	298
7	1	Lederle APF-5	10	2.5	292
8	1	Merck APF-8	2	7.5	304
9	2	None	-	-	305
10	2	Merck APF-3	1	5.0	316
11	2	Lederle APF-5	2.5	5.0	312
12	2	Merck APF-8	.5	2.5	324
13	2	Lederle APF-5	5	-	324
14	2	Merck APF-8	1	5.0	330
15	2	Lederle APF-5	10	-	326
16	2	Merck APF-8	2	2.5	324

A growth response was obtained when either an APF Supplement (Merck APF-8) containing penicillin or an APF Supplement (Lederle APF-5) containing aureomycin was added to the corn-soybean oil meal ration (Basal 1). However, no response was obtained from the addition of the APF Supplements to Basal 2 which contained five percent of fishmeal. The failure to obtain a growth response when fishmeal was present in the diet does not agree with the results reported by McGinnis et al. (1951) who noted that the inclusion of fishmeal in the diet increased the growth response to antibiotic supplementation.

Summary

- (1) The addition of APF Supplements containing either penicillin or aureomycin to a corn-soybean oil meal diet adequate in vitamin B₁₂ resulted in an increased rate of growth of chicks.
- (2) The most effective levels of supplementation were found to be one pound of an APF Supplement (Merck APF-8) containing penicillin or five pounds per ton of an APF Supplement (Lederle APF-5) containing aureomycin per ton of ration. Thus the effective rates of supplementation were two grams of

penicillin or nine grams of aureomycin per ton of ration.

- (3) The addition of either aureomycin or penicillin to a basal diet containing five percent fishmeal was not effective in increasing the rate of growth of chicks under the conditions of the experiment.

Trial 2

Object

The previous trial had indicated that a greater response to antibiotic supplementation was obtained on a corn-soybean oil meal diet. It therefore seemed possible that the response might be related to the vitamin B₁₂ content of the ration and the carry-over of vitamin B₁₂ in the chick. Consequently a study was initiated, using both vitamin B₁₂- deficient chicks and normal chicks to determine the effect of additions of an APF Supplement, penicillin and aureomycin alone, and in combination, to a corn-soybean oil meal ration.

Experimental

Two sources of day-old Single Comb White Leghorn chicks were used in this study. The vitamin B₁₂-deficient chicks were progeny of hens fed a corn-soybean oil meal ration which has been shown to produce chicks of low vitamin B₁₂ reserves (Clandinin and Robblee 1950, unpublished). The normal chicks were progeny of hens fed a ration containing adequate amounts of vitamin B₁₂. Only a limited number of deficient chicks were available and as a consequence four series were necessary to complete the trial. Each group consisted of fifteen chicks. In the case of the normal chicks duplicate lots of twenty-four chicks were used in each group.

The experimental procedure followed was the same as that employed in Trial 1. The basal ration fed had the following composition: ground corn, 40.5, wheat bran 10, wheat middlings 10, dehydrated alfalfa meal 5, soybean oil meal 30, limestone grit 2, bonemeal 1.5, iodized salt .5, fish oil (2400A-400D) .5, manganese sulfate .025 gm., thiamine 0.3, riboflavin 0.6, niacin 5.0, calcium pantothenate 2.0, pyridoxine hydrochloride 0.4, choline chloride 50, para-aminobenzoic acid 10, biotin 0.02, folic acid 0.05, menadione 0.05, alpha-tocopherol 0.3 milligrams.

Results and Discussion

The treatments used and the average weight at twenty-eight days of age of both the deficient and normal chicks are presented in Table 6.

In the four series conducted using vitamin B₁₂-deficient chicks it is evident that the addition of an APF Supplement containing vitamin B₁₂ to the basal ration (Groups 2 and 6) resulted in a marked increase in growth rate as compared to the groups receiving the basal ration (Groups 1 and 5). The magnitude of the response was similar to that reported by other workers (Rubin and Bird 1946 and Robblee et al. 1948).

The addition of penicillin resulted in a stimulation in growth rate in Group 3, Series 1, but not

in the corresponding group in Series 2. The response, however, was much less than that obtained from the addition of an APF Supplement containing vitamin B₁₂. The addition of both the APF Supplement and penicillin (Group 4) resulted in no appreciable increase in rate of growth as compared to the addition of the APF Supplement alone.

