XCVII. THE REARING OF CHICKENS ON THE INTENSIVE SYSTEM. PART V. COMPARATIVE B-VITAMIN REQUIREMENTS OF PIGEONS, CHICKENS AND OTHER BIRDS.

BY ROBERT HENRY ADERS PLIMMER
AND JOHN LEWIS ROSEDALE
(*Beit Memorial Research Fellow*).

WITH THE ASSISTANCE OF
WILLIAM HENRY RAYMOND.

*From the Chemical Department, St Thomas's Hospital
Medical School, London.*

(*Received September 4th, 1923.*)

It is very tempting to think that the food requirements of all species of birds are alike. Sugiura and Benedict [1923] from their experiments with pigeons have been led to generalise that very little A-vitamin is needed in *avian* nutrition. Emmett and Peacock [1923] do not agree with this generalisation and have found that chickens require more A-vitamin than pigeons. The experience of poultry keepers is also against any idea that all birds have the same requirements. It is held by them that turkeys and pheasants at any rate are much more difficult to rear than chickens. Our own data with reference to pigeons and chickens on diets of oatmeal [Part I, 1922] and rice [Part III, 1923] indicate that the B-vitamin requirements of chickens are greater than those of pigeons. It is possible that the difficulties of rearing turkeys and other farm birds may be partly connected with the B-vitamin needs. Some preliminary experiments have therefore been undertaken to study this question. They have indicated that B-vitamin is an important factor in the difference between the ease of raising of chickens and other birds. Further experiments cannot be made till the next season. The present incomplete data are now put forward as they may be of some little value to the poultry keeper.

EXPERIMENTAL.

Oatmeal and rice had been used as the cereal in the previous experiments with chicks and pigeons. As source of protein the chicks had generally been given dried skim milk and the pigeons fishmeal.

With oatmeal, pigeons had been kept for 15 months without any addition of marmite as source of extra B-vitamin. Chicks had an addition of 0.75 g. of marmite per 90 g. of oatmeal.

COMPARATIVE B-VITAMIN REQUIREMENTS OF BIRDS 795

With rice, at the time these experiments were started, both chicks and pigeons had an addition of 3 g. marmite per 90 g. rice. Dried skim milk had probably considerably more B-vitamin in it than fishmeal.

No definite conclusion could be drawn from these data, but it was likely that the B-vitamin requirements of chickens were greater than those of pigeons.

The pigeons were already on a diet of oatmeal (90 g.) and fishmeal (5 g.). To avoid changing their diet, and as chickens had previously been kept on oatmeal the pigeon diet was chosen for the comparative experiments.

The mixture of oatmeal and fishmeal had the following composition:

Water	Salt	Ash	Fibre	Protein	Fat	Carbohydrate
7.9 %	0.2 %	2.7 %	0.9 %	14.5 %	8.2 %	65.8 %

with a protein to fat and carbohydrate ratio of 1 : 5.1.

The amount of ash was suitable, but the A-vitamin content was probably low. In the earlier experiments, no addition of cod-liver oil was made to supply A-vitamin, but later first 0.5 cc., then 1.0 cc., was added per 90 g. of oatmeal, in order to avoid complications on this account.

The experiments were not made in the order described but as follows: chicks, ducks, geese, ducks, guinea fowl, chicks, turkeys, pheasants.

Pigeons. The pigeons were kept on the same diet as described in Part IV. They were not able to rear their young without an addition of extra B-vitamin. Further evidence on this finding must await the next breeding season.

Chickens. Group X. It was not expected that chicks could be reared on oatmeal and fishmeal without the addition of marmite, but since the experiment had not been made it was necessary to establish the supposition, by allowing the birds to die if the food was not suitable.

The experiment was started on Apr. 7th, 1923, with ten day-old Light Sussex chicks.

One bird was unwell on arrival and died the next day. A second bird became ill on Apr. 9th, and died on the 8th day. All the birds showed ruffled feathers on the 12th day. A third bird was "off its legs" on the 17th day and died the following day. A fourth and fifth died on the 20th day. A sixth and seventh were ill on the 30th and 32nd days, and died on the 36th day. An eighth died on the 37th day. A ninth on the 39th day and the last on the 52nd day.

Post mortem examinations were made on the birds. In some cases nothing abnormal could be discovered. In others, the intestines were found full of undigested food. The chicks evidently suffered from constipation and died from absorption of toxic products formed by putrefaction in the gut. In two cases, a small swelling of the gut wall was found with a possible perforation. Chicks cannot thus be reared on a diet which suffices for adult pigeons.

Group XI. To prove that extra B-vitamin is needed by chicks on the oatmeal and fishmeal diet of pigeons, an addition of 1.5 g. of marmite per 90 g. of oatmeal was made. At the same time extra A-vitamin was included as cod-liver oil at the rate of 1 cc. per 90 g. of oatmeal.

