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DIVISION OF POULTRY HUSBANDRY
AND
DIVISION OF CHEMISTRY

The Quantities of Vitamin A Required By Growing Chicks

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
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The vitamin A in the feed of the hen laying the eggs from which the chicks are hatched and the vitamin A intake of the chicks must be adequate if good results are to be obtained. These experiments showed that chicks hatched from eggs laid by hens receiving 265 Sherman-Munsell units of vitamin A per day (or 325 units per 100 grams of feed) had low vitality. The mortality of the chicks for the first eight weeks on different vitamin A levels varied from 64.4 per cent for the chicks from the hens receiving 265 units a day (or 325 units per 100 grams of feed) to 38.5 per cent for the chicks from the hens receiving 539 units per day (or 655 units per 100 grams of feed). The mortality for the chicks from the hens fed the feed low in vitamin A was high regardless of the feed of the chick. Feeding the chick 300 units of vitamin A per 100 grams of feed did not overcome the effect of a deficiency of vitamin A in the feed for the laying hens; but the vitamin A requirements of chicks are higher for those hatched from eggs laid by hens receiving low amounts of vitamin A than for hens fed more liberal amounts. The experiments indicate that from 125 to 150 units of vitamin A potency, or 96 to 110 micrograms of carotene from alfalfa, or 114 to 136 micrograms of cryptoxanthin and carotene from yellow corn per 100 grams of feed, is sufficient for chicks hatched from eggs rich in vitamin A. Chicks hatched from eggs laid by hens receiving low amounts of vitamin A require larger amounts, possibly as high as 300 units of vitamin A potency, or 230 micrograms of carotene from alfalfa, or 270 micrograms of carotene from yellow corn per 100 grams of feed.

CONTENTS

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THE QUANTITIES OF VITAMIN A REQUIRED BY GROWING CHICKS

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Little information is available at the present time regarding the quantities of vitamin A required by growing chickens. Tepper and Reid (7) report that one per cent of cod liver oil was satisfactory, but since the strength of the cod liver oil was not given in their study and since vitamin A is destroyed rapidly when mixed with ground feeds, as shown by Fraps and Kemmerer (2), an estimate of the quantity of vitamin A required is hard to make. Bethke and Record (1) state that approximately 100 micrograms of carotene per 100 grams of basal ration was required to meet the basal requirements of vitamin A for the first 8 weeks of growing chickens.

Sherwood and Fraps (4, 5, 6) have shown that the vitamin A requirements of laying hens are high. They also showed that the vitamin A content of the eggs might vary as much as from 2 to 50 Sherman-Munsell units of vitamin A potency per gram of yolk. The quantity present in the egg was found to depend upon the quantity of vitamin A stored by the hens at the beginning of the laying period and the quantity of vitamin A consumed during the laying period, as well as upon the length of time the hens had been laying. Eggs laid by hens receiving insufficient vitamin A in their feed had a low hatchability. Previous work has shown that eggs may have a good hatchability with only 11 Sherman-Munsell units of vitamin potency per gram of egg yolk.

The work here reported is a study of the effect of the vitamin A content of the feed of the hen, and of the feed of the chick, upon the health and growth of the chick.

Method of Procedure

The chicks used in the 1933 work were hatched from eggs laid by the hens used in the study of vitamin A requirements of laying hens, as reported in Bulletin 493. The eggs were hatched and the chicks cared for under as nearly uniform conditions as it was possible to supply. The ingredients of the rations fed the first lot of hens are given in Table 1, and those for the chicks are given in Tables 2, 5, and 6. The yellow corn used was the same as that used in the experiments with hens and the vitamin A potency was determined by means of rats as described in Bulletins 493 and 514. Mr. Ray Treichler was in charge of this estimation. In the 1933 experiments, each lot of chicks numbered from 30 to 42; in the 1934 experiments, 3 lots of 25 to 26 chicks each were placed on each vitamin level; and in the 1935 experiments, two lots of

26 chicks each were fed on each vitamin level. The chicks were fed for 8 weeks in 1933 and for 12 weeks in 1934 and 1935.

