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B-COMPLEX VITAMIN ALLOWANCES FOR OKLAHOMA BROILER RATIONS

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High-energy broiler rations must contain B-complex vitamin levels considerably in excess of those normally present in natural feed ingredients if maximum growth and efficient feed conversion are to be obtained. This increased requirement of broilers can be met by supplementing high-energy broiler rations with synthetic B-complex vitamins, including niacin, choline, riboflavin, pantothenic acid, and folic acid.

Much research has been done during the past six years in determining the requirements of the growing chick for these B-complex vitamins.** Nevertheless, there remained some uncertainty as to how well the requirements established elsewhere would apply in Oklahoma. Therefore, the Oklahoma Agricultural Experiment Station undertook a series of feeding trials aimed at finding, for each of these five vitamins, the nutrient allowance ranges within which satisfactory broiler growth could be obtained under Oklahoma feeding conditions and using feed ingredients commonly available in this state. Three feeding tests were made, involving a total of 800 New Hampshire chicks.

Recommended Ranges

The data obtained in the three feeding trials described in this bulletin indicate that the following ranges will be satisfactory:

	Milligrams per pound of ration
Riboflavin	5 to 6.5
Niacin	8 to 16
Pantothenic acid	5 to 6
Folic acid	1 to 1.5
Choline	700 to 800

The level given for each vitamin is the amount required per pound of total ration. **The amount of each vitamin supplement added to a ration, therefore, is determined by the difference between the natural vitamin level in the feed and the recommended nutrient allowance.**

** See Bibliography, page 11.

The recommended ranges are rather wide, and permit considerable variation in the actual levels fed, as long as they remain within the ranges given.

In selecting the levels to be used, the determining factors are: (a) the cost of vitamin supplements, and (b) the kind of feed ingredients used. However, the vitamin content of natural feedstuffs may vary due to aging or to the techniques used in processing them; therefore it may be necessary to use allowances in the upper part of the range to fully compensate for possible vitamin deficiencies in the natural feedstuffs being used. If corn is used as the principal grain, the upper limit of niacin probably is preferable.

TABLE I.—Basal Rations Used in Feeding Trials.

BASAL RATION I—SEMI-PURIFIED

Ingredient	Percent
Cerelose	45.4
Dl methionine	.1
T & L Cake (wheat gluten hydrolysate)	1.0
Soybean meal (Low-fiber, 50% protein)	41.0
Mineral Mix No. 1	5.0
Vitamin Mix No. 1	5.0
Soybean oil	2.5

Mineral Mix No. 1

Ingredient	Percent
$CaCo_3$	29.40
$CaHPO_4 \times 2H_2O$	35.58
K_2HPO_4	15.73
NaCl	11.24
$MgSO_4 \times 7H_2O$	9.36
$FeSO_4 \times 7H_2O$	1.03
$MnSO_4 \times 4H_2O$	0.54
KI	0.062
$CuSO_4 \times 5H_2O$	0.028
$ZnCl_2$	0.018
$CoCl_2 \times 6H_2O$	0.0037

Vitamin Mix No. 1

Ingredient	Amount
Vitamin A oil (6000 I.U./gm.)	.2 lb.
Vitamin D (2000 A.O.A.C./gm)	.1 lb.
Tocopherol concentrate (10 mg of alpha tocopherol/gm)	19 cc
Menadione	.018 gm
Thiamin Hydrochloride	.227 gm
Biotin	.0045 gm
Pyridoxine	.227 gm
Mercks B_{12} and Antibiotic Supplement (12 mg B_{12}/lb and 3 gm procaine penicillin/lb)	51 gm
Cerelose	4.5 lbs