Table 6.- Effect of an APF Supplement, penicillin and aureomycin on average weight of vitamin B₁₂-deficient and normal chicks

Group Number	Additions to Basal Ration*	Average weight - 28 days		
		B ₁₂ -Deficient chicks		Normal chicks
		Series 1	Series 2	Series 5
1	None	gm. 155	gm. 198	gm. 267
2	Merck APF-3 Supplement	252	271	261
3	Penicillin	198	208	280
4	Merck APF-3 Supplement + Penicillin	269	282	283
		<u>Series 3</u>	<u>Series 4</u>	
5	None	131	223	285
6	Merck APF-3 Supplement	205	275	295
7	Aureomycin	232	242	297
8	Merck APF-3 Supplement + Aureomycin	264	290	292

* Additions to the basal ration were made at the following levels: Merck APF-3, 1 lb.; Procaine Penicillin G, 2gm.; and Aureomycin HCL, 10 gm. per ton of ration.

The addition of aureomycin resulted in an increase in rate of growth (Group 7) as compared to the unsupplemented group (Group 5). The response was considerably greater in Series 3 than in Series 4. A combination of APF Supplement and aureomycin also appeared to result in an increase in rate of growth although the response varied considerably between Series 3 and Series 4. The overall results with the deficient chicks appear to be in agreement with those of Patrick (1951) and Davis and Briggs (1951) who reported that the degree of response to antibiotic supplements was irregular and did not occur in all cases.

In Series 5, in which normal chicks were used, the addition of the APF Supplement, penicillin, aureomycin or a combination of penicillin or aureomycin and the APF Supplement resulted in no appreciable increase in the rate of growth of the chicks.

Summary

- (1) Using chicks which were the progeny of hens fed a vitamin B₁₂-deficient diet, the addition of penicillin or aureomycin alone or in combination with an APF Supplement resulted in an irregular response in rate of growth.
- (2) Using normal chicks, the addition of either penicillin or aureomycin alone or in combination with an APF Supplement resulted in no improvement in rate of growth of the treated groups.

Trial 3

Object

To determine the effect of additions to a ration of vitamin B₁₂, penicillin, aureomycin and combinations of either penicillin or aureomycin and vitamin B₁₂ on the subsequent liver storage of riboflavin in vitamin B₁₂-deficient and normal chicks.

Experimental

The chicks used in this study were comparable to those used in Trial 2. Ninety-six vitamin B₁₂-deficient chicks were divided into six groups of sixteen chicks each and two hundred and forty normal chicks were divided into six groups of forty chicks each. The experimental procedure followed was the same as that used in Trial 2.

The basal ration used had the following composition: ground yellow corn 39.5, wheat bran 10, wheat shorts 10, dehydrated alfalfa meal 5, soybean oil meal 30, ground limestone 2, bonemeal 1.5, iodized salt 0.5, fish oil (2400A 400D) 0.5, insoluble grit 1, manganese sulfate 0.25 gm., riboflavin 0.11 mg. The ration was calculated to contain two hundred and ninety micrograms of riboflavin per hundred grams of ration which is slightly sub-optimal for maximum growth.

The liver samples for riboflavin assay were obtained by taking five chicks from each group at one, fourteen and twenty-eight days of age. The chicks were killed and the livers were removed for riboflavin determinations. The livers were prepared for assay in the same manner as reported by Clandinin (1946).

The microbiological assay method employed was the same as that used by Clandinin (1949) but adapted for riboflavin assay. The test organism used was Lactobacillus casei.

Results and Discussion

The riboflavin content of the livers of the chicks at one, fourteen and twenty-eight days of age is presented in Table 7. The results indicate that the addition of the APF Supplement (Merck APF-3), penicillin, aureomycin, or combinations of either penicillin, or aureomycin and APF Supplement to the basal ration had no effect on the riboflavin content of the livers of the chicks. The livers of normal chicks contained a higher level of riboflavin initially than did the vitamin B₁₂-deficient chicks but the difference was not apparent at twenty-eight days of age.

The riboflavin content of livers of the normal day-old chicks was lower than the levels reported for day-old chicks by Clandinin (1946), who found that the

livers of day-old chicks contained an average of 21.71 micrograms of riboflavin per gram of liver. No explanation can be offered as to why the values obtained in this study differ from those reported above.

