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Essential Constituents of a Practical Ration for Baby Chicks

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SUMMARY

Chicks grew at a satisfactory rate on diets in which corn and soybean oil meal made up 96 percent of the total weight with no other source of protein. This diet contained added minerals, and vitamins A, D, riboflavin and B_{12}.

Attempts to improve this ration by additions or substitutions were not successful. The nutrients and feedstuffs added to the basal diet included:

(1) the four vitamins, pantothenic acid, nicotinic acid, folic acid and choline.

(2) Wheat bran, wheat shorts, and alfalfa meal.

(3) The protein supplements fish meal, meat and bone scraps, dried whey and corn gluten.

(4) methionine.

There was some evidence, of questionable significance, that the rate of gain was accelerated when the diet was fortified by a combination of methionine and the four vitamins pantothenic acid, nicotinic acid, folic acid and choline.

Chicks that contain liberal stores of vitamin B_{12} when hatched retain enough of the vitamin to last at least four weeks. The addition of iodized casein to the diet increases the requirement for vitamin B_{12}.

Essential Constituents of a Practical Ration for Baby Chicks

ALBERT G. HOGAN AND ROBERT W. CRAGHEAD

Numerous investigators have used rations of a practical type in studies of various phases of chick nutrition. They usually took all possible precautions to have the basal diets adequate except for the nutrient under consideration, and as a rule their rations contained a large variety of constitutents. Many of these are readily available and in common use. Others, especially some of the vitamins and amino acids, are either not readily available or they are expensive. The fact that these supplements were included in the ration has often given the impression that they were added because they had been found useful. As a matter of fact, the nutrients were frequently added as insurance, with no evidence to show that they improved the ration. The object of this investigation was to determine to what extent a practical ration could be simplified with no decrease in rate of growth.

METHODS

Animals

The experimental chicks were White Leghorns. Some were straight-run chicks from the University poultry farm, but most of them were females purchased from a commercial hatchery. As soon as they were received in the laboratory they were wing-banded and distributed evenly by weight in the various groups. There were two groups of chicks on some of the rations and three groups on the others, under observation at different times.

The chicks were housed in a basement room, on raised screen floors, in electrically heated batteries. The criteria of dietary adequacy were the weights of the chicks at four weeks of age.

The diets were made up, with a few exceptions, of practical, commonly used feedstuffs. They consisted chiefly of corn and soybean oil meal, which were included in all diets but in variable amounts. As a rule the others were constant in amount but they were not present in all diets. These constituents and four optional vitamins, are all listed in Table 1. This table gives the percentages of protein in the major feed constituents, and the amounts of each of the four optional vitamins that were included in the diets. With one exception, to be mentioned later, all diets contained 20 percent protein.

TABLE 1--THE PERCENTAGE OF PROTEIN IN THE MAJOR DIETARY CONSTITUENTS

	Protein, %		Protein, %
Corn	7.5	Soybean oil meal	44.6
Corn gluten	40.5	Meat & bone scraps	52.4
Fish meal	73.5	Dried whey	17.3
Wheat bran	14.0	Wheat shorts	17.0
Alfalfa meal	20.0		
	Four optional vitamins, in mg. per lb.		
Ca pantothenate	5	Folic acid	0.5
Nicotinic acid	10	Choline Cl	700.0

The constituents of chick rations most commonly used are deficient in four vitamins, A, D, riboflavin and B_{12}. The amounts of these vitamins that were included in the diets, along with the various minerals, are shown in Table 2.

TABLE 2--CONSTITUENTS ADDED TO ALL RATIONS IN CONSTANT AMOUNTS

	Percent		Per Lb.
Steamed bone meal	2.0	Vitamin A*	2550 I.U.
Ground limestone	1.0	Vitamin D*	450 I.C.U.
Iodized salt	0.75	Riboflavin	1.5 mg.
Manganous sulphate	0.02	Vitamin B_{12}**	15.0 mcg.
Fish oil concentrate	0.25		

* Supplied in the fish oil concentrate.
** Omitted from experimental diets in the last section, Tables 11 and 12.

RESULTS

Added Vitamins—Pantothenic Acid, Nicotinic Acid, Folic Acid and Choline.

