XLI. THE VITAMIN B CONTENT OF MALT EXTRACT.

By ALFRED LOUIS BACHARACH AND EDITH ALLCHORNE.

From the Glaxo Research Laboratory, 56, Osnaburgh Street, London, N.W. 1.

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SOME years ago Cooper [1914] showed that some, but not all, malt extracts cured polyneuritis in pigeons. Randoïn and Lecoq [1927] more recently replaced 65 % to 70 % of the sucrose in a vitamin B-free diet by malt extract, and were able with the modified diet to secure normal growth and reproduction in rats, and also to prevent and cure polyneuritis in pigeons. Stammers [1924] secured satisfactory though sub-maximal growth in rats on a basal diet devoid of vitamin B with a supplementary diet representing 8 g. of malt per animal per day. Southgate [1924] showed that "barley and malt contain water-soluble B, as judged by the effect on rats, in considerable and equal amounts." Finally, Harden and Zilva [1924] showed that "the vitamin B of barley is not affected by the malting process and is frequently present in the finished malt, but is absent from the culms."

In describing our own experiments we shall use the term vitamin B for brevity, without prejudice to the question of the number of constituents in the water-soluble growth-promoting antineuritic vitamin complex. We have throughout used the Norwegian albino rat, of the stock invariably used in this laboratory [Bacharach, 1926].

The experiments described below were made to find out whether vitamin B was normally present in commercial malt extracts, and, if so, what was the source.

In the first set of experiments animals were fed on a diet deficient in vitamin B, according to the technique described by Bacharach and Hartwell [1927]. The animals used were selected so as to secure litter control. The period of feeding the basal diet alone, before adding the daily dose of substance to be tested, was 20 days. The animals were 36 days old when put on to the basal diet, weighing (males) from 54 to 59 g. and (females) from 48 to 53 g.

Two groups of animals were used, one of 8 males and the other of 8 females, and all the animals were put on to experiment on the same day.

The following substances were tested.

A. A blend of wheat and barley flour, unmalted.

B. The same blend of wheat and barley flour after malting.

C. The malt extract made from this flour, containing approximately 78 % total solids.

The malt extract was fed in doses of 1.2, 1.4, 1.6, and 1.8 g., a preliminary experiment having shown that the curative dose lay somewhere in this neighbourhood.

By the courtesy of Mr Gordon Cummings and Mr Frank Marshall of the British Diamalt Co., Sawbridgeworth, who made the malt extract, we obtained the samples referred to in A, B and C above, and were informed that the weight ratio of cereal to extract was approximately 5 : 4. Accordingly, the animals on the cereal supplement were fed 1.5, 1.75, 2.0 and 2.25 g. To make sure that the whole of this cereal was consumed, it was made into a "pill" with some of the basal diet and a little olive oil, and was fed each morning before the basal diet was replenished.

The results of the above experiment are summarised in Table I.

Table I. *Change of weight in grams during 18 days on various supplementary rations of cereal material.*

"Preliminary period," 29 days.					
Controls		Litter I, ♂ -13 (23 days)	Litter II, ♀ -4 (23 days)	Litter I, ♂ -8 (31 days)	Litter II, ♀ +7 (23 days)
Flour	1.5 g.	+16	—	—	—
	1.75	—	+11	—	—
	2.0	—	—	+28	—
	2.25	—	—	—	+26
Malted flour	1.5 g.	+20	—	—	—
	1.75	—	+20	—	—
	2.0	—	—	+28	—
	2.25	—	—	—	+28
Malt extract	1.2 g.	+29	—	—	—
	1.4	—	+41	—	—
	1.6	—	—	+37	—
	1.8	—	—	—	+46
Totals for different dosages		65	72	93	100

Notes on Table I.

