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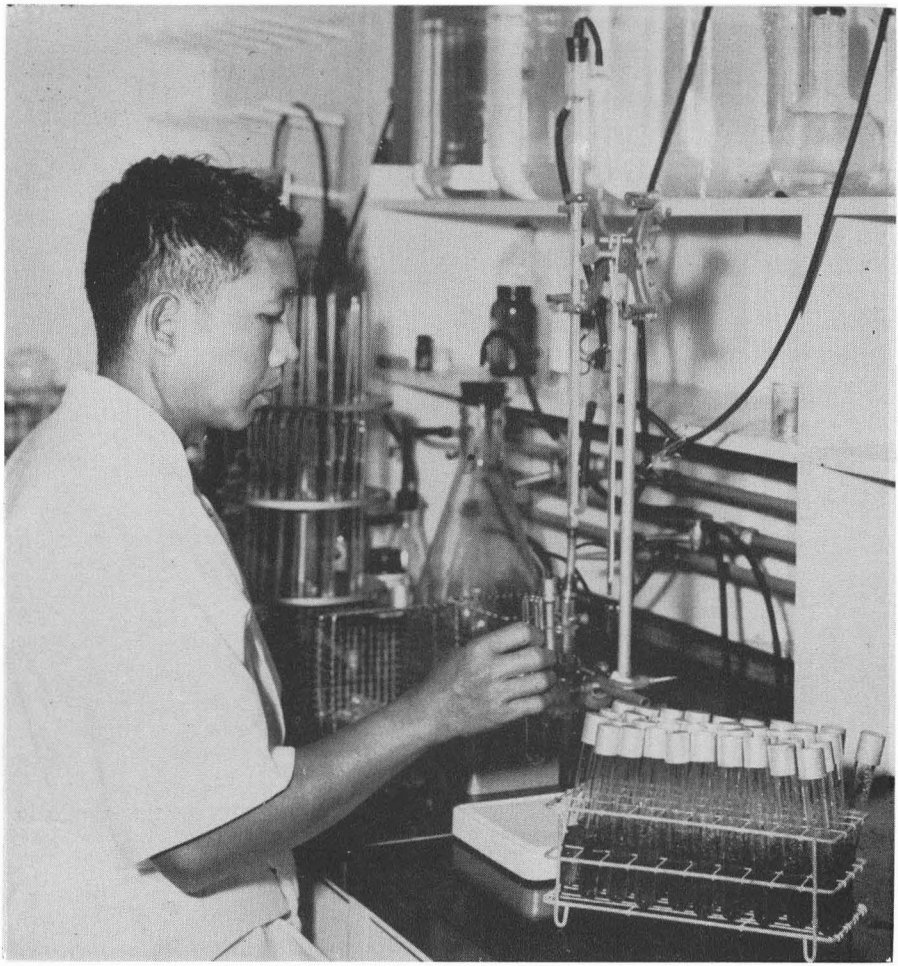


FIGURE 1. Microbiological assay of vitamins in the nutrition and physiology laboratory of the poultry husbandry department, Hawaii Agricultural Experiment Station.

A Comparison of Certain Antibiotics in Several Chick Starter Rations

Recent investigations in poultry nutrition have created new opportunities to combine feedstuffs into more efficient and less costly rations. It has been reported that certain antibiotics have growth-stimulating properties under given conditions, and exert a beneficial effect on hatchability. Unfortunately, much of the extant literature has been reported piecemeal; either several antibiotics were compared in a single ration or a single antibiotic was fed in different rations. Due to the considerable number of reports thus presented, comparatively few persons, aside from nutrition specialists, are able to use these data effectively. This investigation was undertaken, therefore, in an attempt to co-ordinate the evidence on selected antibiotics, and to do this under typical Hawaiian conditions. The latter objective appeared justified since no report was reviewed on studies dealing with antibiotic feed supplementation under tropical conditions. Furthermore, many of the ingredients fed in mainland trials are not imported in Hawaii, and as a consequence it was not known whether the beneficial effects noted above could be obtained locally.