As was previously mentioned, many commonly used feedstuffs are deficient in four important vitamins and all successful poultry growers take measures to insure their presence. Four other vitamins, pantothenic acid, niacin, folic acid and choline, are in a doubtful position. They are frequently included in experimental rations as insurance against a possible deficiency. There have been occasional suggestions that they could be limiting factors in practical diets. To determine whether such deficiencies do occur, our pertinent data on that point are summarized in Table 3.

The object of the first six rations in Table 3 was to determine the advisability of adding the four doubtful vitamins to our basal diets. Ration 3376 contained wheat bran, wheat shorts, alfalfa meal and methionine. Ration 3379 contained methionine as the only supplement. Ration 3381 contained corn gluten. The experimental rations in this comparison, Nos. 3375, 3378 and 3380, contained calcium pantothenate, nicotinic acid, folic acid and choline, the four optional vita-

TABLE 3--THE EFFECT ON GAINS IN WEIGHT OF INCLUDING PANTOTHENIC ACID, NICOTINIC ACID, CHOLINE AND FOLIC ACID IN A PRACTICAL CORN-SOYBEAN OIL MEAL RATION

	Ration						
	3375	3378	3380	3376	3379	3381	3377*
Variable dietary constituents, %							
Yellow corn	42.0	61.2	60.0	42.2	61.2	60.0	47.7
Soybean oil meal	31.0	34.5	24.0	31.0	34.5	24.0	48.0
Methionine	0.3	0.3	---	0.3	0.3	---	0.3
Corn gluten	---	---	12.0	---	---	12.0	---
Wheat bran	5.0	---	---	5.0	---	---	---
Wheat shorts	15.0	---	---	15.0	---	---	---
Alfalfa meal	2.5	---	---	2.5	---	---	---
Four optional vitamins**	+	+	+	---	---	---	+
Four-week weight of chicks, gm.							
Males	356 (5)†	343 (9)	368 (6)	337 (9)	354 (7)	346 (12)	351 (10)
Females	306 (22)	302 (20)	281 (22)	316 (20)	318 (20)	303 (17)	302 (18)
Equivalent final weight	102 (27)	100 (29)	96 (28)	103 (29)	105 (27)	101 (29)	101 (28)
S.D.‡	11.9	10.9	15.5	12.5	12.7	10.9	7.7
Combined groups							
Males		354 (20)			345 (28)		
Range		278-424			282-418		300-388
Females		296 (64)			313 (57)		
Range		164-370			208-400		268-344
Equivalent final weight		99 (84)			103 (85)		
S. D.		13.0			12.0		

* This diet contained 25 per cent of protein.
** Ca pantothenate, nicotinic acid, choline Cl, folic acid.
† Number of chicks in parenthesis.
‡ Standard deviation.

mins. In no case were these additions helpful, and they probably had no objectionable effect.

The chicks on Ration 3377 did not grow appreciably faster than did those on Ration 3378. It was concluded, therefore, that rations which contained 25 percent protein were not superior for our purpose to those that contained 20 percent.

The devices used in comparing the results on different rations require some explanation. As has been mentioned, there were more female chicks than males and the various groups contained different numbers of each sex. To simplify the statistical analysis we calculated the "comparative final weights." These are the percentages of the mean weight on one ration selected as a base. In Table 3 the base ration was 3378 and the mean weight of the males was 343 gm. As an example, the weight of each male on Ration 3375 was calculated as a percentage of 343. In like manner the weight of each female was calculated as a percentage of 302. The mean of the combined percentages on Ration 3375 was 102, and the standard deviation of these percentages was 11.9.

Wheat Bran, Wheat Shorts, Alfalfa Meal.

These three supplements are all useful feed constituents and some rations would be improved by including them. However, if vitamins A and riboflavin are provided in some other manner it may be that these constituents do not make a unique contribution. Our data have been rearranged in Table 4 to facili-