Table 7.- Effect of an APF Supplement, penicillin and aureomycin on the riboflavin content of livers of vitamin B₁₂-deficient and normal chicks

Group Number	Additions to Basal Ration*	Riboflavin Content of Livers		
		1 day	14 days	28 days
		mg./gm.	mg./gm.	mg./gm.
<u>Deficient chicks</u>				
1	None	11.5	11.2	15.9
2	Merck APF-3	11.5	11.2	15.2
3	Penicillin	11.5	10.7	15.7
4	Aureomycin	11.5	12.1	15.8
5	As 2 + Penicillin	11.5	12.1	15.9
6	As 2 + Aureomycin	11.5	11.7	14.5
<u>Normal chicks</u>				
7	None	13.8	12.1	15.2
8	Merck APF-3	13.8	13.1	14.1
9	Penicillin	13.8	13.3	15.9
10	Aureomycin	13.8	14.2	15.3
11	As 8 + Penicillin	13.8	11.8	13.6
12	As 8 + Aureomycin	13.8	19.2	14.4

* Additions to the basal ration were made at the following levels: Merck APF-3, 1 lb.; Procaine Penicillin G, 2 gm.; and Aureomycin HCL, 10 gm. per ton of ration.

From the results of the study it would appear that additions of an APF Supplement, aureomycin or penicillin or combinations of the APF Supplement and aureomycin or penicillin had no effect on subsequent liver storage of riboflavin of chicks under the conditions of the experiment.

Summary

- (1) The addition of an APF Supplement (Merck APF-3) penicillin, aureomycin or combinations of either penicillin or aureomycin and the APF Supplement to the basal ration did not result in an increased storage of riboflavin in the livers of either vitamin B₁₂-deficient or normal chicks.

III. The Use of Antibiotics in Broiler Rations

Status of the Problem

In practical poultry feeding the producer is interested in the effect of the feed on the performance of the birds to the time they are marketed. The use of antibiotics in broiler rations has been reported to increase the rate of growth and feed efficiency of broilers to market age. However, the majority of the studies have made use of a corn-soybean oil meal type of ration. No information has appeared on the effect of energy level of the ration or level of protein in the ration on subsequent performance of growing birds fed antibiotics. It was therefore deemed advisable to set up trials to study the effect of antibiotics in broiler rations.

Trial 1

Object

To study the effect of the addition of an APF Supplement containing penicillin on the rate of growth of broilers fed rations which varied in protein and energy content.

Experimental

Six hundred day-old Single Comb White Leghorn chicks were divided into six comparable lots of one hundred chicks each and fed the experimental rations shown in Table 8.

Table 8.- Composition of broiler rations

Ingredients	1	2	3	4	5	6
Ground wheat	47	47	53.5	53.5	20	20
Ground oats					10	10
Ground barley					10	10
Ground yellow corn	25	25	25	25	15	15
Dehydrated alfalfa meal	3	3	3	3	3	3
Wheat bran					8	8
Wheat shorts					9	9
Herring meal	7	7	4.5	4.5	7	7
Meat meal	7	7	4.5	4.5	7	7
Soybean oil meal	7	7	4.5	4.5	7	7
Fish oil (2400A-400D/g.)	.25	.25	.25	.25	.25	.25
Premix I*	1	1	1	1	1	1
Ground limestone	1	1	1	1	1	1
Iodized salt	.75	.75	.75	.75	.75	.75
Insoluble grit (chick)	1	1	1	1	1	1
Bone meal			1	1		
MnSO ₄ .H ₂ O, lb./ton	.50	.50	.50	.50	.50	.50
Merck APF-3 supplement, lb./ton	2		2		2	
Merck APF-8 supplement, lb./ton		2		2		2

* Premix I contains 1 gram of riboflavin, 3 grams calcium pantothenate and 5 grams niacin in 10 pounds of shorts.

Lot 1 was fed a high energy type ration whereas Lot 3 received a high energy, low protein ration. The ration fed Lot 5 was modified to a low energy type ration by adding oats and barley, bran and shorts and decreasing the level of wheat and corn in the diet. The rations fed to Lots 2, 4 and 6 were the same as those fed to Lots 1, 3 and 5 respectively except that an APF Supplement (Merck APF-8) containing penicillin was added in place of the APF Supplement (Merck APF-3) without antibiotic. The chicks were brooded in radiant heated floor pens using straw as litter. Feed and water were supplied ad libitum. The birds were weighed at the termination of the thirteen-week experimental period.

