CVII. VITAMINS IN HUMAN NUTRITION

VITAMIN B₁ AND THE "BROWN VERSUS WHITE BREAD PROBLEM". II

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THE principal object of the experiments to be described in the present paper was to obtain information about the vitamin B₁ content of the flours corresponding with the breads used in the experiments described in the preceding paper [Harris, 1937]. In the first place, however, a preliminary confirmatory experiment was carried out, on further specimens of "germ bread" and wholemeal bread. The work to be described was carried out in the early part of 1935.

TESTS ON "GERM BREAD" AND WHOLEMEAL BREAD

These breads were purchased locally, and the tests on rats by the bradycardia method carried out in the same manner as previously described, a considerable number of rats being used in the present work to reduce the percentage error of the observation.

The responses of the rats on different levels of the two unknowns and standard are arrayed in Fig. 1, and the relative activities calculated in Table I, with the aid of a combined dose-response curve, Fig. 2.

Table I. *Confirmatory test with breads (1935)*

Material	Dose given g.	No. of days cured		Activity I.U. per g.
			Average	
International standard (activated acid clay)	0.01	1.5, 2, 2, 2, 2.5, 2.5, 2.5, 3, 3, 3.5, 5	2.6	} 100
	0.02	3, 4, 4.5, 5, 5, 5, 5, 6, 6	4.8	
	0.03	6, 6, 6.5, 7, 8.5, 9, 9, 9, 10, 14.5	8.6	
Proprietary "germ bread"	1	1.5, 2, 2.5, 3, 3, 4	2.7	1.04
	2	4, 4, 4, 4.5, 5.5, 6	4.7	0.98
	3	4, 5, 5.5, 7, 7, 8	6.1	0.71
			Av.	0.91
Proprietary wholemeal bread	1	2, 2, 2, 2.5, 3, 3	2.4	0.99
	2	2.5, 3, 4, 4, 4, 4	3.6	0.75
	3	2, 4, 4, 4, 5.5, 6.5	4.3	0.50
			Av.	0.75

"*Flattening of curve.*" As in the earlier work, it will be observed that a proportionally lessened effect is produced with larger doses than with smaller doses of the breads. Owing presumably to the fact that the vitamin is less completely absorbed when a large dose of the material is given, the calculated activity appears to be relatively higher when the dose is low than when it is high. The final result expressed in terms of units per g. of material will therefore depend somewhat on the sizes of the doses given.

The average values found however agree well with those in the preceding paper.

Fig. 1. Responses with graded doses of International standard, "germ bread" and wholemeal bread.

Fig. 2. Dose-response curve with International standard, "germ bread" and wholemeal bread.
 × International Standard. • "Germ bread." ◆ Wholemeal bread.

TESTS ON VARIOUS FLOURS

The "germ bread" examined in the foregoing tests is made from a "germ flour" which is stated to be prepared by the admixture of 25 parts of prepared wheat germ with 75 parts of white flour. (This quantity of wheat germ is claimed to be 18-20 times the amount present "in ordinary brown bread".) As has been

mentioned in the preceding paper, the vitamin B₁ potency of the “germ bread” is less than might be calculated theoretically from its content of wheat germ. Two explanations might be advanced: either the wheat germ used is not in reality so potent as the values cited in the literature for “good” specimens of wheat germ (see below) might lead one to suppose, or possibly some activity is lost during the preliminary heating treatment to which the germ is submitted. Further tests have accordingly been carried out to investigate these points.

Table II. *Results with flours, etc. (1935)*

Material	Dose given g.	Number of days cured	
		Individual animals	Average
International standard	0.01	2, 2, 2.5, 3, 3	2.5
	0.02	3.5, 4.5, 4.5, 5, 5.5	4.6
	0.03	4.5, 5.5, 6, 6, 8	6
	0.04	6, 7, 7.5, 9, 10	7.9
Wheat germ:			
Commercial, Specimen I (as used for “germ flour”)	0.5	4, 5.5, 7, 7, 10	6.7
Commercial, Specimen II	0.5	5, 5, 5, 5, 6, 6, 7, 8	6.1
Pharmaceutical, proprietary preparation	0.5	6, 7, 9, 11	8.3
	0.25	5, 5	5
Proprietary “germ flour”:			
From retailer	2	4, 4.5, 5, 5.5, 6	5
From manufacturer	2	4, 5, 5.5, 6, 6.5	5.4
Wholemeal flour	2	5, 5, 5, 6, 9	6
White flour, 3 parts + wheat germ, 1 part	2	4, 5, 5.5, 8, 8	5.9
Middlings	0.5	4, 5, 5, 5, 5	4.8
Bran	0.5	3, 4, 4, 4, 4.5	3.9
White flour, specimen I	2.0	1, 2, 2, 3	2
White flour, specimen II	2.0	1, 1, 2, 2	1.5

Fig. 3. X International standard. ● “Germ flour” (2 g.). ◆ Wholemeal flour (2 g.). + White flour, 3 parts + germ, 1 part (2 g.). • Wheat germ (0.5 g.). ◆ Middlings (0.5 g.). ● Bran (0.5 g.). ○ White flour (2 g.).