REVIEW OF LITERATURE

Stokestad *et al.* (*10*) found that a product resulting from the culture of *Streptomyces aureofaciens* contained an unidentified factor which stimulates the growth of chicks. Others, including Sherwood and Couch (*8*) and Reed and Couch (*6*), later found that certain fermentation products enhanced the growth of chicks fed all-vegetable rations. Berg *et al.* (*1*) obtained similar results from the inclusion of aureomycin by-products in a high-energy fryer ration. This phenomenon was found by Stokestad *et al.* (*9*) to be due to the interrelationship between aureomycin and vitamin B_{12}. The interdependence of vitamin B_{12} and aureomycin was also observed by Oleson *et al.* (*4*) in a series of studies in which the two growth factors were reciprocally supplemented in the experimental diets.

According to Swenson (*12*), vitamin B_{12} may be supplied by animal proteins. Matterson and Singsen (*3*) reported that certain antibiotics, including terramycin and penicillin, improved a diet containing 2.5 percent fish meal. The all-plant protein diets were improved by the antibiotics to the extent that they were statistically equal to the basal ration containing 2.5 percent fish meal. Reports from Pfizer & Company (*5*) indicated that terramycin had a sparing action on vitamin B_{12}.

Certain reports have shown that the stimulatory effect of these antibiotics and of vitamin B_{12} were not unlimited or even universal. It may be inferred that the effectiveness of antibiotic feed supplements was dependent upon the nutritive contents of the rations to which they were added. No improvement in growth, except for a slight response due to the addition of aureomycin to a corn-soya ration, was reported by Scott and Glista (*7*). Sunde *et al.* (*11*) found that the addition of vitamin B_{12} concentrate did not promote growth as well as did 3 percent fish solubles. Bieley and March (*2*) noted that the addition of

aureomycin to a diet containing five vitamins at levels above those recommended by the N.R.C. resulted in no further increase in chick growth.

Although the literature referred to above, together with other studies, has established the widespread phenomenon of growth stimulation by minute quantities of antibiotics, no specific reference has been found relating to the comparative stimulatory effect of aurofac,* Bi-Con TM-5,† R.E. B-Meg B_{12},‡ and R.E. Antibiotic Feed Supplement‡ in all-vegetable rations. As a consequence, this comparison was also included in the studies that follow.

TABLE 1. Composition of Basal Diets.

INGREDIENTS[1]	CONTROL	
	Positive (Ration 1)	*Negative* (Ration 10)
Ground wheat	20.0	20.0
Ground yellow corn	26.5	26.5
Ground oats	10.0	10.0
Fish meal (70%)	6.0	....
Soybean oil meal (44%)	30.0	36.0
Dehydrated alfalfa meal (17%)	5.0	5.0
Ground oyster shell	1.0	0.5
Defluorinated phosphate	1.0	2.0
Iodized salt	0.5	0.5
Manganese sulfate, gm.	10.0	10.0
Choline chloride (25%), gm.	125.0	125.0
Delsterol (2000 AOAC/gm.), gm	15.0	15.0
Riboflavin, mg.	160.0	160.0

[1]Unit of measure is pound(s), unless otherwise specified.

MATERIALS AND METHODS

Straight-run day-old New Hampshire chicks were weighed and randomized into different lots of 20 chicks each. They were reared in electrically heated raised-wire-floor starting batteries, and moved at 4 weeks of age to intermediate grower batteries. Body weight and feed consumption were recorded biweekly to 6 weeks of age. The diets fed in this sequence of studies are shown in tables 1, 2, 3, 4, 5, and 6.

*Aurofac (Lederle) contains not less than 1.8 mg. vitamin B_{12} and 1.8 mg. aureomycin hydrochloride per pound.

†Bi-Con TM-5 contains an equivalent of 5.0 g. crystalline terramycin hydrochloride per pound. (Kindly supplied by Pfizer & Company.)

‡R.E. B-Meg. B_{12} contains 4.0 mg. vitamin B_{12}, and R.E. Antibiotic Feed Supplement contains 2 g. diamine penicillin per pound. (Kindly supplied by Ray Ewing Company.)