Results and Discussion

The average weight of the different Lots at thirteen weeks of age is shown in Table 9. In the lots fed the high energy ration, the addition of an APF Supplement (Merck APF-8) containing antibiotic (Lot 2) did not result in any increase in growth rate over that obtained with the APF Supplement (Merck APF-3) alone (Lot 1). The addition of an APF Supplement (Merck APF-8) containing penicillin did not result in a growth response when added to the high energy, low protein ration (Lot 4).

In the lots fed the low energy ration the addition of an APF Supplement (Merck APF-8) containing penicillin (Lot 6) resulted in a slight increase in growth rate over that obtained with the APF Supplement (Merck APF-3) alone (Lot 5).

The low energy type of ration itself (Lot 5) did not appear to support quite as high a level of growth as did either the high energy (Lot 1) or the high energy, low protein (Lot 3) types of rations.

The birds were graded for fat finish at the termination of the experiment. No differences were noted in the grades of any of the lots as a result of ration treatment.

Table 9.- The effect of APF Supplements on the growth rate of broilers

Lot Number	APF Supplement Used	Ration Type	Number Chicks	Average Weight 13 Weeks
1	Merck APF-3	High energy	92	lb. 3.00
2	Merck APF-8	High energy	92	2.93
3	Merck APF-3	High energy Low protein	93	2.96
4	Merck APF-8	High energy Low protein	93	2.98
5	Merck APF-3	Low energy	93	2.70
6	Merck APF-8	Low energy	92	2.88

From the results of the study it would appear that the addition of an APF Supplement containing penicillin to either a high energy, or a low energy, low protein ration did not result in any increase in growth rate over that obtained with a vitamin B₁₂ Supplement alone. A slight response, however, was obtained when the vitamin B₁₂

Supplement containing penicillin was added to a low energy type of ration.

Summary

- (1) The addition of an APF Supplement containing penicillin did not stimulate the growth rate of chicks fed either a high energy or a high energy, low protein ration.
- (2) A growth response was obtained when an APF Supplement containing penicillin was added to a low energy type ration.
- (3) A low energy type ration did not support as high a level of growth as did either a high energy or high energy, low protein ration.

Trial 2

Object

To further extend the studies on the use of antibiotics in broiler rations.

Experimental

Day-old Single Comb White Leghorn chicks were used in this study. Four hundred and forty-eight chicks were divided into eight comparable groups of fifty-six chicks each. The chicks were raised in electrically heated batteries to five weeks of age and then were transferred to growing batteries and continued to thirteen weeks of age at which time the birds were marketed.

The rations used are shown in Table 10. Ration 7, a high energy type of diet, was similar to Ration 1 in the previous trial. Ration 9, also a high energy ration, differed in that meat meal was the only protein supplement used. This change was made since it was known that meat meal is a less satisfactory supplement for chicks than the combination of protein used in Ration 7 and it was considered that such a modification might allow a greater response to antibiotic supplementation. Ration 11 was modified by reducing the protein level of the ration. Ration 13 contained the same level of meat meal as Ration 9 but the energy value was lowered by including a higher level of fibrous feeds.

Table 10.- Composition of broiler rations

Ingredients	7	8	9	10	11	12	13	14
Ground wheat	47	47	45	45	50.5	50.5	18	18
Ground oats							10	10
Ground barley							10	10
Ground yellow corn	25	25	25	25	25	25	15	15
Dehydrated alfalfa meal	3	3	3	3	3	3	3	3
Wheat bran							8	8
Fish oil (2400A-400D)	.25	.25	.25	.25	.25	.25	.25	.25
Wheat shorts							9	9
Premix I*	1	1	1	1	1	1	1	1
Herring meal	7	7						
Meat meal	7	7	23	23	15	15	23	23
Soybean oil meal	7	7						
Ground limestone	1	1	1	1	1	1	1	1
Iodized salt	.75	.75	.75	.75	.75	.75	.75	.75
Insoluble grit	1	1	1	1	1	1	1	1
Bone meal					2.5	2.5		
MnSO ₄ ·H ₂ O, lb./ton	.50	.50	.50	.50	.50	.50	.50	.50
Merck APF-3 Supplement, lb./ton	1		1		1		1	
Merck APF-8 Supplement, lb./ton		1		1		1		1

* Premix I contains 1 gram of riboflavin, 3 grams of calcium pantothenate and 5 grams of niacin in 10 pounds of shorts.