In the 1933 and 1934 work the chicks were exposed to direct sunlight for 30 minutes each week. In the 1935 experiments cod liver oil in which the vitamin A had been destroyed by heat and aeration was fed for vitamin D.

Table 1. Ingredients of mixtures differing in units of vitamin A potency per 100 grams of feed used for hens (1933).

Ingredients of feed	325 units group	495 units group	655 units group
	per cent	per cent	per cent
Mash			
Alfalfa leaf meal	0	4	8
Yellow corn meal	20	20	20
Wheat gray shorts	20	20	20
Wheat bran	20	16	12
50 per cent protein meat and bone scraps	20	20	20
Ground whole oats	20	20	20
Grain			
Yellow corn ad lib			

Table 2. Ingredients of chick rations, differing in units of vitamin A potency in 100 grams of feed (1933).

Feed	50 units group	100 units group	150 units group	300 units group
	per cent	per cent	per cent	per cent
Ground yellow corn	10	20	30	60
Ground kafir	50	40	30	0
Wheat gray shorts	20	20	20	20
43% protein cottonseed meal	8	8	8	8
50% protein meat and bone scraps	8	8	8	8
Oyster shell	3	3	3	3
Salt	1	1	1	1

Relation of the Vitamin A Requirement of the Chick to the Vitamin A in the Ration Fed the Hen

In the 1933 experiment chicks hatched from eggs from three groups of hens were used. These hens were in the experiment described in Bulletin 493. From November 15 to April 1 these hens consumed an average of 265, 425, and 539 Sherman-Munsell units of vitamin A potency per day, or 325, 495, and 655 units per 100 grams of feed (Table 1). The chicks received, on an average, 50, 100, 150, and 300 units of vitamin A potency per 100 grams of feed (Table 2). Details of this experiment are given in Table 3 and a summary is given in Table 4.

It is seen from Tables 3 and 4 that the mortality of the chicks from the hens receiving 265 units of vitamin A potency daily (or 325 units

Table 3. Mortality and gains of chicks (1933).

Units of vitamin A potency in 100 grams of chick feed	Units of vitamin A potency in 100 grams of hen feed	Number of chicks on ration	Mortality by period						Gain in live weight in grams
			1-2 wks.	3-4 wks.	5-6 wks.	7-8 wks.	Total	Per cent	
50	325	31	8	3	6	7	24	77.4	143.7
		36	2	3	8	8	21	58.3	156.9
	495	42	2	5	8	12	27	64.3	155.0
Mean or total	655	109	12	11	22	27	72	66.1	153.7
100	325	33	8	3	7	5	23	69.7	158.6
		34	3	1	3	7	14	41.2	149.6
	495	42	0	3	3	8	14	33.3	156.6
Mean or total	655	109	11	7	13	20	51	46.8	154.6
150	325	33	7	7	1	5	20	60.6	154.9
		34	1	3	2	7	13	38.2	202.3
	495	42	0	3	4	7	14	33.3	174.7
Mean or total	655	109	8	13	7	19	47	43.1	179.9
300	325	30	7	5	1	2	15	50.0	133.1
		37	1	1	3	1	6	16.2	201.6
	495	41	1	1	3	4	9	22.0	152.0
Mean or total	655	108	9	7	7	7	30	27.8	168.1

per 100 grams of feed) was appreciably more than that of the chicks from the hens receiving the two larger amounts of vitamin A, regardless of the quantity of vitamin A fed the chicks. The average mortality was

Table 4. Relation of vitamin A potency in the ration of the hen to the mortality and gain in weight of the chicks.