TABLE 2. Average Biweekly Weights and Feed Efficiency of New Hampshire Chicks Fed a Soybean-Fish Basal Diet Supplemented with Antibiotics and Vitamins B_{12}. (Trials I, II, and III.)

CHARACTERISTICS	RATION		
	1	2	3
Basal	Pos.	Pos.	Pos.
Terramycin, mg./lb.	....	....	....
Aureomycin, mg./lb.	....	6.61	7.93
Vitamin B_{12}, mcg./lb.	....	....	7.93
Body weight, in grams			
males and females			
1 day	39	39	39
14 days	137	164	162
28 days	369	414	405
42 days	678	718	730
males only, 42 days	730	809	808
females only, 42 days	640	659	669
Growth index			
males	100	111	111
females	100	103	105
Feed efficiency[1]	2.43	2.34	2.34
Average feed, gm[1]	1554	1591	1615

Between treatments	F= 10.54	P>0.01
Between sexes	F=146.20	P>0.01
Between trials	F= 9.38	P>0.01
Between treatments x sexes	F= 3.18	P<0.05
Least significant difference between treatments		27.9 gm. at 5%
Least significant difference between sexes		22.7 gm. at 5%
Least significant difference between trials		27.9 gm. at 5%

[1]Males and females, 1 - 42 days.

RESULTS

Trials I, II, and III were conducted to ascertain the supplementary effect of terramycin, aureomycin, and vitamin B_{12} when added to a soybean-fish basal ration containing 6 percent fish meal. Diets 1, 2, and 3 were tested in each trial. The results are shown in table 2. Cockerels fed the unsupplemented control diet weighed, on the average, 730 grams at 6 weeks of age. When terramycin contained in Bi-Con TM-5 supplemented the above diet, the average weight attained was 809 grams, an 11 percent improvement in growth. When aureomycin and vitamin B_{12} contained in aurofac were used as supplements, the average weight was 808 grams; improvement in growth was also 11 percent.

An analysis of the data showed that terramycin or a combination of aureomycin and vitamin B_{12} significantly improved the soybean-fish basal diet.

TABLE 3. Effect of Terramycin, aureomycin, and Vitamin B_{12} in Diets with or without Animal Protein. (Trial IV.)

CHARACTERISTICS	RATION					
	1.1	2.1	3.1	10	11	12
Basal	Pos.	Pos.	Pos.	Neg.	Neg.	Neg.
Terramycin, mg./lb.	....	6.61	....	....	6.61	....
Aureomycin, mg./lb.	....	....	7.93	....	....	7.93
Vitamin B_{12}, mcg./lb.	....	....	7.93	....	....	7.93
Body weight, in grams *males and females*						
1 day	39	39	39	39	39	39
14 days	162	193	196	157	181	187
28 days	363	409	406	329	353	377
42 days	667	729	735	600	628	690
males only, 42 days	708	778	771	614	635	779
females only, 42 days	616	657	677	592	624	618
Growth index						
males	100	110	109	100	103	127
females	100	107	110	100	105	104
Feed efficiency[1]	2.32	2.17	2.08	2.31	2.31	2.26
Average feed, gm.[1]	1546	1586	1526	1387	1449	1561

Between treatments, males and females	F= 8.33	P<0.01
Between sexes	F=41.32	P<0.01
Between treatments, males only	F= 4.79	P<0.01
Between treatments, females only	F= 1.76	P>0.05

[1]Males and females, 1 - 42 days.

Three replicate tests showed 6.7–17.8 percent improvement in growth of cockerels when either terramycin or aurofac and vitamin B_{12} supplemented the soybean-fish diet. These data also revealed a highly significant F ratio for between-trial means, denoting that the rates of growth obtained in trials I, II, and III were significantly different. The differences in growth response may be attributed in part to variation between experimental chicks and feedstuffs, and the intangible effects of environment. Nevertheless, improvement in growth rate due to supplementation of either terramycin or aureomycin and vitamin B_{12} in rations 11 and 12 was highly significant and would not be expected to result from chance alone more than once in 100 trials.