BASAL RATION II—PRACTICAL

Ingredient	Percent
Ground Yellow Corn	55.6
Pulverized Oats	5.0
Corn Gluten Meal	5.0
Fish Meal (60% protein)	5.0
Soybean Oil Meal (41% protein)	25.0
Vitamin A Oil (6000 I.U./gm)	0.13
Dry D (2000 A.O.A.C./gm)	0.057
Manganese Sulfate	0.013
Salt	1.0
Calcium Carbonate	1.0
Steamed Bone Meal	2.0
Mercks B_{12} and Antibiotic Supplement (12 mg B_{12}/lb and 3 gm procaine penicillin/lb)	0.2

THE FEEDING TESTS

General Experimental Procedure

A total of 800 New Hampshire chicks was used in three feeding trials. In Test One, 12 pens with 20 chicks per pen were housed in a continuous brooder house and fed for an eight-week growing period. In Tests Two and Three, the chicks were kept for a four-week growing period in multiple-section battery brooders. Each lot included two battery sections with 10 chicks per section. A total of 23 lots was used in Test Two and five lots in Test Three.

The two types of basal rations used in this study are shown in Table I. In Tests One and Two, graduated levels of niacin, choline, pantothenic acid, riboflavin, and folic acid were added to Basal Ration I. In Test Three, graduated levels of these vitamins were added to Basal Ration II, which was a practical-type broiler ration containing adequate levels of all required nutrients except the B-complex vitamins with which the experiment was concerned.

Vitamin ranges for Test One were chosen to include levels at and below the National Research Council allowances and above the levels recommended by Connecticut workers (17). In each individual ration the level of one specific B-complex vitamin was varied experimentally. With the exception of this specific vitamin, the ration levels of the other B-complex vitamins were: Riboflavin, 4.8 mg/lb.; pantothenic acid, 5 mg/lb.; niacin, 16 mg/lb.; choline, 900 mg/lb.; and folic acid 2.5 mg/lb. In Test Two, the level of each vitamin which had given the best results in Test One was used as a basis for narrowing down the allowance range.

After tentative vitamin allowance ranges had been established on the basis of data from Tests One and Two, Test Three was set up to observe the effects of using these ranges in a practical broiler ration. The data from all three tests were then used as a basis for the recommended allowance ranges given above.

Results and Discussion

TEST ONE

The results of Test One are summarized in Table II.

Riboflavin.—The National Research Council nutrient allowance of 1.6 milligrams per pound of ration was not adequate. There appeared to be some slight advantage to feeding a level of 6.4 milligrams as compared to a level of 4.8 milligrams per pound of ration. The difference between the two higher levels and the low level of riboflavin was not significant during the first four weeks of the growing period. Apparently sufficient body stores in the chick compensated for any ration deficiency during this period.

TABLE II.—Test One

Weight Gains and Feed Conversion Efficiency of Chicks in Relation to Varying Levels of Five B-complex Vitamins, Using a Semi-purified Ration

Vitamin	Level fed (mg/lb.)	Average weekly weight grain (Grams)								Total gain 8 wks.	Lbs. feed per lb. gain
		1st wk.	2nd wk.	3rd wk.	4th wk.	5th wk.	6th wk.	7th wk.	8th wk.		
Riboflavin	1.6	31	65	98	84	117	118	190	147	850	2.55
	4.8	40	69	105	103	160	154	211	161	1003	2.71
	6.4	37	72	99	116	161	137	221	165	1008	2.69
Pantothenic acid	2.5	36	62	92	128	144	145	197	129	933	2.64
	5.0	40	69	105	103	160	154	211	161	1003	2.71
	7.5	37	65	96	140	139	141	211	166	995	2.50
Niacin	8	38	69	98	103	139	159	213	163	982	2.63
	16	40	69	105	103	160	154	211	161	1003	2.71
	24	35	54	81	112	110	142	191	158	883	2.47
Choline	700	38	71	88	102	156	141	223	111	930	2.50
	900	40	69	105	103	160	154	211	161	1003	2.71
	1400	38	67	96	95	128	140	205	162	931	2.60
Folic acid	1.25	38	70	107	84	144	155	198	157	953	2.67
	2.5	40	69	105	103	160	154	211	161	1003	2.71
	5.0	41	65	101	67	140	132	194	172	912	2.64

Pantothenic Acid.—The National Research Council allowance of 5 milligrams of pantothenic acid per pound of ration was adequate for growth as measured by over-all growth to eight weeks of age. No advantage was gained by feeding a level of 7.5 milligrams per pound of ration.