Units of vitamin A potency in 100 grams of chick feed	325 units per 100 grams hen feed	495 units per 100 grams hen feed	655 units per 100 grams hen feed
	Mortality, per cent	Mortality, per cent	Mortality, per cent
50	77.4	58.3	64.3
100	69.7	41.2	33.3
150	60.6	38.2	33.3
300	50.0	16.2	22.1
Average	64.4	38.5	38.3
	Gain in weight, grams	Gain in weight, grams	Gain in weight, grams
50	143.7	156.9	155.0
100	158.6	149.6	156.6
150	154.9	202.3	174.7
300	133.1	201.6	152.0
Average	147.6	177.6	159.6
Vitamin A per gram of yolk	11	13	14

64.4 in one lot and 38.5 in the other. The mortality of the chicks from the hens receiving 425 and 539 units of vitamin A daily, or 325, 495, and 655 units per 100 grams of feed, was practically the same. The gain in live weight of the chicks was also less where the hens received the smallest quantity of vitamin A, but the difference is not as marked as the difference in mortality. The quantity of vitamin A fed the hens was too low and therefore had a great effect upon the vigor of the chicks, so that the mortality was higher and the gains in weight of the chicks were lower than were those of chicks from hens receiving adequate quantities of vitamin A.

It appears that hens receiving low quantities of vitamin A produce eggs of low vitality. The chickens hatched from these eggs had a high mortality, even though they were fed as much as 300 units of vitamin A potency per 100 grams of feed. Feeding vitamin A to the chicks reduced the mortality only to a small extent.

Effect of Vitamin A in the Feed Upon the Mortality, Health, and Gain in Weight of Chicks from Eggs High in Vitamin A

In addition to the experiment of 1933 just described, two other experiments were conducted, one in 1934 and the other in 1935. The chicks used were hatched from eggs from hens which were on Bermuda and Sudan grass pasture, and therefore received high quantities of vitamin A. The eggs were thus high in vitamin A. In the 1934 experiment the

various lots of chicks received, respectively, no vitamin A, and 41, 82, and 123 units of vitamin A potency per 100 grams of feed (Table 5), and in 1935 they received 25, 50, 75, 100, and 125 units per 100 grams of feed (Table 6).

Table 5. Ingredients of chick rations, differing in vitamin A potency per 100 grams of feed (1934).

Feed	0 units group	41 units group	82 units group	123 units group
	per cent	per cent	per cent	per cent
Ground yellow corn	0	15	30	45
Ground white corn	60	45	30	15
Wheat gray shorts	21	21	21	21
43% protein cottonseed meal	8	8	8	8
50% protein meat and bone scraps	8	8	8	8
Ground oyster shell	2	2	2	2
Salt	1	1	1	1

Table 6. Ingredients of chick rations, differing in vitamin A potency in 100 grams of feed (1935).

Feed	25 units group	50 units group	75 units group	100 units group	125 units group
Ground yellow corn	10	20	30	40	50
Ground white corn	47⅞	37⅞	27⅞	18⅞	8⅞
Wheat gray shorts	21½	21½	21½	21½	21½
50% protein meat and bone scraps	6	6	6	6	6
43% protein cottonseed meal	6	6	6	6	6
Dried skimmed milk	6	6	6	6	6
Cod liver oil (Vitamin A destroyed)	⅛	⅛	⅛	⅛	⅛
Ground oyster shell	1½	1½	1½	1½	1½
Salt	1	1	1	1	1

The effect of the vitamin A was measured by the mortality of the chicks, their gain in weight, and the percentage of those chicks alive at the end of the experiment which appeared to be suffering from a deficiency of vitamin A. The condition of the eyes, nose, and throat was used as an index to the vitamin A deficiency. If the eyes, nose, or throat appeared to be infected, it was concluded that a deficiency of vitamin A existed. It is possible that the chicks fed during 1934 and 1935 did not receive enough vitamin A for maximum results, but the results were satisfactory.

Detailed results of these experiments are given, for reference, in Tables 8, 9, 10, and 11. A summary of the results is given in Table 7.