The pullets tested in the first three trials attained average weights of 640, 658, and 669 grams, respectively, for rations 1, 2, and 3. The growth indexes were 100, 103, and 105 in the same order. When these data were analyzed, it was found that there was no significant improvement in growth of pullets due to added terramycin or aureomycin and vitamin B_{12} in a basal diet containing

6 percent fish meal. Nor was there any consistent improvement in growth from the addition of the above supplements.

Average feed efficiency for both cockerels and pullets was 2.43, 2.34, and 2.33, respectively, for the soybean-fish basal, terramycin, and aureomycin-vitamin B_{12} diets. There was no significant difference in the amount of feed consumed to produce a unit of gain. A difference of 0.27 in feed efficiency was required for significance at the 5 percent level. At the end of 6 weeks, birds which were fed the antibiotics consumed, on the average, 37–71 grams more per bird than those of the control group. However, those receiving antibiotics ate less feed per unit of gain.

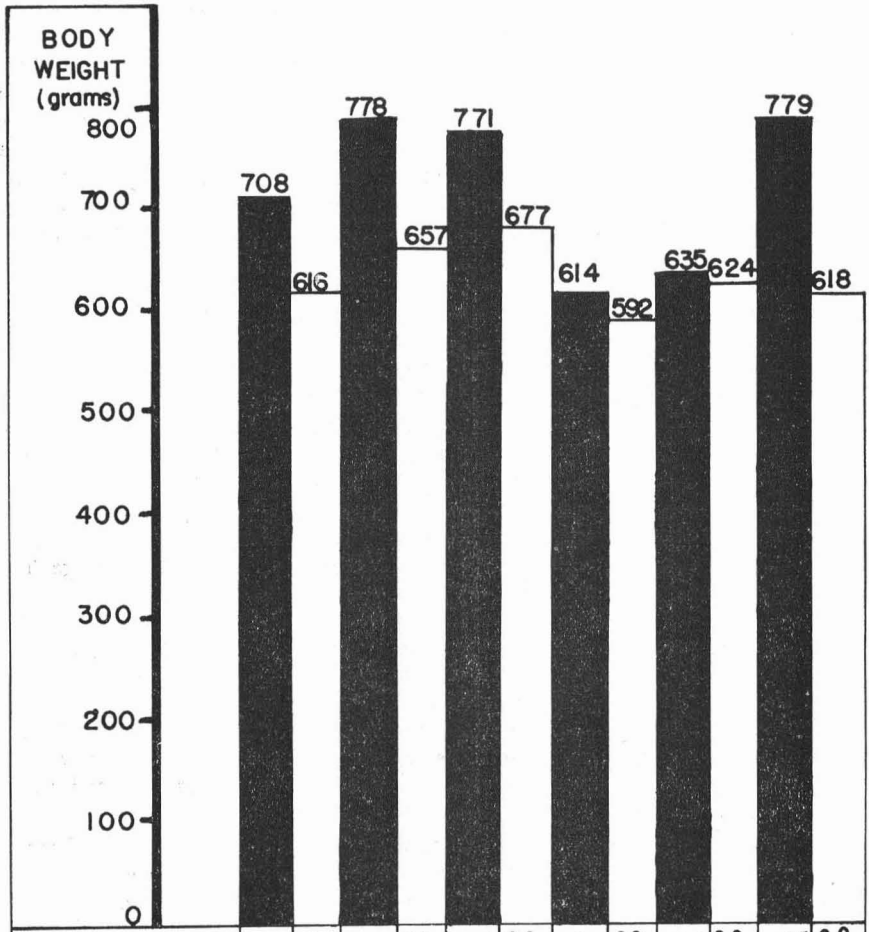
Trial IV was conducted primarily to find the effect of terramycin, aureomycin, and vitamin B_{12} in all-vegetable protein rations. Diets with animal protein were tested to ascertain their comparative value with all-vegetable protein diets when the same hatch of chicks were used. The results may be seen in table 3. It was noted that cockerels and pullets showed different growth responses when fed the antibiotic rations. When the 6-week weights of cockerels were analyzed, there was a highly significant difference, $P<0.01$, between treatments. The final 6-week weight of pullets showed a nonsignificant difference of $P>0.05$ between treatments.