TABLE 4--THE EFFECT ON GAINS IN WEIGHT OF INCLUDING WHEAT BY-PRODUCTS AND ALFALFA MEAL IN A PRACTICAL RATION

	Ration			
	3375	3376	3378	3379
Variable dietary constituents, %				
Yellow corn	42.0	42.2	61.2	61.2
Soybean oil meal	31.0	31.0	34.5	34.5
Methionine	0.3	0.3	0.3	0.3
Four optional vitamins	+	-	+	-
Wheat bran	5.0	5.0	---	---
Wheat shorts	15.0	15.0	---	---
Alfalfa meal	2.5	2.5	---	---
Four-week weight of chicks, gm.				
Males	356 (5)	337 (9)	343 (9)	354 (7)
Females	306 (22)	316 (20)	302 (20)	318 (20)
Equivalent final weight	102 (27)	103 (29)	100 (29)	105 (27)
S. D.	11.9	12.5	10.9	12.7
Combined Groups				
Males	343 (14)		348 (16)	
Range	290-424		278-422	
Females	311 (42)		310 (40)	
Range	198-388		234-400	
Equivalent final weight	100 (56)		100 (56)	
S. D.	12.1		11.9	

tate comparisons.

Rations 3375 and 3376 contain wheat bran, wheat shorts and alfalfa meal. Rations 3378 and 3379 are similar in other respects but they do not contain the three feedstuffs mentioned. There was no decline in the rate of growth when they were omitted. Wheat bran, wheat shorts and alfalfa meal are useful but they are dispensable.

Dried Whey, Meat and Bone Scraps, Fish Meal and Corn Gluten.

Soybean oil meal is an excellent source of protein for the chick. However, several other useful protein sources are available and should be used. It is of some importance though to know whether these other supplements improve the ration or whether they are merely alternatives. Our data on dried whey, meat scraps, fish meal and corn gluten are shown in Tables 5, 6 and 7.

The basal rations in Table 5 are Nos. 3378 and 3417. Rations 3383 and 3384 contain added meat scraps, and Rations 3387 and 3388 contain added dried whey. Neither addition had any effect on the rate of growth.

The basal rations in Table 6 are Nos. 3092 and 3378. Rations 3093 and 3385 contain added fish meal. Ration 3386 also contains fish meal, and is compared with Ration 3382. However, these rations were not prepared for this purpose. Thus ration 3382 contains added pantothenic acid, nicotinic acid, folic acid and choline, and these adjuvants are missing from Ration 3386, Table 3 shows that they have no significant effect on the rate of growth, and these two rations were included in Table 6 to obtain larger numbers.

It will be observed that fish meal had no significant effect on the weights of the chicks. In fact, those that did not receive fish meal were slightly heavier.

Fish meal of good quality is a valuable constituent in chick rations but it, too, is dispensable. Our data confirm the report of Briggs, Hill and Giles[1] who observed a retarded rate of gain when chicks consumed an all-plant diet. The rate of gain was accelerated to the same extent by crystalline vitamin B_{12} as it was by supplements of whole liver substance, meat and bone scraps, or fish meal. One could conclude from the evidence that any unique properties of the animal proteins were due to the vitamin B_{12} which they supplied.

Our observations on corn gluten are shown in Table 7. Two rations, Nos. 3380 and 3381, contained this protein. Rations 3378 and 3379 did not contain corn gluten but they did contain added methionine. The average weights of the males on the control, and on the experimental diets, were almost identical. However, the females, on the control diets were heavier than those on the corn gluten diet. The equivalent final weights were compared and the difference was statistically significant at the 5 percent level. However, since all of the difference was due to the females, there is some doubt concerning the validity of the statistical analysis. However that may be, one can not expect to increase the rate of gain by including corn gluten in our basal corn-soybean oil meal rations.

TABLE 5--THE EFFECT ON GAINS IN WEIGHT OF INCLUDING MEAT SCRAPS OR DRIED WHEY IN A PRACTICAL CORN-SOYBEAN OIL MEAL RATION

	Ration					
	3378	3417	3383	3384	3387	3388
Variable dietary constituents, %						
Yellow corn	61.2	61.5	62.2	62.5	57.5	57.8
Soybean oil meal	34.5	34.5	28.5	28.5	33.2	33.2
Methionine	0.3	---	0.3	---	0.3	---
Four optional vitamins	+	-	+	-	+	-
Meat scraps	---	---	5.0	5.0	---	---
Dried whey	---	---	---	---	5.0	5.0
Four-week weight of chicks, gm.						
Males	343 (9)	360 (2)	354 (6)	356 (3)	351 (7)	340 (4)
Females	302 (20)	313 (19)	314 (22)	294 (17)	321 (21)	293 (15)
Equivalent final weight	100 (29)	104 (21)	104 (28)	99 (20)	105 (28)	98 (19)
S. D.	10.9	13.0	10.4	8.9	9.3	11.4
Combined groups						
Males	346 (11)		355 (9)		347 (11)	
Range	278-422		304-384		310-400	
Females	307 (39)		305 (39)		310 (36)	
Range	228-396		258-370		214-390	
Equivalent final weight	102 (50)		102 (48)		102 (47)	
S. D.	11.8		10.1		10.8	