Rations 8, 10, 12 and 14 were the same as rations 7, 9, 11 and 13 respectively except that 1 pound of an APF Supplement (Merck APF-8) containing penicillin per ton of ration was used in place of an APF Supplement (Merck APF-3).

Results and Discussion

The results obtained are shown in Table 11. The addition of the APF Supplement to the high energy ration with a mixed protein supplement (Ration 8) appeared to result in a slight increase in the rate of growth although no response was obtained in the previous trial. No response to

Table 11.- The effect of APF Supplements on the growth rate of broilers

Lot Number	APF Supplement Used	Ration Type	Number Birds	Average Weight 13 Weeks
				Lb.
7	Merck APF-3	High energy	51	2.80
8	Merck APF-8	High energy	45	3.02
9	Merck APF-3	High energy (meat)	54	2.69
10	Merck APF-8	High energy (meat)	50	2.68
11	Merck APF-3	High energy Low protein (meat)	48	2.62
12	Merck APF-8	High energy Low protein (meat)	51	2.61
13	Merck APF-3	Low energy	46	2.65
14	Merck APF-8	Low energy	46	2.98

antibiotic supplementation was obtained on the high energy ration containing meat meal (Ration 10) or on the high energy low protein ration (Ration 12).

When the level of energy in the diet was reduced (Ration 13) the addition of the APF Supplement containing penicillin resulted in an increase in average weight at market age (Ration 14). This agrees with the results obtained in the previous trial.

Summary

- (1) The addition of an APF Supplement containing penicillin was not effective in increasing the rate of growth of broilers on a high energy diet in which meat meal was used as a protein supplement or a similar diet of lower protein content.
- (2) The addition of the APF Supplement containing penicillin to a low energy basal diet resulted in a response in growth rate.

Trial 3

Object

To obtain further information on the effect of additions to broiler rations of APF Supplements containing vitamin B₁₂ (Merck APF-3) or vitamin B₁₂ and penicillin (Merck APF-8) on the growth rate of broilers.

Experimental

Seven hundred and ninety-two day-old Single Comb White Leghorn chicks were divided into eighteen comparable lots of forty-four chicks each. The experimental procedure followed was the same as that employed in the previous trial.

The compositions of the basal rations used in the study are shown in Table 12. Ration 15, a high energy type of diet, was the same as Ration 7 in the previous trial. Ration 18 was also a high energy ration but the protein content was lowered by decreasing the level of protein supplements (herring meal, meat meal and soybean oil meal) and increasing the level of wheat. Ration 21 was a low energy type of ration, similar to Ration 5 used in Trial 1. Ration 24 was a low energy, low protein ration.

Since the previous trials had shown a variable response to antibiotic supplementation it was considered possible that a response might be obtained if the birds were fed a corn-soybean oil meal ration similar to that

Table 12.- Composition of broiler rations

Ingredients	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
Ground wheat	47	47	47	53.5	53.5	53.5	20	20	20	26.5	26.5	26.5						
Ground oats							10	10	10	10	10	10						
Ground barley							10	10	10	10	10	10						
Ground yellow corn	25	25	25	25	25	25	15	15	15	15	15	15	56.5	56.5	56.5	63.5	63.5	63.5
Dehydrated alfalfa meal	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Wheat bran							8	8	8	8	8	8						
Wheat shorts							9	9	9	9	9	9						
Herring meal	7	7	7	4.5	4.5	4.5	7	7	7	4.5	4.5	4.5						
Meat meal	7	7	7	4.5	4.5	4.5	7	7	7	4.5	4.5	4.5						
Soybean oil meal	7	7	7	4.5	4.5	4.5	7	7	7	4.5	4.5	4.5	35	35	35	28	28	28
Fish oil(2400A-400D)	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25	.25
Premix I*	1	1	1	1	1	1	1	1	1	1	1	1						
Ground limestone	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2
Iodized salt	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75	.75
Bone meal				1	1	1				1	1	1	1.5	1.5	1.5	1.5	1.5	1.5
Insoluble grit	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
MnSO ₄ ·H ₂ O, lb./ton	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
**APF Supplement, lb./ton		1			1			1			1			1			1	
***APF Supplement and penicillin, lb./ton			1			1			1			1			1			1

*Premix I contains 1 gram of riboflavin, 3 grams of calcium pantothenate, and 5 grams of niacin in 10 pounds of shorts.