Terramycin, aureomycin, and vitamin B_{12} exerted different supplementary effect when added to diets with or without animal protein. The average final 6-week weights of cockerels fed the soybean-fish basal with or without antibiotic supplement were 708, 778, and 771 grams, respectively, for rations 1.1, 2.1, and 3.1. Those fed the soybean basal with or without supplement weighed 614, 635, and 779 grams, respectively, for rations 10, 11, and 12. The soybean-fish basal diet was significantly superior to the soybean basal ration for growth of chicks to 6 weeks of age. Terramycin and a combination of aureomycin and vitamin B_{12} significantly improved the soybean-fish basal ration; they were statistically equal in supplementary effect when added to a basal diet containing animal protein.

The data also showed that the addition of terramycin did not significantly improve the soybean basal ration. However, the addition of aureomycin and vitamin B_{12} significantly improved the soybean basal diet; the supplemented diet was statistically equal to the soybean-fish basal ration supplemented with either terramycin or aureomycin and vitamin B_{12}. There was a 27 percent improvement in growth of cockerels when aureomycin and vitamin B_{12} supplemented the all-vegetable protein diet.

Pullets fed the soybean-fish basal ration supplemented with antibiotics weighed 616, 657, and 677 grams, respectively, for rations 1.1, 2.1, and 3.1. Those that were fed the soybean basal diets without animal protein and supplemented with antibiotics weighed 592, 624, and 618 grams for rations 10, 11, and 12 in the same order. Further analysis of the data showed a nonsignificant difference between means, $P>0.05$. Figure 2 shows the growth response of cockerels and pullets due to the antibiotic supplements.

Feed efficiency ranged from 2.08 to 2.32 grams of feed per unit of gain. The birds fed diets supplemented with either terramycin or aureomycin and vitamin B_{12} required the same or less feed per unit of gain compared to their respective controls.



Sex	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Basal	Pos.		Pos.		Pos.		Neg.		Neg.		Neg.	
Terramycin, mg/lb	0		6.61		0		0		6.61		0	
Aureomycin, mg/lb	0		0		7.93		0		0		7.93	
Vitamin B-12, mcg/lb	0		0		7.93		0		0		7.93	
Growth index	100	100	110	107	109	110	100	100	103	105	127	104
Ration No.	1.1		2.1		3.1		1.0		1.1		1.2	

FIGURE 2. Effect of terramycin, aureomycin, and vitamin B_{12} on the final 6-week weight of cockerels and pullets.

TABLE 4. Effects of Antibiotics and Vitamin B_{12} in All-Vegetable Diets. (Trial V.)

CHARACTERISTICS	RATION							
	10.1	13	12.1	14	15	16	17	11
Basal	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Terramycin, mg./lb.	....	7.93	....	....	7.93	7.93	....	7.93
Aureomycin, mg./lb.	....	....	7.93	....	7.93	....	7.93	7.93
Vitamin B_{12}, mg./lb.	0	....	7.93	7.93	7.93	7.93	15.86	15.86
Body weight, in grams *males and females*								
1 day	37	37	37	37	37	37	37	37
14 days	127	157	153	132	160	158	168	161
28 days	300	363	375	311	361	386	400	370
42 days	558	632	689	572	660	701	756	658
males only, 42 days	582	676	720	579	748	770	780	788
females only, 42 days	546	550	651	566	588	618	716	615
Growth index								
males	100	116	124	99	129	132	134	135
females	100	101	119	104	108	113	131	113
Feed efficiency[1]	2.68	2.52	2.22	2.42	2.36	2.29	2.26	2.50
Average feed, gm.[1]	1492	1592	1528	1384	1560	1606	1711	1647

Between treatments, males $F=5.11$ $P<0.01$
Between treatments, females $F=2.18$ $P<0.05$

[1]Males and females, 1-42 days.

Trial V was conducted to ascertain the supplementary effect of two levels of vitamin B_{12} and an antibiotic in all-vegetable protein rations. As shown in table 4, when the final 6-week weights of cockerels were analyzed, a highly significant difference, $P<0.01$, between treatments was obtained. The pullet data showed a significant difference between treatments, $P<0.05$.