TABLE 6--THE EFFECT ON GAINS IN WEIGHT OF INCLUDING FISH MEAL IN A PRACTICAL CORN-SOYBEAN OIL MEAL RATION

	Ration					
	3092	3378	3382	3093	3385	3386
Variable dietary constituents, %						
Yellow corn	47.0	61.2	61.5	50.2	63.5	63.8
Soybean oil meal	25.7	34.5	34.5	17.5	29.2	29.2
Methionine	---	0.3	---	---	0.3	---
Wheat bran	5.0	---	---	5.0	---	---
Wheat shorts	15.0	---	---	15.0	---	---
Alfalfa meal	2.5	---	---	2.5	---	---
Four optional vitamins	+	+	+	+	+	-
Fish meal	---	---	---	5.0	3.0	3.0
Four-week weight of chicks, gm.						
Males	350 (5)	343 (9)	337 (8)	331 (4)	327 (5)	326 (6)
Females	283 (4)	302 (20)	321 (21)	306 (5)	305 (23)	308 (23)
Equivalent final weight	98 (9)	100 (29)	104 (29)	99 (9)	100 (28)	101 (29)
S. D.	6.6	10.9	7.1	8.2	12.2	12.3
Combined groups						
Males		342 (22)			328 (15)	
Range		278-422			276-394	
Females		309 (45)			306 (51)	
Range		234-382			204-376	
Equivalent final weight		102 (67)			100 (66)	
S. D.		9.1			11.6	

TABLE 7--THE EFFECT ON GAINS IN WEIGHT OF SUBSTITUTING CORN GLUTEN FOR PART OF THE SOYBEAN OIL MEAL

	Ration			
	3378	3379	3380	3381
Variable dietary constituents, %				
Yellow corn	61.2	61.2	60.0	60.0
Soybean oil meal	34.5	34.5	24.0	24.0
Four optional vitamins	+	-	+	-
Methionine	0.3	0.3	---	---
Corn gluten	---	---	12.0	12.0
Four-week weight of chicks, gm.				
Males	343 (9)	354 (7)	368 (6)	346 (12)
Females	302 (20)	318 (20)	281 (22)	303 (17)
Equivalent final weight	100 (29)	105 (27)	96 (28)	101 (29)
S. D.	10.9	12.7	15.5	10.9
Combined groups				
Males	348 (16)		353 (18)	
Range	278-422		282-424	
Females	310 (40)		291 (39)	
Range	234-400		164-370	
Equivalent final weight	102 (56)		98 (57)	
S. D.	11.7		13.3	
T-values for significance of difference of means:				
Found	2.05			
Required at 5% level	1.98			

Methionine

It is a common practice to include methionine in experimental diets and some of our data have been rearranged in Table 8 to determine to what extent this practice is helpful.

The rations described in Table 8 contain no source of protein except corn and soybean oil meal. Rations 3378 and 3379 contain added methionine; Rations 3382 and 3417 do not. When the results on these two sets of rations are compared it is evident that the addition has been ineffective.

Other investigators have studied corn-soybean oil meal diets as a source of sulfur-containing amino acids, with conflicting results. Machlin, Denton and Bird (2) observed an increase in the rate of gain when they added methionine to a corn-soybean oil meal ration. Briggs, Hill and Giles (1) reported a subnormal rate of growth in chicks on an all-plant ration. However, the chicks grew at a normal rate when the diet was supplemented with either vitamin B_{12} or methionine. One would conclude that the diet contained all the methionine that was required as structural units for growth. However, methionine has a sparing effect for vitamin B_{12}. If a liberal amount of vitamin B_{12} is included in the diet

