Absorption and Utilization of B-Vitamins in Chick Diets

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(Received September 1966)

THE nutritional importance of B-vitamins lies in the fact that they are intimately connected with the biochemical processes leading to the production of energy within animal tissues. Most of these B-vitamins form a part of the prosthetic group of the coenzyme systems that catalyse the chemical reactions involved in the intermediary metabolism of nutrients, viz., carbohydrates, fats and proteins. A deficiency of any one of these B-vitamins is immediately reflected in a slowing down of the growth rate of the animal. A prolonged deficiency of B-vitamins in chickens gives rise to other externally visible symptoms such as dermatitis, ' curly toes ', perosis, convulsions etc. In animal bodies, the liver tissue contains the highest concentration of B-vitamins. But unlike other nutrients, B-vitamins are not stored in the animal body for any appreciable length of time. The lack of storage reserves of B-vitamin necessiate the continual replenishment of B-vitamins in the animal body via the daily intake of feed.

B-vitamin requirements of the chick

The chick's requirement of B-vitamins has been reported by the National Research Council in 1966. (Table I). Recent reports, however, suggest the need for re-evaluation of the B-vitamin requirements of the chick. For instance, Yoshida, Hoshii and Morimoto (1966) have indicated that there are differences in the requirement for niacin and riboflavin between meat-type and egg-type chickens. These differences in B-vitamin requirements are obviously due to genetic differences, which are perhaps accentuated by variations in the availability and absorptibility of the B-vitamins present in the feed. The nutritionally critical nature of some B-vitamins and the present-day prolificity of poultry strains are two factors that necessiate the re-examination of the optimum B-vitamin requirements of poultry. Further-

more, the economics of poultry production dictate the need for more efficient utilization of B-vitamins in poultry diets.

TABLE I.—The B-vitamin requirements of chickens

Vitamin	*Chicks (0-8 wks.)*	*Chicks (8-18 wks.)*	*Laying hens*	*Breeding hens*
	(mg per kg of diet)			
Thiamine	1.8	*	*	0.8
Riboflavin	3.6	1.8	2.2	3.8
Pantothenic acid	10.0	10.0	2.2	10.0
Niacin	27.0	11.0	*	*
Pyridoxine	3.0	*	3.0	4.5
Biotin	.09	*	*	0.15
Choline	1,300.0	*	*	*
Folic acid	1.2	*	0.25	0.35
Cyanocobalamin	0.009	*	*	0.003

* not definitely known.

Absorption and utilization of B-vitamins

Recent investigations have revealed that within different species of animals, viz. rat (Middleton and Morrison, 1962, 1965) man (Morrison and Campbell, 1960) ; chick (Karunajeewa, 1966), there are differences in the efficiencies with which certain B-vitamins are absorbed and utilized. Middleton and Morrison (1962) have shown in their experiments with rats that large doses of radioactive riboflavin were absorbed inefficiently while similar doses of radioactive thiamine were absorbed efficiently. The large doses of thiamine, however, were not utilized effectively. Then in 1965, the same workers suggested that both pyridoxine and pantothenate were absorbed readily and utilized efficiently by rats. Hitherto, it was assumed that these B-vitamins being water-soluble were readily absorbed through the intestines of animals. The experimental evidence now available indicates that this is true only in the case of some B-vitamins.

Feed ingredients and B-vitamins

It has been shown quite recently that the supplementation of a broiler chick diet (basal diet) with distillers' by-products (fermentation residues) causes an increase in the amounts of riboflavin, niacin and folic acid retained in the livers of chicks fed such diets (Karunajeewa, 1966). The data in Table illustrate the fact that the addition of Distillers' dried solubles (DDS) and Distillers' dried grains (DDG) at the 2.5 percent. level to a chick diet caused significantly (PL4.05) higher quantities of niacin and folic acid to be deposited in the livers of five week-old broiler type chickens. The deposition of riboflavin showed a trend similar to that of niacin and folic acid. These results (Table 2) also show that Molasses Distillers' dried solubles (MDS) was not as effective as either DDS or DDG in this respect. This suggests that

MDS has a lower content of the factors responsible for absorption and utilization of B-Vitamins. This qualitative difference between MDS and the other two distillers' by-products may be related to their respective origins viz. MDS being derived from the fermentation of sugar cane juice while DDS and DDG are derived from the fermentation of cereal mixtures predominated by maize.

In the case of pantothenic acid and biotin, liver retention was found to be proportional to the intake of these two B-vitamins.

These differences in the liver retention of B-vitamins occurred despite the fact that there were no significant variations, in the consumption of these B-vitamins by the chicks.

In fact, the proportions in which all the five B-vitamins studied were consumed remained remarkably constant between the various experimental groups (Table 3). This may ha been due partly to the slight variation in the B-vitamin composition of the experimental diets, and partly to the unique nutrient intake regulating mechanism prevailing in chickens.

It has also been observed that stabilized animal fat (SAF) at the 5.0 per cent level of supplementation masks the B-vitamin absorption and liver retention of distillers' by-products (Karunajeewa, 1966). The data in Table 4 reveal that there were no statistically significant differences in the amounts of riboflavin, niacin, pantothenic acid and biotin deposited in the livers of chicks fed a basal diet supplemented with 5.0 percent stabilized animal fat plus 2.5 percent of anyone of the three distillers' by-products.

These results seem to confirm the findings of Pepper and Summers (1960) who observed that there was a sparing relationship between fat and unidentified growth factor (UGF) sources (*viz.* fermentation residues) for the growth of turkeys.