The average weights of cockerels fed the soybean basal diets with or without antibiotic supplement were 582, 676, 720, 579, 748, 770, 780, and 788 grams, respectively, for rations 10.1, 13, 12.1, 14, 15, 16, 17, and 18. Vitamin B_{12} did not significantly improve the soybean basal. Terramycin improved growth of cockerels 16 percent, and a combination of terramycin and vitamin B_{12} improved growth 32 percent. Aureomycin and vitamin B_{12} improved growth 24 percent. As seen in table 5, there was no significant difference in the supplementary value of either a combination of terramycin and vitamin B_{12} or aureomycin and vitamin B_{12}. When the antibiotic supplement was increased from 7.93 to 18.56 milligrams per pound of feed, there was no significant improvement in growth. When vitamin B_{12} was increased from 7.93 to 18.56 micrograms per pound of feed, no significant difference in growth was observed. Birds fed aureomycin, terramycin, and vitamin B_{12} required less feed per unit of gain than when fed the unsupplemented all-vegetable soybean basal. Feed efficiency ranged from 2.22 to 2.68 grams of feed per unit of gain.

TABLE 5. Significant Differences Between Means of Final 6-week Weights of Chicks Fed All-Vegetable Rations with or without Antibiotics and Vitamin B_{12}.[1] (Trial V.)

CHARACTERISTICS		RATION							
		10.1	13	12.1	14	15	16	17	18
Basal		Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.	Neg.
Terramycin, mg./lb.		....	7.93	....	....	7.93	7.93	....	7.93
Aureomycin, mg./lb.		....	....	7.93	....	7.93	....	7.93	7.93
Vitamin B_{12}, mcg./lb.		....	....	7.93	7.93	7.93	7.93	15.86	15.86
Cockerels:	Final weight, gm.	582	676	720	579	748	770	780	788
Ration	10.1	....							
	13	S*	....						
	12.1	S*	S*	....					
	14	N	S*	S*	....				
	15	S*	S*	S*	S*	....			
	16	S*	S*	S*	S*	S*	....		
	17	S*	S*	S*	S*	S*	N	....	
	18	S*	S*	S*	S*	S*	S*	N	....
Pullets:	Final weight, gm.	546	550	651	566	588	618	627	615
Ration	10.1	....							
	13	N	....						
	12.1	S*	S	....					
	14	N	N	S	....				
	15	N	N	N	N	....			
	16	S	N	N	N	N	....		
	17	S	N	N	N	N	N	....	
	18	S	N	N	N	N	N	N	....

[1]Significance of difference:
N=Not significant
S=Significant at 5%
S*=Significant at 1%

Trial VI was designed primarily to discover the supplementary effect of penicillin in chick diets. The difference between treatments was highly significant: $P<0.01$ for the cockerels and also for the pullets (table 6). At 6 weeks of age the cockerels averaged 667, 787, 733, 738, 736, 612, 732, 706, 686, and 600 grams, respectively, for rations 1.2, 4, 3.2, 5, 6, 10.2, 13.1, 12.2, 19, and 14.1. It was observed that 7.93 milligrams of terramycin per pound of feed (Ration 4) improved the growth of cockerels 18 percent while those fed the same amount of penicillin (Ration 5) improved growth 10 percent when these supplements were incorporated in a soybean-fish basal diet. A combination of penicillin and vitamin B_{12} was not significantly different from penicillin alone as a supplement to the soybean-fish diet. Vitamin B_{12} did not improve the soybean-fish diet.

TABLE 6. Effect of Terramycin, Penicillin, and Vitamin B_{12} in Chick Rations with or without Animal Protein. (Trial VI.)