TABLE 8--THE EFFECT ON GAINS IN WEIGHT OF INCLUDING METHIONINE IN A PRACTICAL CORN-SOYBEAN OIL MEAL RATION

	Ration			
	3378	3379	3382	3417
Variable dietary constituents, %				
Yellow corn	61.2	61.2	61.5	61.5
Soybean oil meal	34.5	34.5	34.5	34.5
Four optional vitamins	+	-	+	-
Methionine	0.3	0.3	---	---
Four-week weight of chicks, gm.				
Males	343 (9)	365 (4)	337 (8)	360 (2)
Females	302 (20)	321 (15)	321 (21)	313 (19)
Equivalent final weight	100 (29)	106 (19)	104 (29)	104 (21)
S. D.	10.9	12.9	7.1	13.0
Combined groups				
Males	350 (13)		341 (10)	
Range	278-422		310-366	
Females	310 (35)		317 (40)	
Range	234-382		228-396	
Equivalent final weight	103 (48)		104 (50)	
S. D.	12.0		9.9	

there is no response to the addition of methionine. If a scanty amount of vitamin B_{12} is included in the diet, an added supply of methionine elicits a growth response.

Up to this point our simplest basal rations had not been improved by adding methionine or by adding the four vitamins mentioned previously. Inspection indicated that when methionine and the vitamins were added simultaneously to rations that contained some animal protein, there may have been an acceleration of the rate of gain. Our data have been rearranged in Table 9 in an attempt to determine whether or not the differences were significant. It will be noted that there was no increase in the growth rate when methionine and vitamins were included in the fish meal ration (diets 3385 and 3386). The growth rate did appear to be accelerated though when methionine and vitamins were added to rations that contained either meat and bone scraps or dried whey (diets 3383, 3387, 3384 and 3388). When the three supplemented rations were compared with the three unsupplemented rations the difference of the means seemed to be significant at the 1 percent level.

However, it is our view that when all of our data are considered the evidence of significance is equivocal. Thus Ration 3417, Table 8, contains none of the supplements, yet the chicks that consumed it gained as rapidly as those on diets that contained any of the supplement combinations. Furthermore, the combination of cystine and methionine supplied by the corn and protein supple-

TABLE 9--THE EFFECT ON GAINS IN WEIGHT OF INCLUDING METHIONINE IN A PRACTICAL RATION WITH MIXED PROTEIN SUPPLEMENTS

	Ration					
	3383	3385	3387	3384	3386	3388
Variable dietary constituents, %						
Yellow corn	62.2	63.5	57.5	62.5	63.8	57.8
Soybean oil meal	28.5	29.2	33.2	28.5	29.2	33.2
Meat scraps	5.0	---	---	5.0	---	---
Fish meal	---	3.0	---	---	3.0	---
Dried whey	---	---	5.0	---	---	5.0
Four optional vitamins	+	+	+	-	-	-
Methionine	0.3	0.3	0.3	---	---	---
Methionine + cystine*	0.97	0.99	0.96	0.67	0.69	0.66
Four-week weight of chicks, gm.						
Males	354 (6)	327 (5)	351 (7)	327 (6)	326 (6)	315 (7)
Females	314 (22)	305 (23)	321 (21)	286 (23)	308 (23)	293 (19)
Equivalent final weight	104 (28)	100 (28)	105 (28)	95 (29)	101 (29)	96 (26)
S. D.	10.4	12.2	9.3	10.2	12.3	12.2
Combined groups						
Males		345 (18)			323 (19)	
Range		276-400			238-394	
Females		313 (66)			296 (65)	
Range		204-390			206-376	
Equivalent final weight		103 (84)			97 (84)	
S. D.		10.8			11.7	
"t" values for significance of difference of means						
Found			3.448			
Required at 1% level			2.609			

* Total. The amounts of cystine and methionine in the dietary constituents were calculated from the analyses of Block and Weiss (3, p. 296).

ments was practically 0.7 percent, in all rations. As is indicated in Table 10, we regard this estimate as slightly low. If the correct value is approximately 0.8 percent, one would not expect the rate of gain to be accelerated by added methionine. It should be noted, too, that it is not uncommon to find reports of significant differences which cannot be confirmed at a later date by the same investigator. It is our view that if a mechanical analysis is at variance with experienced judgement, it should be accepted with reservation until all important inconsistencies are eliminated.