The group consisted of 24 Black Leghorn day-old chicks and the experiment was started on June 1st and concluded on Aug. 17th, 1923 (11 weeks). One bird died on the second day. An unabsorbed yolk sac was found on post mortem examination. The remaining 23 birds were reared without any loss. Throughout the time of experiment the birds looked perfectly well and never showed signs of illness. The cockerels of the group began crowing in the seventh and eighth weeks. The best proof of their health is given by their steady rate of growth:

Average weekly weights.

	June 1	June 8	June 15	June 22	June 29	July 6
	g.	g.	g.	g.	g.	g.
	34.4	58.0	78	130	182	270
Increase	—	24	20	52	52	88
	July 13	July 20	July 27	Aug. 3	Aug. 10	Aug. 17
	g.	g.	g.	g.	g.	g.
	314	411	502	607	737	837
Increase	44	97	91	105	120	100

On the above diet the addition of 1.5 g. of marmite or 0.8 % of the food is sufficient for the health and growth of chicks. It is possible that 0.75 g. would be enough, but the more delicate birds would probably be lost.

Ducks. I. Aylesbury. The experiment was started on Apr. 12th, 1923, with four day-old Aylesbury ducklings.

During the first week there was an average gain in weight of 28 g.

One duck died during the second week; the others gained 21 g. Two other ducks died during the third week. The last duck died on the 30th day.

The pigeon diet was therefore not suitable.

II. White Runner. A group of 12 day-old White Runner ducklings was started on the oatmeal and fishmeal diet with an addition of 0.75 g. of marmite on Apr. 30th, 1923. Most of the ducks were shaky on their legs on the fourth day and seemed to have little appetite; they seemed better on the fifth day.

On the sixth day, five of them showed the typical symptoms of polyneuritis with the head bent back as is seen with pigeons. They were dosed with 2 cc. of 2 % marmite. Three died, but the other two were better; they died, however, on the next day.

0.75 g. marmite was obviously insufficient. It was raised to 2.25 g.

As no extra A-vitamin was present in the food, 0.5 cc. of cod-liver oil was included on the 10th day.

With the extra marmite the ducks flourished for the next two weeks. As it was desired to find the lowest amount of marmite necessary, the quantity was reduced on the 22nd day to 1.5 g. per 90 g. of oatmeal.

After this reduction another duck died on the 30th day; the gut was found full of food and perforated by a piece of undigested oatmeal.

During the sixth week, two ducks were noticed with a sort of contracted neck; one of them was better the next day; the other recovered after receiving several doses of 1 g. marmite dissolved in about 10 cc. of water.

COMPARATIVE B-VITAMIN REQUIREMENTS OF BIRDS 797

As the ducks were getting ill on 1.5 g. additional marmite, the amount was obviously insufficient and it was raised to 2.25 g. on the 40th day. On the 47th day the cod-liver oil was raised to 1 cc.

After these additions all the ducks were kept in good health till the experiment was ended on 17th Aug. The duck which had suffered from the contracted neck and recovered after the doses of marmite always remained smaller than the others.

Six out of twelve ducks were reared with the addition of 2.25 g. of marmite, the other six died with a smaller quantity per 90 g. oatmeal.

The average weekly weights show that the final amount was sufficient:

	Apr. 30	May 7	May 14	May 21	May 28	June 4	June 11	June 18
	g.	g.	g.	g.	g.	g.	g.	g.
	36.3	56.8	127.7	265	411	690	817	1036
Increase	—	20.5	70.9	137	146	288	118	219

	June 25	July 2	July 9	July 16	July 23	July 30	Aug. 6	Aug. 13
	g.	g.	g.	g.	g.	g.	g.	g.
	1197	1305	1473	1454	1543	1629	1578	1603
Increase	161	108	168	- 19	89	86	- 51	25

The two occasions on which a decrease in weight was observed were during very hot weather, not much food being eaten.

Geese. This experiment was started with 13 day-old goslings on Apr. 26th, and concluded on Aug. 17th, 1923 (16 weeks).

It had been found that chicks and ducklings could not be reared on the oatmeal and fishmeal diet without additional B-vitamin. It was not likely that it would be suitable for day-old goslings, so 0.75 g. of marmite was included at the start.

The birds were rather unsteady on their feet on arrival, but looked better after a few days, though they were very quiet. They gained on the average 51 g. in weight in the first week.

Two died on the eighth day. No cause of death could be discovered on post mortem examination.

The marmite was therefore raised to 1.5 g. per 90 g. oatmeal.

Two more died on the ninth day. Since the others looked ill, they were given a dose of 4 cc. of 2 % marmite for the remainder of the second week. Six more however died. Post mortem examination showed the gut filled with food, largely undigested; in one case there was perforation of the intestine. Death was probably due to absorption of toxic products from the stagnated food in the gut.

At the beginning of the third week, 0.5 cc. of cod-liver oil was put into the food. It was increased to 1 cc. per 90 g. oatmeal at the seventh week to conform with the food of the other kinds of birds.

The three remaining goslings survived the fourth week though their condition was not satisfactory. One died at the beginning of the fifth week. Marmite was then raised to 2.25 g. per 90 g. oatmeal.