CHARACTERISTICS	RATION									
	1.2	4	3.2	5	6	10.2	13.1	12.2	19	14.1
Basal	Pos.	Pos.	Pos.	Pos.	Pos.	Neg.	Neg.	Neg.	Neg.	Neg.
Terramycin, mg./lb.	....	7.93	....	....	....	....	7.93	....	....	....
Penicillin, mg./lb.	....	....	7.93	7.93	....	....	....	7.93	7.93	....
Vitamin B_{12}, mcg./lb.	....	....	7.93	....	7.93	....	....	7.93	....	7.93
Body weight, in grams *males and females*										
1 day	41	41	41	41	41	41	41	41	41	41
14 days	146	181	175	176	159	133	172	164	168	143
28 days	372	427	406	411	404	358	406	395	397	349
42 days	620	730	658	667	698	591	683	618	636	567
males only, 42 days	667	787	733	738	736	612	732	706	686	600
females only, 42 days	581	646	592	637	659	556	657	596	597	545
Growth index										
males	100	118	110	111	110	100	120	115	112	100
females	100	111	102	110	113	100	118	107	107	98
Feed efficiency[1]	2.74	2.35	2.36	2.61	2.41	2.89	2.49	2.81	2.55	2.92
Average feed, gm.[1]	1584	1621	1459	1635	1593	1600	1621	1515	1535	1580

Between treatments, males $F = 7.47$ $P < 0.01$
Between treatments, females $F = 21.32$ $P < 0.01$

[1]Males and females, 1 - 42 days.

The addition of penicillin to the soybean basal diet resulted in an improvement in growth of cockerels which was 8 percent less than that of terramycin. The use of penicillin and vitamin B_{12} resulted in a 3 percent improvement of growth over that of penicillin alone. Vitamin B_{12} showed no improvement in growth over that of the control.

The effect of antibiotics on feed cost to produce a unit of gain is shown in table 7. The addition of terramycin to the basal diet increased feed cost 3 percent; whereas, the addition of aureomycin and vitamin B_{12} increased the cost 4 percent. However, growth was improved 9 percent by supplementing the soybean-fish basal with terramycin, and the addition of aureomycin and vitamin B_{12} to the same basal improved growth 10 percent. On the other hand, the percentage improvement in growth of the cockerels fed the soybean basal supplemented with terramycin did not exceed the increase in feed cost. Aureomycin and vitamin B_{12} improved growth of cockerels 27 percent, although feed cost was only increased 4 percent. The cost of feed to produce a unit of gain for the soybean-fish basal supplemented with terramycin was the same as that for the soybean basal supplemented with aureomycin and vitamin B_{12}.

TABLE 7. Effect of Antibiotics and Vitamin B_{12} on Feed Cost to 6 Weeks of Age.

CHARACTERISTICS	RATION					
	1.1	2.1	3.1	10	11	12
Basal	Pos.	Pos.	Pos.	Neg.	Neg.	Neg.
Terramycin, mg./lb.	....	6.61	....	....	6.61	....
Aureomycin, mg./lb.	....	....	7.93	....	....	7.93
Vitamin B_{12}, mcg./lb.	....	....	7.93	....	....	7.93
Average weight, in grams						
males and females	667	729	735	600	628	690
males only	708	778	771	614	635	779
females only	616	657	677	592	624	618
Growth index						
males	100	110	109	100	103	127
females	100	107	110	100	105	104
Cost of feed per 100 lbs.	6.41	6.59	6.65	6.08	6.26	6.32
Average feed consumed, gm.[1]	1546	1586	1526	1387	1449	1561
Average feed consumed, lb.[1]	3.41	3.49	3.36	3.06	3.19	3.44
Average cost of feed, cents[1]	19.5	23.0	22.4	18.6	20.0	21.7
Feed efficiency	2.32	2.17	2.08	2.31	2.31	2.26
Feed cost per unit of gain, cents	14.9	14.3	13.8	07.1	14.5	14.3
Cost index[2]	100	103	104	100	103	104

[1]Males and females.

[2]Cost index = $\frac{\text{Cost of test diet per 100 pounds.}}{\text{Cost of control diet per 100 pounds.}}$

DISCUSSION

The different growth responses due to antibiotics and vitamin B_{12} in trials I, II, and III have clarified, in part, the conflicting reports that antibiotics may or may not stimulate growth. The analysis of variance of the individual data within groups in each trial revealed a significant difference between treatments only in trials I and III. These differences were significant at the 5 percent level when the final weights of cockerels were analyzed. In trial II, although there was a slight improvement in growth, the addition of either terramycin or aureomycin and vitamin B_{12} did not significantly improve the soybean-fish diet.