Feeding 123 to 125 units of vitamin A potency per 100 grams of feed (Table 7) was sufficient to produce low mortality in the 1934 and the 1935 experiments, but 150 units was not sufficient in the 1933 experiments.

Feeding 100 units was sufficient to produce good growth in the 1935 experiments and appeared to be sufficient for growth of the chicks in the 1934 experiments, but between 100 and 150 units was required in the

Table 7. Relation of vitamin A content of feed to mortality, gain, and health of the chicks.

Units of vitamin A potency in 100 grams of chick feed	Mortality, per cent			Gain in live weight, grams			Per cent chicks showing vitamin A deficiency at the end of experiment	
	1933	1934	1935	1933 8 wks.	1934 12 wks.	1935 12 Wks.	1934	1935
0		100			0		All dead	
25			53.9			448.2		20.8
41		58.7			440.9		58.7	
50	66.1		21.2	153.7		543.1		24.4
75			25.0			557.1		2.6
82		14.9			474.9		14.9	
100	46.8		13.5	154.6		615.7		6.7
123		5.8			506.1		5.8	
125			5.8			580.4		0
150	43.1			179.9				
300	27.8			168.1				

1933 experiments. Feeding 123 units of vitamin A in the 1934 work produced chickens which had symptoms of vitamin A deficiency, but no symptoms of vitamin A deficiency were found at the end of the 1935 experiments in the chicks fed the 125 units of vitamin A.

It would appear that 125 units of vitamin A potency per 100 grams of feed may supply the minimum requirement for growing chicks, but this does not allow a safe margin under field conditions. Under some conditions, 150 units per 100 grams of feed or even more may be necessary.

Since the vitamin A potency in alfalfa seems to be due almost entirely to carotene, and that in corn to carotene and cryptoxanthin, and since the determination of carotene in a feed requires only a few hours, while the determination of vitamin A potency by means of rats requires as much as 8 weeks, it is desirable to express these results in terms of carotene.

Fraps, Treichler, and Kemmerer (3) have shown that as measured under Texas conditions 1 milligram of beta carotene in alfalfa is on an average equal to 1.3 Sherman-Munsell units of vitamin A potency in alfalfa, or to 1.1 units in yellow corn.

Therefore, 125 units of vitamin A potency in 100 grams of feed is equal to about 96 micrograms of carotene per 100 grams of feed in alfalfa or to 114 units in corn, and 150 units is equal to 115 micrograms of carotene in alfalfa or to 136 micrograms in yellow corn.

The lower limit of 125 Sherman-Munsell units of vitamin A potency per day is practically the same as the 100 micrograms of carotene per 100 grams of feed specified by Bethke and Record (1).

Table 8. Mortality and vitamin A deficiency of chicks (1934).

Units of vitamin A potency in 100 grams of chick feed	Number chicks in experiment	Mortality by periods								Chicks showing vitamin A deficiency		Per cent of original chicks healthy at close
		1-2 wks.	3-4 wks.	5-6 wks.	7-8 wks.	9-10 wks.	11-12 wks.	Total	Per cent	Number at close	Per cent remaining chicks	
0	26	0	5	10	11	0	0	26	100.0	ALL DEAD		
	25	2	3	10	9	1	0	25	100.0			
	26	1	3	14	8	0	0	26	100.0			
Mean or total	77	3	11	34	28	1	0	77	100.0			
41	26	1	0	1	3	6	2	13	50.0	7	53.8	23.1
	25	2	0	1	0	2	4	9	36.0	10	62.5	24.0
	26	0	2	0	0	3	4	9	34.6	10	58.8	26.9
Mean or total	77	3	2	2	3	11	10	31	40.3	27	58.7	24.7
82	26	1	0	0	0	1	2	4	15.4	2	9.1	76.9
	25	0	0	0	0	1	0	1	4.0	4	16.7	80.0
	26	1	1	0	0	1	3	5	19.2	4	19.0	65.4
Mean or total	77	2	1	0	0	3	5	10	13.0	10	14.9	74.0
123	26	1	0	0	0	1	0	2	7.7	1	4.2	88.5
	26	3	0	0	0	0	0	3	11.5	1	4.4	84.6
	25	0	0	1	2	0	0	3	12.0	2	9.1	80.0
Mean or total	77	4	0	1	2	1	0	8	10.4	4	5.8	84.4

Table 9. Gain in weight of chicks in grams (1934).

