VITAMIN B_{12} AND AMINO ACIDS AS SUPPLEMENTS TO SOYBEAN OIL MEAL AND COTTONSEED MEAL FOR GROWING CHICKS

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Plant proteins from different sources have been used extensively in poultry diets for a long time when supplemented with proteins from animal sources. Many investigations have been carried out on soybean oil meal as a protein supplement for growing chicks and the value of large amounts of it in practical poultry diets is universally recognized. With the discovery and isolation of vitamin B_{12} it is now possible to obtain an optimum rate of growth in chicks with soybean oil meal as the only source of protein in the diet.

Relatively few studies have been carried out with cottonseed meal as the sole source of protein for growing chicks. It has been used successfully when supplemented with other protein concentrates such as fish meal, sardine meal, dried skim milk and meat scraps (Hartwell and Lichtenthaeler, '14; Berry, '34; Barnett and Polk, '42; Ringrose and Morgan, '38; Sherwood and Couch, '39, '40; and Ackerson et al., '38). Draper and Evans ('44) reported that soybean oil meal had a higher nutritive value than any combination of soybean oil meal and cottonseed meal. The results with combinations of herring fish meal and cottonseed meal were similar to those with soybean and cottonseed meals. Grau ('46) investigated cottonseed meal as the sole source of protein for growing chicks in a synthetic type of diet by the method described by

Grau and Almquist ('43). A commercial type of diet gave a growth rate of 7.0% by this method. The addition of lysine alone to cottonseed meal increased the growth rate from 4.4% to 5.7%, and the addition of both lysine and methionine resulted in a rate of 6.9%. Methionine alone had no effect.

Large amounts of commercially prepared cottonseed meal in poultry rations are not recommended because of the toxic effect of gossypol or some other substance which is present in the pigment glands (Eagle et al., '48).

In preliminary studies on the value of cottonseed meal for growing chicks it was found that diets which contained 25 to 40% of cottonseed meal and 5% of sardine meal supported a normal rate of growth. Meat scraps, dried skim milk and fish solubles were less effective than sardine meal in supplementing the cottonseed meal. While these experiments were in progress vitamin B_{12} became available and it was possible to investigate the value of protein concentrates with a more highly purified diet. The results of such studies with soybean oil meal and with cottonseed meal are described in this report.

EXPERIMENTAL

Crossbred chicks (White Leghorn females, New Hampshire Red males) were used throughout the investigation. The dams were kept in batteries so that they did not have access to feces or litter and they received a diet low in vitamin B_{12} for a sufficient period of time to reduce the store of this vitamin in the chicks to a low level. Day-old chicks were placed in electrically heated batteries and were given the various diets and water ad libitum. The experimental diets contained 20% of protein. The protein content ($N \times 6.25$) of each ingredient which contributed to the total protein was determined before it was mixed in the diet. When a new lot of milo or protein concentrate was used, the milo and protein concentrate or the cerelose and protein concentrate were adjusted so that the diet contained a total of 20% protein. This was also true when sardine meal was added to the diet. The composition

of a diet typical of that which contained milo, diet 1, and of that which contained cerelose, diet 2, is given in table 1. The observations on the chicks which received the various diets and supplements are summarized in table 2. When amino acids were tested as supplements to cottonseed meal there were three to 5 chicks per group in each series. The other tests were carried out with 8 to 12 chicks per group in each series. Every test, with the exception of that involving the group which received a mixture of soybean and cottonseed meals and no vitamin B_{12}, group 14, was repeated at least once.

TABLE 1

Composition of typical diets

CONSTITUENTS	TYPICAL DIET		VITAMINS ADDED PER 100 GM	TYPICAL DIET	
	1	2		1	2
	gm	*gm*		*mg*	*mg*
Ground milo	61.5	..	Alpha-tocoperhol acetate	..	2.5
Cerelose	...	48	Menadione	2.5	2.5
Soybean or cottonseed meal	35	47	Thiamine hydrochloride	0.4	0.4
			Riboflavin	0.4	0.4
Mineral mixture [1]	...	3	Pyridoxine hydrochloride	0.4	0.4
Iodized salt	0.5	..	Calcium pantothenate	2.0	2.0
Calcium carbonate	...	1	Niacin	5.0	5.0
Steamed bone meal	2.0	..	Choline chloride	200.0	200.0
Fish liver oil	1.0	1.0	Folic acid	0.2	0.2
$MnSO_4H_2O$	0.04		Biotin	..	0.02

[1] Richardson and Hogan, '46.