This analysis also emphasized the importance of replication in an experimental design. While there was no significant difference between treatments in trial II, and there were significant differences between treatments within trials I and III at the 5 percent level, there was a highly significant difference between treatments at the 1 percent level when variance analysis was made on the combined data from trials I, II, and III.

The analysis revealed further that the average stimulation of pullet growth of 3–5 percent in trials I, II, and III was not significant at the 5 percent level. This finding has indicated a significant difference between sexes to 6 weeks of age in growth stimulation due to antibiotics.

The data obtained from studies on all-vegetable diets supplemented with either terramycin or aureomycin and vitamin B_{12} corroborated the differential growth response observed between cockerels and pullets. Males fed the all-vegetable diet supplemented with terramycin showed a growth response of only 3 percent; when the same diet was supplemented with a combination of aureomycin and vitmin B_{12}, the growth response was 27 percent. Concomitantly, females revealed a growth increase of only 4–5 percent. These data suggest that the two sexes differ in their tolerance for the above supplements.

Since it was noted that the addition of an antibiotic plus vitamin B_{12} to an all-vegetable diet made the diet statistically equal to the soybean-fish basal diet supplemented with either terramycin or a combination of aureomycin and vitamin B_{12}, it was presumed that vitamin B_{12} and aureomycin were responsible for the phenomenal increase in growth rate. To further verify this assumption, terramycin, penicillin, and vitamin B_{12} were fed singly or in combination in an all-vegetable diet. It was observed that terramycin, penicillin, and vitamin B_{12} fed singly as supplements did not result in the improvement of growth as well as did vitamin B_{12} combined with an antibiotic.

The data also revealed that antibiotics cannot be used indiscriminately in chick rations. It has been observed in six trials that the feed cost increased 3–4 percent when these supplements were fed; consequently, their use may be warranted only when certain conditions are met. In this study, antibiotics in all-vegetable diets were effective only in the presence of supplemented vitamin B_{12}. On the other hand, antibiotics in diets containing animal protein may not benefit from additional vitamin B_{12}. This will depend largely on the sample of animal protein contained in each ration. The significant differences obtained between trials I, II, and III were due primarily to the lack of significance between treatments in trial II when either terramycin or aureomycin and vitamin B_{12} supplemented the basal ration containing 6 percent herring meal.

This study has shown that the amount of animal protein in chick diets may be influenced by the cost of the antibiotic and of soybean oil meal. It has also been shown that cockerels fed an all-vegetable diet require both antibiotic and vitamin B_{12} supplementation; whereas pullets grew just as well when fed an antibiotic with or without vitamin B_{12}. The degree of response to the supplement will, therefore, also be influenced by sex.

SUMMARY

Six experiments involving 660 straight-run day-old New Hampshire chicks were conducted to ascertain the supplementary value of terramycin, aureomycin, penicillin, and vitamin B_{12} in practical chick starter rations with or without animal protein.

Both terramycin and a combination of aureomycin and vitamin B_{12} significantly improved a soybean-fish diet containing 6 percent herring meal when cockerels were used as experimental subjects. No significant increase in the growth of pullets was noted.

Either terramycin, penicillin, or vitamin B_{12} did not significantly improve a soybean-basal diet. A combination of terramycin, aureomycin, or penicillin, with vitamin B_{12} significantly improved the all-vegetable diet containing 36 percent soybean oil meal.

Feed efficiency was improved when an antibiotic and vitamin B_{12} supplemented diets with or without animal protein.

There was a different growth response of the sexes due to antibiotics and vitamin B_{12}.

In the all-vegetable diets used in this study, antibiotics were only effective in the presence of supplemented vitamin B_{12}.

The amount of animal protein used in chick diets may be influenced by the cost of the antibiotic and soybean oil meal. It has been shown that an all-vegetable diet supplemented with aureomycin and vitamin B_{12} was statistically equal to a soybean-fish ration supplemented with either terramycin or aureomycin and vitamin B_{12}.

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