**Merck APF-3 Supplement.

***Merck APF-8 Supplement and antibiotic (contains 2 grams of penicillin per pound).

used by many American investigators. Consequently a ration of this type (Ration 27) was used. Ration 30 was also a corn-soybean oil meal diet but the protein content was lowered by removing a portion of the soybean oil meal and replacing it with a comparable amount of corn.

The effect of supplementing the above rations with an APF Supplement (Merck APF-3) or an APF Supplement (Merck APF-8) containing penicillin was studied.

Results and Discussion

The additions to the basal rations, and the average weights of the birds at thirteen weeks of age are shown in Table 13. From the results presented it is apparent that the addition of either vitamin B₁₂ (Merck APF-3) or an APF Supplement (Merck APF-8) containing penicillin did not result in any appreciable increase in growth rate when added to a high energy; high energy, low protein; low energy, low protein or a corn-soybean oil meal, low protein basal ration. Although the addition of vitamin B₁₂ (Merck APF-3) to a low energy basal ration did not stimulate any growth response (Lot 22), the addition of a vitamin B₁₂ Supplement (Merck APF-8) containing penicillin resulted in an increase in growth rate (Lot 23) when added to the same ration. This agrees with the results of Trials 1 and 2.

Table 13.- The effect of APF Supplements on the growth rate of broilers

Lot Number	APF Supplement Used	Ration Type	Number Chicks	Average Weight 13 Weeks
				lb.
15	None	High energy	42	2.79
16	Merck APF-3	High energy	42	2.84
17	Merck APF-8	High energy	43	2.87
18	None	High energy low protein	42	2.73
19	Merck APF-3	High energy low protein	42	2.75
20	Merck APF-8	High energy low protein	42	2.94
21	None	Low energy	42	2.73
22	Merck APF-3	Low energy	41	2.80
23	Merck APF-8	Low energy	42	3.11
24	None	Low energy low protein	42	2.83
25	Merck APF-3	Low energy low protein	42	2.77
26	Merck APF-8	Low energy low protein	42	2.74
27	None	Corn-soybean oil meal	42	2.40
28	Merck APF-3	Corn-soybean oil meal	43	2.38
29	Merck APF-8	Corn-soybean oil meal	42	2.78
30	None	Corn-soybean oil meal, low protein	42	2.65
31	Merck APF-3	Corn-soybean oil meal, low protein	42	2.31
32	Merck APF-8	Corn-soybean oil meal, low protein	42	2.59

A significant increase in rate of growth was noted when an APF Supplement (Merck APF-8) containing penicillin was added to the corn-soybean oil meal basal ration (Lot 29). No response was obtained, however, when the ration was supplemented with vitamin B₁₂ (Merck APF-3) alone.

Summary

- (1) An increase in rate of growth of broilers was obtained when an APF Supplement (Merck APF-8) containing penicillin was added to either a corn-soybean oil meal or a low energy basal ration.
- (2) No response to either vitamin B₁₂ (Merck APF-3) or vitamin B₁₂ (Merck APF-8) with antibiotic was obtained when these supplements were added to a high energy; high energy, low protein; low energy, low protein or a corn-soybean oil meal, low protein type of ration.

General Summary

Three experiments, designed to study the effect of additions of antibiotic to rations of breeding birds, chicks and broilers, were conducted. The results of these experiments are summarized below:

I. The Use of Antibiotic (penicillin) in Breeding Rations.

This study describes the effect of the addition of an APF Supplement containing penicillin on the performance of Single Comb White Leghorn hens fed rations which varied in protein or energy level.

The results obtained indicated that the addition of penicillin to the diet of breeding hens had no effect on percent mortality, egg production, feed efficiency or average body weight of the birds. The apparent fertility and hatchability of eggs produced was not affected by the treatment. The riboflavin content of the livers of the treated birds was the same as that of the controls.

II. The Use of Antibiotics in Chick Rations.

Three trials were conducted to study the effect of additions of antibiotics to chick rations. In the first trial the relative efficacy of two APF Supplements, one of which contained penicillin and the other aureomycin was studied. It was found that the addition of APF Supplements

containing either penicillin or aureomycin resulted in an increase in the rate of growth of chicks fed a corn-soybean oil meal diet, but resulted in no increase when added to a diet containing five percent of fish meal. The most effective level of supplementation appeared to be one pound of an APF Supplement (Merck APF-8) containing penicillin or five pounds of an APF Supplement (Lederle APF-5) containing aureomycin per ton of ration. Thus the effective rates of supplementation were two grams of penicillin or nine grams of aureomycin per ton of ration.