The gossypol content of the various batches of cottonseed meals ranged from 0.033 to 0.04%. These meals were not toxic at a level of 50%. One batch which contained 0.116% of gossypol was very toxic at a level of 35%. A charcoal adsorbate [1] was used as a source of vitamin B_{12}; it contained the equivalent of 2 mg of vitamin B_{12} per pound.

Vitamin B_{12} as a supplement to soybean oil meal

The average weights of chicks which received 0.0, 1.0 and 5.0 gm of charcoal adsorbate of vitamin B_{12} per kilogram of

[1] Prepared by Merck and Company and found by their assay to contain the equivalent of 2 mg of vitamin B_{12} per pound.

TABLE 2

Vitamin B_{12} as a supplement to soybean oil meal (A); vitamin B_{12} and amino acids as supplements to cottonseed meal (B); and soybean oil meal as a supplement to cottonseed meal for growings chicks (C)

GROUP NO.	SUPPLEMENT	CHARCOAL ADSORBATE	CHICKS OBSERVED			AVERAGE WEIGHT — WEEKS						"t" value [1]
			Total	Males	Females	Males			Females			
						2	4	6	2	4	6	
		gm/kg	*no.*	*no.*	*no.*							
	(A) VITAMIN B_{12} AS SUPPLEMENT TO SOYBEAN OIL MEAL											
	Basal = Milo-soybean oil meal											
1	Basal		51	19	32	99	222	382	90	171	263	
2	Vitamin B_{12}	1	45	20	25	101	249	488	94	233	435	8.1**
3	Vitamin B_{12}	5	30	13	17	110	268	496	106	251	435	8.47**
	Basal = Cerelose-soybean oil meal											
4	Basal		35	16	19	119	273	453	101	217	338	
5	Vitamin B_{12}	1	26	18	8	116	264	451	113	264	433	1.71
6	Vitamin B_{12}	5	29	11	18	118	306	530	112	262	435	2.45*
7	Sardine meal 5%		27	10	17	121	274	493	118	257	455	2.98**
	(B) AMINO ACIDS AND VITAMIN B_{12} AS SUPPLEMENTS TO COTTONSEED MEAL											
	Basal = Cerelose-cottonseed meal											
8	Basal	5	25	10	15	94	208		92	183		
9	DL-Lysine 0.8%		14	2	12	115	256		109	226		3.66**
10	DL-Lysine 0.8%	5	12	5	7	123	277		130	304		8.37**
11	All combinations of lysine	5	48	24	24	126	296		124	286		12.08**
12	DL-Lysine 0.8% DL-Methionine 0.2% DL-Tryptophan 0.1%	5	20	10	10	128	302		121	270		9.73**
13	Sardine meal 5%		12	5	7	132	320		111	273		7.11**
	(C) SOYBEAN OIL MEAL AS SUPPLEMENT TO COTTONSEED MEAL											
	Basal = Cerelose-soybean oil meal 20%, cottonseed meal 30%											
14	Basal		8	3	5	91	236	406	84	227	323	
15	Vitamin B_{12}	5	19	5	14	124	289	508	116	264	427	2.59*

[1] The "t" values refer to the final weights in each series and are for comparison with the basal diet.
* = Significant to 0.05 and ** = significant to 0.01.

diet as a supplement to a milo-soybean oil meal and a cerelose-soybean oil meal diet are given in section A of table 2. There it can be seen that 1 gm of the concentrate or an amount equivalent to about 5 μg of crystalline vitamin B_{12} as a supplement to the milo diet supported as rapid a rate of growth as 5 gm. When the diet contained cerelose, 5 gm gave a slightly faster rate of growth than 1 gm. The addition of 10 gm of adsorbate to either diet did not increase the rate of growth over that obtained with 5 gm. These data show that the amount of vitamin B_{12} supplied by 1 to 5 gm of charcoal adsorbate was sufficient for a normal rate of growth in chicks when the diet contained milo with soybean oil meal as the only protein concentrate. The smaller amount may be slightly inadequate with the cerelose diet. The vitamin B_{12} was as effective in supplementing the soybean oil mean as 5% of sardine meal.