In the first place a proprietary "germ flour" and wholemeal flour were compared to ascertain whether their relative potencies were similar to those of the breads prepared from them. This was found to be the case.

Secondly, a specimen of the raw germ was obtained from the manufacturers of the "germ flour" and its activity determined. At the same time a product was prepared in the laboratory by mixing 25 parts of this untreated germ with 75 parts of white flour. This was compared with the proprietary "germ flour", which differs from it only in the fact that the germ with which it is compounded has been first heated with salt. Finally, for comparison, tests were carried out on preparations of wheat germ derived from other sources, and also on specimens of middlings, bran and white flour.

Results. A summary of the animal responses is given in Table II, and the values for the activities of the different flours, as calculated from the dose-response curve (drawn up from the results of simultaneous experiments with the International Standard: Fig. 3), are set out in Table III.

Table III. *Summary of conclusions with flours (1935)*

Material	Activity I.U. per g.
Wheat germ:	
Commercial, Specimen I	6.6
Commercial, Specimen II	6.0
Pharmaceutical, proprietary preparation	8.4
	9.6
Proprietary "germ flour":	
From retailer	1.2
From manufacturer	1.3
Wholemeal flour	1.5
White flour, 3 parts + wheat germ, 1 part	1.5
Middlings	4.5*
Bran	3.6
White flour, specimen I	0.3
White flour, specimen II	0.2

* We are informed by Dr J. J. Fox that the middlings produced in flour mills contain variable proportions of endosperm and bran, and although under some conditions they may be almost free from germ, it is the practice, especially when the miller has no outlet for the sale of the germ, to include some or all of the germ in the middlings. This may account for the middlings examined having a higher value than the bran (cf. also Table V, Part I).

It will be seen that, as with the corresponding breads, the "germ flour" has an activity similar to that of wholemeal flour. Furthermore, the mixture of 3 parts of white flour with 1 part of raw germ, as compounded in the laboratory, simulated the proprietary "germ flour" in its activity. These results seem to show that the main reason for the "germ flour" having little or no greater activity than wholemeal flour is that the added germ is less potent than has been supposed. This is confirmed by the direct assay of the specimen of raw germ itself.

The activity of the raw germ, as supplied, was found to be 6.6 I.U. per g. This may be compared with the finding of Baker & Wright [1935] that a proprietary brand of wheat germ had an activity of 15.0 I.U. per g., while different specimens of "crude wheat germ" assayed at 5.9, 8.5, 10.5, 12.0 and 18.8 I.U. per g.¹ Taking 10 I.U. per g. as a representative and moderate value, a

¹ Baker *et al.* [1937] write, "A wide range of samples [of hand-picked germ] gave values from 11 to 15 units per g. Ordinary commercial grades of germ usually contain bran and give slightly lower values, a good average being in the neighbourhood of 10 I.U. per g. Considerable variation has, however, been found and values as low as 5 and as high as 20 do occur."

product containing 25% of such wheat germ should have a value of not less than $10/4 = 2.5$ i.u. per g., instead of 1.3–1.5 i.u. per g. as actually found for the specimens which were examined by us. (Crude “commercial wheat germ” as ordinarily marketed—in contrast with a “hand-picked wheat germ”, or wheat germ which has been dissected out in the laboratory—necessarily contains a considerable amount of other milling residues in addition to the actual germ itself; and no doubt its potency will depend on the efficiency of the separation.)

It may be concluded therefore that the fact that the “germ flour” is so little different in potency from wholemeal flour is due to the following causes. (1) The “germ flour” is prepared by mixing prepared germ with white flour, and the latter contains none of the branny matter to which the vitamin B₁ potency of wholemeal flour is mainly to be ascribed (see Table III). (2) The germ itself is not so potent as certain specimens previously tested, whose activity is to be found recorded in the literature. (3) Apparently the treatment of the germ during the preliminary processes is not responsible for any serious loss of activity: additional investigation would be necessary to obtain detailed quantitative data on this last point.

SUMMARY

Further confirmation is given to the finding that the “germ bread” investigated is little superior in vitamin B₁ content to wholemeal bread.

The corresponding “germ flour” is likewise similar in activity to a wholemeal flour, instead of, as might have been anticipated, appreciably richer. One reason for this is that the “germ flour” is prepared by admixture of germ with white (not wholemeal) flour, and that a large proportion of the activity of the wholemeal flour is due to the branny matter present. A further reason is that the crude germ itself as used is found to be less potent than might have been expected from the data given in the literature. The preliminary heating process to which the germ is submitted is apparently only a minor cause of loss.

The results for white flour (which is confirmed to be an inadequate source of vitamin B₁), for wholemeal flour and “germ flour”, and for bran, middlings and various specimens of wheat germ, are summarized in Table III.

REFERENCES

- Baker & Wright (1935). *Biochem. J.* **29**, 1802.
— — & Drummond (1937). Private communication.
Harris (1937). *Biochem. J.* **31**, 799.