The effect of distillers' by-products and SAF on increasing liver retention of B-vitamins may be due to any one of the factors mentioned by Harris (1949). He has stated that the activity of a vitamin present in feed stuff may be influenced by several factors such as variation variation in availability (due to differences in solubility, absorption, utilization, storage or mobilization), vitamin enhancers (viz. fat, typtophan) vitamin balance and intestinal microsynthesis. Then again, Wakelam (1960) suggested that the UGF, which are present in several feed ingredients including distillers' by-products and other fermentation residues, act by increasing the efficiency of absorption of known nutrients and that the increase in absorption known nutrients and that the increase in absorption may be effected by some action of the permeability of the gut-wall and/or by stimulating the growth of beneficial intestinal micro-organisms, e.g. some strains of *lactobacilli.*

Table 2.—The effect of distillers' by-products on the deposition of some B-vitamins in the livers of five week-old chicks (Karunajeewa, 1966)

Treatment	*Riboflavin*		*Niacin*		*Pantothenic acid*		*Biotin*		*Folic acid*	
	mcg/g of diet fed	*mcg/ liver* *	*mcg/g of diet fed*	*mcg/ liver* *	*mcg/g of diet fed*	*mcg/ liver* *	*mcg/g of diet fed*	*mcg/ liver* *	*mcg/g of diet fed*	*mcg/ liver* *
Basal + 2.5% DDS	3.99	242.3..	40.40	1741.7*a*..	13.44	493.0*a*..	0.08	7.1..	0.20	111.8*a*
Basal + 2.5% DDG	3.90	260.6..	40.18	1604.7*a*..	13.46	748.8*b*..	0.08	9.9..	0.20	104.3*a*
Basal + 2·5% MDS	3.90	188.4..	40.04	1333.9*b*..	13.41	820.9*b*..	0.08	10.9..	0.20	66.9*b*

*Mean values

Within columns, figures not having similar superscripts are significantly different—*a*, *b*, (P 0.05). Columns not showing significant differences are not provided with superscripts.

Table 3. The effect of feeding distillers' by-products on the B-vitamin intake ratios of chicks (Karunajeewa 1966)

Treatment	*Biotin*	*Folic acid*	*Riboflavin*	*Pantothenic acid*	*Niacin*
Basal + 2.5% DDS	1	2.5	48.3	162.7	489.2
Basal + 2.5% DDG	1	2.4	47.0	162.4	484.7
Basal + 2.5% MDS	1	2.4	46.3	159.3	475.6

Table 4. The effect of animal fat plus distillers' by-products on the deposition of some B-vitamins in the livers of five week-old chicks (Karunajeewa, 1966)

Treatment	*Riboflavin*		*Niacin*		*Pantothenic acid*		*Biotin*	
	mcg/g of diet fed	*mcg/ liver* *	*mcg/g of diet fed*	*mcg/ liver* *	*mcg/g of diet fed*	*mcg/ liver* *	*mcg/g of diet fed*	*mcg/ liver* *
Basal + 5.0% SAF+2.5% DDS	3.99	165.2..	40.40	1653.1..	13.44	607.5..	0.08	15.5
Basal + 5.0% SAF+2.5% DDG	3.90	208.5..	40.18	1885.4..	13.46	642.1.,	0.08	17.5
Basal + 5.0% SAF+2.5% MDS	3.90	217.4..	40.04	2094.1..	13.41	672.4	0.08	16.0

*Mean values

Summary

Recent experimental work with rats and chickens has shown that some B-vitamins, particularly riboflavin, niacin and folic acid are less easily absorbed than pantothenic acid, biotin and pyridoxine. The absorption and liver retention of riboflavin, niacin and folic acid in chicks is influenced to a certain extent by DDS and DDG while MDS is not so effective in this respect. SAF also possesses the properties for enhancing the absorption of these vitamins.

Thus it appears that the supplementation of chick diets with either 5.0 percent stabilized animal fat or 2.5 percent distillers' by-product such as DDS or DDG would increase the efficiency of absorption and utilization of certain B-vitamins. This offers a way of ensuring the maximum utilization of the minimum amounts of synthetic B-vitamins that need be incorporated into chick diets.

LITERATURE CITED

(1) National Research Council, 1966. Nutrient requirements of poultry. Washington, D. C.

(2) Yoshida, M., Hoshii, H. and Morimoto, H. (1966). Studies on the vitamin requirements of poultry. 8. Genetic differences in the requirements of niacin and riboflavin of meat-type and egg-type chicks. *Poultry Sci.* 45: 746—744.

(3) Middleton, E. J. and Morrison, A. B. (1962). Vitamin absorption studies II. The utilization of riboflavin and thiamine given orally or parenterally at periodic intervals *J. Nutr.* 77: 115—120.

(4) ————————————, 1965. Vitamin absorption studies. V. A. note on the utilization of pyridoxine and calcium pantothenate given orally at periodic intervals. *Can. J. Biochem* 43: 1889—1892.

(5) Morrison, A. B. and Campbell, J. A. (1960). Vitamin absorption Studies. 1. Factors influencing the excretion of oral test doses of thiamine and riboflavin by human subjects, *J. Nutr.* 72 : 435—440.

(6) Karunajeewa, H. (1966). Studies on the utilization of some B-vitamins in chick diets supplemented with fermentation residues. Ph. D. Thesis, McGill University Library.

(7) Pepper, W. F., Slinger, S. J. and Summers, J. D. (1960). Studies with chickens and turkeys on the relationship between fat, unidentified factors and pelleting. *Poultry Sci.* 39 : 66—74.

(8) Harris, L. J. (1949). Anti-vitamins and other factors influencing vitamin activity. *Brit J. Nutr.* 2 : 362—372.

(9) Wakelam, J. (1960). Present status of unidentified growth factors in animal feeds. Agric. and Vet. Chemicals 2 : 23—25.