Amino acids and vitamin B_{12} as supplements to cottonseed meal

The data showing the effect of supplementing cottonseed meal with vitamin B_{12} and amino acids are given in section B, table 2. The chicks (group 10) which received vitamin B_{12} and 0.8% of DL-lysine grew as rapidly as those which received the same basal diet (group 13) supplemented with 5.0% of sardine meal. Those (group 8) which received the basal diet plus vitamin B_{12} but without lysine grew slowly. Methionine and tryptophan (group 12), in addition to lysine, did not increase the rate of growth. In a few tests which were carried out to determine if smaller quantities of lysine would supplement cottonseed meal, 0.5% DL-lysine and 0.2% of L-lysine gave as rapid a rate of growth as 0.8% of DL-lysine. The combined average weights of all chicks which received a supplement of at least 0.5% of DL-lysine or 0.2% of L-lysine whether alone or in various combinations with methionine or tryptophan, are given in section B of table 2 (group 11). Chicks which received 0.2% DL-lysine grew only slightly faster than those which received the control diet. The amount of lysine

required to supplement different lots of cottonseed meal may vary greatly, depending upon the method by which it was prepared, but these data show that one may expect a normal rate of growth when most commercial cottonseed meals are supplemented with at least 0.2% of L-lysine or its equivalent in DL-lysine.

The chicks (group 9) which received the basal diet plus lysine without vitamin B_{12} grew much slower than those (group 10) which received the vitamin. It is obvious that the cottonseed meal was deficient in vitamin B_{12}.

Soybean oil meal as a supplement to cottonseed meal

It seemed possible, with vitamin B_{12} available to alleviate the deficiency of this vitamin in plant proteins, that one plant protein concentrate could be used to supplement the amino acid deficiency of another plant protein. In order to test this possibility, chicks were given a diet which contained cerelose, 20% of soybean oil meal and 30% of cottonseed meal, with and without vitamin B_{12}. The soybean oil meal supplied 8.4% of the total protein and the cottonseed meal supplied 11.6%. These data are summarized in section C, table 2. The chicks (group 15) which received vitamin B_{12} grew as fast as when all the protein was furnished by soybean oil meal (group 6). Without vitamin B_{12} the chicks (group 14) grew at a slower rate. Another diet which contained milo, 15% of soybean oil meal and 25% of cottonseed meal supported a rapid rate of growth when supplemented with vitamin B_{12}. These data show that it is possible to utilize plant proteins of low nutritive value by supplementing them with another plant protein of high nutritive value, if the diet is also supplemented with vitamin B_{12}.

SUMMARY

Soybean oil meal and a commercial cottonseed meal low in gossypol were investigated as the sole sources of protein for growing chicks. Soybean oil meal supported a normal rate

of growth when it was supplemented with a vitamin B_{12} concentrate equivalent to 10 to 20 μg of crystalline vitamin B_{12} per kilogram of diet. Cottonseed meal was equal to soybean oil meal when it was supplemented with vitamin B_{12} and 0.2% of L-lysine. Cottonseed meal with lysine but without vitamin B_{12} gave a subnormal rate of growth, which showed that it was deficient in this vitamin.

Soybean oil meal was used to supplement the lysine deficiency of cottonseed meal. The combination of the two protein concentrates supported as rapid a rate of growth when supplemented with vitamin B_{12} as did soybean oil meal alone. Without vitamin B_{12} growth was at a subnormal rate. These data suggest that plant proteins of relatively low value may be used as a source of protein for growing chicks when they are supplemented with soybean oil meal and vitamin B_{12}.

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