One serious difficulty in a study of the requirement for cystine and methionine is the lack of satisfactory assay methods for these two amino acids. Block and Weiss (3) have assembled the best data available and some of these have been used for a test of their reliability. It was assumed that the corn (p. 306) contained 7.5 percent of protein, the soybean oil meal (p. 321) contained 45 percent, and the percentages of cystine and methionine in the protein were converted into percentages of the feedstuffs, as shown below.

Corn

Cystine—0.098, 0.113, 0.135, 0.143
Methionine—0.068, 0.098, 0.11, 0.12, 0.13, 0.14; 0.15, 0.17, 0.17, 0.19, 0.20.

Soybean Oil Meal

Cystine—0.27, 0.32, 0.54, 0.77
Methionine—0.32, 0.45, 0.50, 0.54, 0.59, 0.63.

The range in values is least for cystine in corn, though, as will appear later, we do not regard this as an index of accuracy. The maximum values of the others were from 200 to 300 percent of the minimum, which is unreasonable variability. The mean or median value could be used but before doing so one should search for an independent check on reliability. The amount of inorganic sulfur in most feedstuffs is negligible; therefore, such a check can be made by comparing the total sulfur in a feed with the sulfur in the estimated values for cystine and methionine. The highest of these values were used in our calculations in Section A, Table 10.

It will be observed in Section A that the maximum values for cystine and methionine in corn account for less than two-thirds of the sulfur. There can be no doubt that there is a serious error in one or both of these values. Soybean oil meal is a high protein feed and in this case the sulfur-containing amino acids do account for all of the sulfur. It should be remembered though that this agreement could not be obtained unless every value below the maximum, for each amino acid, was discarded. It is evident that assays for cystine and methionine, especially in low protein feeds, are of a low order of reliability. The values in Section B were obtained in this institution, after an intensive effort to obtain values that would account for all of the organic sulfur. The agreement for both corn and soybean oil meal was, by chance, better than one could reasonably ex-

TABLE 10--THE AMOUNTS OF TOTAL SULFUR IN CORN AND IN SOYBEAN OIL MEAL, AND THE AMOUNTS ACCOUNTED FOR BY ASSAYS FOR CYSTINE AND METHIONINE

	Cystine		Methionine		Cystine + Methionine	Sulfur		
						Cystine + Methionine	By Analysis	
	%	gm.	%	gm.	gm.	gm.	%	gm.
61.5 Corn (7.5%)*	0.14	0.086	0.20	0.123	0.209	0.049	0.12†	0.074
A 34.5 Soybean oil meal (45%)*	0.77	0.266	0.63	0.217	0.483	0.118	0.33†	0.114
Combined	0.37	0.353	0.35	0.340	0.692	0.167	0.20	0.188
61.5 Corn (7.5%)**	0.22	0.135	0.23	0.141	0.276	0.066	0.11	0.068
B 34.5 Soybean oil meal (45%)**	1.04	0.359	0.50	0.173	0.532	0.133	0.375	0.129
Combined	0.51	0.494	0.33	0.314	0.808	0.199	0.21	0.197

* Calculated from data reported by Block and Weiss (3).
** Preliminary data supplied by Dr. Laura M. Flynn.
† Taken from Morrison (4, pp. 1100-1101).

pect. It is our opinion now that these four assays are approximately correct, though one cannot be certain until they have been verified. It does seem certain though that the sums of the values for cystine and methionine are of the correct magnitude. Our experience agreed with that of Briggs and co-workers.

According to Almquist (5) a diet that contains 20 percent of protein, such as No. 3417, should contain 0.8 percent of methionine, or methionine and cystine, to support the maximum rate of growth. In section A the sum of the sulfur-containing amino acids is 0.69 percent of the diet. By some estimates this is too low and one would expect a subnormal rate of gain. In section B, however, it is estimated that this sum is 0.81 percent. This quantity is regarded as sufficient, and one would not expect a positive response if additional methionine were included in the diet. It is our opinion that our basal diets 3417 or 3382 would not be improved by the addition of methionine. It would seem that the published assays for cystine and methionine in low-protein feeds are minimal values.