1. It will be noticed that the increases in growth are regular. If they are summed horizontally or vertically they give consistent results. The average daily growth per animal per gram of supplementary ration is almost identical for the unmalted and the malted flour, but considerably greater for the malt extract; the average daily growth increase per animal in each of the four groups is a function of the dosage of supplementary ration.

2. The malt extract used was a potent source of vitamin B, approximately 1.3 g. per day appearing adequate to restore young rats on a vitamin B-deficient diet to normal growth.

3. The malt extract appears to give better growth than the corresponding amount of the malted cereal from which it was made. It is out of the question that the mere process of extraction should have increased the amount of vitamin and this apparent advantage must be due to one or both of two

causes. First, the 5 : 4 ratio of cereal to extract, on which the dosage was based, may be slightly biased in favour of the malt extract. Secondly, an "appetite" effect may come into play. It was certainly noticed that the animals on the malt extract consumed their supplementary ration with much greater avidity than did those on the malted or unmalted flours. The latter, after consuming their "pills," which contained 2 or 3 g. of oil and basal diet as well as the cereal, generally retired to the back of their cages and ate very little more of the basal diet. The former attacked the malt extract with enthusiasm, and consumed almost the whole of their basal diet.

4. There is no significant difference between the vitamin B contents of the malted and the unmalted flours. The slightly better growth given by the malted flour is almost certainly also an "appetite" effect.

5. There is no evidence that vitamin B is either produced or destroyed during malting.

It having been established that the testing of malted substances for vitamin B on the albino rat is susceptible of giving consistent results, a further series of experiments was undertaken with four commercial brands of malt extract, of which the samples were bought in the open market except extract *M* which came from the same source as that used in the first set of experiments.

In this case three groups of animals were used, two groups of 5 males each and one group of 5 males and 5 females, all the animals from each group being from one litter; these we shall refer to as groups I, II and III respectively.

The technique used in these tests was identical with that used in the series of experiments described above, but the supplementary ration given was in all cases 1.0 g. per animal per day: the preliminary period on basal diet alone was 21 days. Groups I and II were put on experiment at the same time, and group III a week later. The results are summarised in Table II. The animals were 38 (groups I and II) and 34 (group III) days old when put on to the basal diet, weighing (males) from 40 to 53 g. and (females) from 42 to 51 g.

Table II. *Change in weight in grams during 35 days on 1.0 g. per day of malt extract.*

	Group I	Group II	Group III		Average
	♂	♂	♂	♀	
Extract <i>M</i>	+50	+49	+40	+34	43
Extract <i>T</i>	+50	+37	+20	+25	33
Extract <i>K</i>	+21	+24	+38	+30	28
Extract <i>B</i>	+41	+35	+3	+23	26
Controls	-9	+1	-11	-13	
	(37 days)	(49 days)	(33 days)	(31 days)	

Notes on Table II.

1. The animals placed on experiment at the same time gave consistent results.

2. There is a discrepancy with extracts *B* and *K* between their effects on groups I and II on the one hand and on group III on the other.

3. The control animal in group II behaved abnormally, in that its weight increased from 50 to 76 g. over a period of 26 days. It then declined rapidly, and at the end of 49 days had reached its original weight, was in a very poor condition and had to be killed. The other three control animals behaved normally, showing very little increase in weight and then declining rapidly until they were moribund or dead.

4. On the average, extract *M* showed itself definitely to be possessed of the highest growth-promoting power; in all the groups extract *M* was the best source of vitamin B and extract *T* came second, except in group I where they were equal.

5. Extracts *B* and *K* are also active, though less so, but their comparative activity is difficult to assess owing to the complication mentioned in 2 above. No explanation has been found for this complication.

It is of interest to note that extract *M* was a brand which was known by previous examination to have a higher diastatic power than any other make examined.

SUMMARY.

1. Several brands of commercial malt extract have been found to be rich sources of that vitamin which will restore to normal growth rats on a diet devoid of water-soluble growth-promoting factors.

2. The vitamin is derived from the unmalted flour.

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