	0 units group	41 units group	82 units group	123 units group
Cockerels	all dead	466.2	529.7	539.8
Pullets	all dead	415.6	420.0	472.3
Mean of cockerels and pullets	all dead	440.9	474.9	506.1

Table 10. Mortality and vitamin A deficiency of chicks (1935).

Units of vitamin A potency in 100 grams of chick feed	Number chicks in experiment	Mortality by periods								Chicks showing vitamin A deficiency		Per cent of original chicks healthy at close
		1-2 wks.	3-4 wks.	5-6 wks.	7-8 wks.	9-10 wks.	11-12 wks.	Total	Per cent	Number at close	Per cent remaining chicks	
25	26	1	0	3	3	5	3	15	57.7	2	18.2	34.6
	26	1	2	2	6	1	1	13	50.0	3	23.1	38.5
Mean or total	52	2	2	5	9	6	4	28	53.9	5	20.8	36.5
50	26	1	0	1	2	2	0	6	23.1	3	15.0	65.4
	26	2	0	0	1	2	0	5	19.2	7	33.3	57.7
Mean or total	52	3	0	1	3	4	0	11	21.2	10	24.4	59.6
75	26	2	0	1	4	0	1	8	30.8	0	0.0	69.2
	26	1	0	0	3	1	0	5	19.2	1	4.8	76.9
Mean or total	52	3	0	1	7	1	1	13	25.0	1	2.6	73.1
100	26	0	0	0	0	1	2	3	11.5	1	4.3	84.6
	26	2	0	0	1	0	1	4	15.4	2	9.1	76.9
Mean or total	52	2	0	0	1	1	3	7	13 5	3	6.7	80.8
125	26	2	0	0	0	0	0	2	7.7	0	0.0	92.3
	26	0	0	0	0	1	0	1	3.8	0	0.0	96.2
Mean or total	52	2	0	0	0	1	0	3	5.8	0	0.0	94.2

Table 11. Gain in live weight of chicks in grams (1935).

	25 units group	50 units group	75 units group	100 units group	125 units group
Cockerels	454.3	604.4	561.6	671.2	627.6
Pullets	442.0	481.8	552.5	560.1	533.2
Mean of cockerels and pullets	448.2	543.1	557.1	615.7	580.4

SUMMARY

Chickens hatched from eggs laid by hens receiving 265 Sherman-Munsell units of vitamin A per day (or 325 units per 100 grams of feed) had an average mortality of 64.4 per cent. Chicks from hens receiving an average of 425 or 539 units per day (or 495 or 655 units per 100 grams of feed) hatched chickens with a mortality of 38.5 per cent under the same conditions. Chickens produced from hens receiving insufficient quantities of vitamin A have much higher mortality than those which receive adequate amounts of vitamin A. Feeding the chicks high amounts of vitamin A did not overcome the effect of the deficiency in the hen.

From three experiments in which different quantities of vitamin A potency were fed to the chicks, it appears that 125 units of vitamin A potency or 114 micrograms of cryptoxanthin and carotene from yellow corn per 100 grams of feed may be sufficient for growing chickens under some conditions. Under other conditions higher amounts seem to be required, so that 150 units of vitamin A potency, or 136 micrograms of carotene from yellow corn per 100 grams of feed may be necessary. When chicks are hatched from eggs laid by hens on low vitamin A rations it is possible that as much as 300 units of vitamin A potency, or 270 micrograms of carotene from yellow corn per 100 grams of feed, may be necessary.

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