After this addition the last two geese were kept till Aug. 17th without any illness. Their final weights averaged 5835 g.

2.25 g. marmite is thus needed by geese on the oatmeal and fishmeal diet.

Guinea Fowl. Five day-old and six rather older guinea fowl were used for this experiment. It was started on May 18th and concluded on Aug. 17th (13 weeks).

From the first day an addition of 1.5 g. marmite and 0.5 cc. of cod-liver oil was made. To conform with the other groups the cod-liver oil was increased to 1 cc. per 90 g. of oatmeal at the beginning of the fourth week. Two birds died during the first week; one of them had its caeca full of food blocking the passage through the gut. The others at this period had very little appetite. On this account the marmite was raised to 2.25 g. per 90 g. oatmeal (May 25).

A third died during the second week, and a fourth during the third.

No further loss occurred. The remaining seven were kept without any signs of illness. Their feathering was perhaps not as good as is seen normally. The growth of the birds is seen by their average weekly weights:

May 18	34 g.	June 1	92 g.	July 6	463 g.	Aug. 3	830 g.
„ 25	57	„ 8	156	„ 13	551	„ 10	966
		„ 15	212	„ 20	619	„ 17	1028
		„ 22	295	„ 27	724		
		„ 29	359				

Again, 2.25 g. is the required addition of marmite to the diet.

Turkeys. Ten day-old turkey poults were started on the diet with 1.5 g. marmite and 1 cc. of cod-liver oil on May 26th. One bird was kept till Aug. 5th, 1923. The birds did not like the diet and ate very little. At the end of the first week six had died. The others only gained an average of 6 g. Marmite was at once raised to 2.25 g. per 90 g. of oatmeal.

With this increase, the remaining four gained 15 g. during the second week. An unfortunate accident then occurred in which three of them were lost by fire in the foster mother. The last bird grew steadily each week, but in the tenth week it met with some accident in which its legs were damaged and it was chloroformed.

It appears thus that 2.25 g. of marmite is just sufficient for rearing turkeys on the oatmeal and fishmeal diet.

The bird weighed 560 g. at the end of the tenth week.

Pheasants. These birds were most kindly supplied for the experiment by Mr J. Q. Rowett. The experiment was started on June 4th and terminated on Aug. 27th, 1923. 1.5 g. of marmite and 1 cc. cod-liver oil were added to the food mixture at the start.

One bird died during the second week; no definite symptoms could be found on post mortem examination. Another broke its leg and was chloroformed. During the third week three died. These were found to have enlarged caeca causing stoppage in the gut.

The marmite was raised to 2.25 g. after these losses. Except for one more loss in the fifth week, the others were reared for 12 weeks. Unfortunately

COMPARATIVE B-VITAMIN REQUIREMENTS OF BIRDS 799

one of them damaged its leg and had to be chloroformed. Though they lived and grew quite well, it was very noticeable that the food was not entirely suitable; their sizes were very unequal and their feathering was very poor. The larger birds were continually pecking at new feathers which formed on the smaller ones.

Their rate of growth was slow as seen from their weekly weights:

June	4	18.8 g.	July	2	72 g.	Aug.	6	240 g.
"	11	25	"	9	96	"	13	295
"	18	35	"	16	132	"	20	356
"	25	49	"	23	174	"	27	422
			"	30	200			

GENERAL REMARKS.

Except adult pigeons and chicks, all the birds have needed an addition of 2.25 g. of marmite per 90 g. of oatmeal for their successful rearing. Chicks required 1.5 g.

This quantity is the minimum. Better results would undoubtedly have been secured with an addition of 3 g. per 90 g. oatmeal. 1 cc. of cod-liver oil per 90 g. oatmeal is sufficient.

The diet was specially chosen with only 5 g. of fishmeal. An increase to 10 g. would be likely to give very satisfactory growth. As pointed out in Part III, a change of cereal might not lead to a successful result since the quantity of B-vitamin in cereals is not yet known.

A diet upon which adult pigeons can exist is certainly inadequate for all other farm birds. It is curious that chickens have a smaller B-vitamin requirement than the others. It is possible that they are able to digest oatmeal better and thus obtain the whole of the B-vitamin present in it, whereas some of this B-vitamin is not assimilated by the other birds. The difference is not great.

SUMMARY.

Pigeons on 90 g. oatmeal and 5 g. fishmeal do not require any extra B-vitamin.

Chickens on the same diet need an addition of 1.5 g. marmite per 90 g. of oatmeal.

Ducks, geese, guinea fowl, turkeys, pheasants, need an addition of 2.25 g. of marmite to supply extra B-vitamin.

REFERENCES.

- Emmett and Peacock (1923). *J. Biol. Chem.* **56**, 679.
 Plimmer and Rosedale (1922). *Biochem. J.* **16**, 11, 19.
 ——— (1923). *Biochem. J.* **17**, 772.
 Sugiura and Benedict (1923). *J. Biol. Chem.* **55**, 33.