In the second trial, the relative effectiveness of addition of pure penicillin and aureomycin to a chick ration was studied. It was observed that the addition of either penicillin or aureomycin to a corn-soybean oil meal diet resulted in an irregular growth response when fed to vitamin B₁₂-deficient chicks, and no improvement in growth rate when fed to normal chicks.

The third trial was conducted to study the effect of additions to the ration of vitamin B₁₂, penicillin, aureomycin or combinations of either penicillin or aureomycin and vitamin B₁₂ on the subsequent liver storage of riboflavin in vitamin B₁₂-deficient and normal chicks. The various treatments did not affect riboflavin storage in the livers of the chicks.

III. The Use of Antibiotics in Broiler Rations

Three trials were conducted to study the effect of additions of an APF Supplement containing penicillin on the performance of broiler fed rations which varied in energy and protein levels.

The results of Trial 1, indicated that the addition of penicillin did not stimulate the growth rate of broilers fed either a high energy, or a high energy, low protein diet. A growth response was obtained when penicillin was added to a low energy type ration.

In the second trial similar results were noted. The addition of penicillin to the ration was effective in stimulating the growth rate of broilers on a low energy diet. No effect was obtained on the high energy or high energy, low protein diets.

In the third trial the results obtained were in general agreement with those of the previous studies. An increase in rate of growth of broilers was obtained when penicillin was added to either a low energy basal ration or a corn-soybean oil meal basal ration. No response was obtained when penicillin was added to a high energy; high energy, low protein or a corn-soybean oil meal, low protein basal ration.

BIBLIOGRAPHY

- Berg, L.R., G.E. Bearse, J. McGinnis and V.L. Miller, 1950. The effect on the growth of fryers of adding an aureomycin fermentation product to a high energy fryer ration. Poultry Sci. 29:629-631.
- Biely, J., and B. March, 1951. The effect of aureomycin and vitamins on the growth rate of chicks. Science 114:330-331.
- Biely, J., B. March, J. Stevens and R. Casorso, 1951. APF Supplements in the chick ration. Poultry Sci. 30:143-147.
- Branion, H.D., and D.C. Hill, 1951. The comparative effect of antibiotics on the growth of poults. Poultry Sci. 30:793-798.
- Carlson, C.W., W. Kohlmeyer, D.G. Jones and A.L. Moxon, 1951. Aureomycin and vitamin B₁₂ supplements in a turkey breeder diet. Poultry Sci. 30:909.
- Carver, J.S., J. McGinnis, L.R. Berg and G.E. Bearse, 1951. The effects of antibiotic supplements on egg production. Poultry Sci. 30:909.
- Clandinin, D.R., 1946. The significance of the level of riboflavin in the ration of breeding birds. Poultry Sci. 25:223-231.
- Clandinin, D.R., 1949. The effects of methods of processing on the nutritive value of herring meals. Poultry Sci. 28:128-133.
- Clandinin, D.R., and A.R. Robblee, 1950. Unpublished data.
- Couch, J.R., and H.L. German, 1950. Vitamin B₁₂, APF concentrates and dried whey in the nutrition of the growing chick. Poultry Sci. 29:754.
- Cunha, T.J., J.E. Burnside, D.M. Buschman, R.S. Glasscock, A.M. Pearson and A.L. Shealy, 1949. Effect of vitamin B₁₂ animal protein factor and soil for pig growth. Arch. Biochem. 23:324-326.
- Davis, R.L., and G.M. Briggs, 1951. Studies with antibiotics in chick and poult starting rations. Poultry Sci. 30:767-771.