Vitamin B_{12}

It is an almost universal practice to add vitamin B_{12} to chick starter rations and under some circumstances this practice is necessary. In our experience, however, this addition has not been helpful. Thus, Ration 3378, which contains added vitamin B_{12}, is compared in Table 11 with Ration 3456 which does not contain it. The chicks on Ration 3378 are slightly the heavier, but the difference

TABLE 11--EFFECT OF IODIZED CASEIN ON THE REQUIREMENT FOR VITAMIN B_{12}

	Ration			
			A	B
			3457	3458
			3531	3484
			3614	3537
	3456	3378		3616
Iodized Casein	-	-	+	+
Vitamin B_{12}	-	+	-	+
Four-week weight of chicks, gm.				
Males	346 (19)	349 (26)	335 (25)	367 (23)
Range	310-406	298-406	282-390	260-366
Females	310 (29)	318 (21)	309 (20)	319 (34)
Range	242-362	214-412	300-428	246-394
Equivalent final weight	98 (48)	100 (47)	96 (45)	102 (57)
S. D.	11.0	10.3	11.6	10.6
T-Values, significange of difference of means				
Found	0.79		2.54	
Required at 5% level	1.99		1.98	
Required at 1% level			2.65	

lacks statistical significance. If the hens that laid the hatching eggs received liberal amounts of vitamin B_{12} the chicks will contain enough of the vitamin when hatched to last them several weeks. However, our diets contained 0.3 percent of added methionine and, according to Briggs *et al.* (1), this addition would make it unnecessary to supply additional vitamin B_{12}. It developed though that if a significant amount of iodized casein (Protamone) was included in a diet such as No. 3531, it was necessary to add vitamin B_{12} also. Our data on that point are summarized in Table 11 and additional details are shown in Table 12.

TABLE 12--EFFECT OF IODIZED CASEIN ON THE REQUIREMENT FOR VITAMIN B_{12}, GROUPS SHOWN SEPARATELY

Ration Number	Variables in the Diets: Vitamin B12	Variables in the Diets: Iodized Casein	Weight of Chicks at 4 Weeks: Male	Weight of Chicks at 4 Weeks: Female
3457	0	0.03	368 (8)	317 (12)
3531	0	0.075	323 (13)	278 (5)
3614	0	0.15	308 (4)	326 (3)
3458	45	0.03	376 (7)	330 (12)
3484	15	0.03	357 (6)	326 (4)
3537	15	0.075	365 (8)	321 (12)
3616	15	0.15	370 (2)	291 (6)

All of these diets are identical with No. 3378, except for the omission of vitamin B_{12}, or the inclusion of iodized casein. Diets 3457, 3458 and 3484 contained 0.03 percent of iodized casein, but this quantity was too small to have any inhibitory effect. Rations 3531 and 3614 contained larger amounts, and the rate of gain of chicks that consumed them was retarded. However, when vitamin B_{12} was added along with iodized casein, there was little or no retardation. In Table 11 these rations with no added vitamin B_{12} are combined in Group A and those with added vitamin B_{12} are combined in Group B. The difference of the means barely fails to reach significance at the 1 percent level. The effect of vitamin B_{12} in overcoming the toxicity of iodized casein was reported some time ago by Nichol, Dietrich, Cravens and Elvehjem (6). They gave day-old chicks a diet that contained 0.05 percent of iodized casein, no vitamin B_{12}, but was somewhat similar in other respects to our No. 3375, Table 3. The rate of gain of the chicks during a 14-day test period was drastically reduced. However, this depression did not occur when vitamin B_{12} was added to the diet. One could say the requirement for vitamin B_{12} was increased by adding thyroxine to the diet.

In judging whether or not our data have any applications in practice it is important to know whether or not the rates of gain we obtained equal those reported by other investigators. A search of our reprint file shows that our highest 4-week weights for White Leghorns are approximately the same as the highest that have been reported elsewhere. The highest weight for males was 364 grams, reported by Wisman, Holmes and Engel (7). Our maximum was almost the same, 368 grams. However, the average weight of several of our groups was over

350 grams. The highest weight listed in our file for mixed sexes was 338 grams, by Heywang and Bird (8). Our highest average was 345 grams, almost exactly the same. Our highest average for pullets was 321 grams, but several groups averaged over 315 grams. All of the weights for females that happen to be in our file are abnormally low and will not be quoted. It is fair to say then that our chicks grew well by any standard, and the observations are pertinent in modern practice.

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