Niacin.—A niacin level of 24 milligrams per pound of ration depressed growth. There was a slight advantage to feeding a level of 16 milligrams per pound as compared to 8 milligrams per pound of ration. Apparently the range over which the niacin level in the ration may be varied with equally good results lies between 8 and 16 milligrams per pound.

Choline.—Growth was somewhat depressed when a level of 1400 milligrams of choline was fed. This is in agreement with research findings from other stations (13). A level of 700 milligrams per pound of ration appeared to be marginal, since weight gain was below that obtained with a higher level of choline. Based on these results, it seems desirable to add choline in excess of that recommended in the National Research Council allowances.

Folic Acid.—A ration level of 5 milligrams of folic acid per pound seemed to depress growth. A level of 2.5 milligrams per pound gave the best results in this test, but subsequent tests indicated that a still lower level was nearer the desired allowance level.

TEST TWO

The results of Test Two are summarized in Table III. There were

TABLE III—Test Two.

Weight Gains of Chicks in Relation to Varying Levels of Five B-complex Vitamins, Using a Semi-purified Ration.

Vitamin	Level fed (mg/lb.)	Average weekly weight gains (Grams)				Total gain 4 wks.
		1st wk.	2nd wk.	3rd wk.	4th wk.	
Riboflavin	4.8	36	62	69	87	254
	5.6	35	65	60	116	276
	6.4	37	63	66	94	260
Pantothenic acid	5.0	36	62	69	87	254
	6.25	40	67	79	98	284
	7.50	38	71	67	94	270
Niacin	8	39	60	62	86	247
	12	37	67	78	95	277
	16	36	62	69	87	254
Choline	700	35	61	68	62	226
	800	36	61	73	104	274
	900	36	62	69	87	254
Folic acid	1.25	35	61	61	119	276
	1.85	38	71	91	79	279
	2.50	36	62	69	87	254

TABLE IV.—Test Three.
Weight Gains of Chicks in Relation to Various Combinations of Five B-complex Vitamins, Using a Practical-type Broiler Ration.

B-complex combination	Average weekly weight gains (Grams)				Total gain 4 wks.
	1st wk.	2nd wk.	3rd wk.	4th wk.	
(1)	22	55	83	119	279
(2)	21	45	83	125	274
(3)	21	52	80	120	273
(4)	21	55	81	123	280
(5)	23	57	70	124	274

	Combinations (Levels in mg/lb.)				
	(1)	(2)	(3)	(4)	(5)
Riboflavin	4.8	6.4	5.6	6.4	6.4
Pantothenic acid	5.0	7.5	6.25	7.5	7.5
Niacin	20	12	16	16	24
Choline	900	700	800	800	1400
Folic acid	1.0	1.0	1.5	1.5	2.0

no significant differences in growth among the various levels of riboflavin, pantothenic acid, and niacin. There was some indication that a choline level of 800 milligrams per pound was nearest to the most desirable allowance level. A level of 700 mg per pound was inadequate, while a level of 900 mg per pound seemed to depress growth somewhat. Folic acid levels within the range of 1.25 and 1.85 mg per pound showed little difference in growth response.

TEST THREE

The results of Test Three are summarized in Table IV. In Test Three, five different combinations of riboflavin, pantothenic acid, niacin, choline, and folic acid were fed with Basal Ration II. In most combinations, the vitamin levels used were within the allowance ranges which had given the best growth response in Test One and Two. In two of the combinations, however, niacin and choline levels above the apparent optimum allowance range were included in order to check their effect when used at that level in a practical broiler ration.

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