- Elam, J.F., L.L. Gee and J.R. Couch, 1951. Effect of feeding penicillin on the life cycle of the chick. Proc. Soc. Expt. Biol. Med. 77:209-213.
- Groschke, A.C., 1950. Relation of growth stimulating properties of antibiotics to unidentified growth factors required by the chick. Poultry Sci. 29:760.
- Groschke, A.C., and R.J. Evans, 1950. Effect of antibiotics, synthetic vitamins, vitamin B₁₂ and an APF Supplement on chick growth. Poultry Sci. 29: 616-618.
- Halick, J.V., and J.R. Couch, 1951. Antibiotics in mature fowl nutrition. Proc. Soc. Expt. Biol. Med. 76:58-62.
- Johnson, E.L., 1950. Providing vitamin B₁₂ and animal protein factor activity for chick diets. Poultry Sci. 29:765.
- McGinnis, J., 1950. Antibiotics as growth stimulants for chicks and turkey poults. Proceedings 1950 Cornell Nutrition Conference:40-46.
- McGinnis, J., L.R. Berg, J.R. Stern, R.A. Wilcox and G.E. Bearse, 1950. The effect of aureomycin and streptomycin on growth of chicks and turkey poults. Poultry Sci. 29:771.
- McGinnis, J., J.R. Stern, R.A. Wilcox and J.S. Carver, 1951. The effect of different antibiotics on growth of turkey poults. Poultry Sci. 30:492-496.
- Moore, P.R., A. Evenson, T.D. Luckey, E. McCoy, C.A. Elvehjem and E.B. Hart, 1946. Use of sulfasuxidine, streptothricin and streptomycin in nutritional studies with the chick. J. Biol. Chem. 165:437-441.
- Patrick, H., 1951. Vitamin B₁₂ and antibiotics in turkey poult nutrition. Poultry Sci. 30:549-551.
- Peterson, C.F., C.E. Lampman and A.C. Wiese, 1950. Role of vitamin B₁₂ and other APF factors for reproduction and chick growth. Poultry Sci. 29:775.

- Peterson, C.F., A.C. Wiese, R.V. Dahlstrom and C.E. Lampman, 1952. Influence of vitamin B₁₂ and antibiotics on hatchability. Poultry Sci. 31: 129-132.
- Reed, J.R., and J.R. Couch, 1950. The efficacy of different APF concentrates for chicks. Poultry Sci. 29:897-902.
- Reid, B.L., J.H. Quisenberry and J.R. Couch, 1951. Aureomycin, vitamin B₁₂, methionine and level of protein in mature fowl nutrition. Poultry Sci. 30:935-936.
- Reynolds, J.W., T.D. Runnels and E.F. Waller, 1951. A comparison of terramycin and penicillin at various levels on rate of growth and feed efficiency in broiler diets. Poultry Sci. 30:928.
- Rickes, E.L., N.G. Brink, F.R. Koneuszy, T.R. Wood and K. Folkers, 1948. Crystalline vitamin B₁₂. Science 107:396-397.
- Robblee, A.R., C.A. Nichol, W.W. Cravens, C.A. Elvehjem and J.G. Halpin, 1948. The effect of hen diet and chick diet on the need of chicks for an unidentified growth factor. Poultry Sci. 27:442-447.
- Rubin, M., and H.R. Bird, 1946. A chick growth factor in cow manure. I. Its non identity with chick growth factors previously described. J. Biol. Chem. 163:387-392.
- Runnels, T.D., J.W. Reynolds and E.F. Waller, 1951. The influence of various levels of penicillin and streptomycin on rate of growth and feed efficiency in broiler diets. Poultry Sci. 30:929.
- Scott, H.M., and W.A. Glista, 1950. The effect of aureomycin and arsonic acid on chick growth. Poultry Sci. 29:921-923.
- Singsen, E.P., and L.D. Matterson, 1949. Effect of the animal protein factor on the growth of turkeys and chickens. Report presented at New England Feedmens Meeting, Connecticut Ag. Exp. Sta.

- Sherwood, R.M., and J.R. Couch, 1950. The effect on chick growth of supplementing a vegetable protein diet with an APF concentrate. Poultry Sci. 29:501-507.
- Stamburg, O.E., C.F. Petersen and C.E. Lampman, 1947. Riboflavin content of the chicken meats as affected by level of intake. Poultry Sci. 26:126-127.
- Stokstad, E.L.R., T.H. Jukes, J.V. Pierce, A.C. Page, Jr., and A.L. Franklin, 1949. The multiple nature of the animal protein factor. J. Biol. Chem. 180: 647-654.
- Stokstad, E.L.R., and T.H. Jukes, 1950. Further observations on the "animal protein factor". Proc. Soc. Expt. Biol. Med. 73:523-528.
- Whitehill, A.R., J.J. Oleson and B.L. Hutchings, 1950. Stimulatory effect of aureomycin on the growth of chicks. Proc. Soc. Expt. Biol. Med. 74:11-13.

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