VITAMIN B_1 EXCRETION ON A VARIED INTAKE

By MARGARET D. WRIGHT, M.B.
AND
AUDREY Z. BAKER, B.Sc., M.R.C.S., L.R.C.P.

From the Research Laboratories, Vitamins Limited

Harris & Leong (1936) found that vitamin B_1, adsorbed from urine, could be measured by the rat bradycardia method of assay. The amount of vitamin B_1 excreted was found to correspond in general with both the dietary intake and the physiological state of the subjects.

By further use of this method Harris, Leong & Ungley (1938) defined the following grades of excretion:

3·5 international units of vitamin B_1 or less were excreted daily in beri-beri.

10 international units of vitamin B_1 and less were excreted daily in milder conditions of deficiency.

12 to 35 international units of vitamin B_1 were excreted by normal individuals.

An excretion of 19–35 units corresponded with a food intake of 360–590 units and 34–50 units with an intake of 750 units. Owing to the large mass of material dealt with it was necessary that the procedure in each assay should be as simple as was consistent with the provision of useful information. Harris & Leong pointed out that the figures obtained by them were not to be regarded as final but might require modification when further work had been done on the same lines.

This method of measuring the excretion of vitamin B_1 appeared to be of considerable value and worth further exploration. It was decided therefore to make tests over a long period with one subject, both to verify the usefulness of the method and also to determine whether any modifications result in improvements. The subject chosen was a laboratory worker of a stationary weight of 12 stone, in good health, taking hard physical exercise (swimming) daily, and on a diet believed to be optimum (see later).

Assays were made over a period of a year to determine the approximate excretion at a high nutritional level. The vitamin B_1 values of the customary diet were found to range between 500 and 750 international units daily. The latter was the more usual level (e.g. 670, 650, 730).

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The following are representative diets:

Food	Quantity oz.	Vitamin B_1 taken int. units	Calories
	Diet 1		
Sausage	3 (=1½ oz. pork)	70	231
Bacon	0·5	54	74
Turog bread	2	90	134
Butter	0·5	0	110
Marmalade	0·5	0	40
Grape fruit	2·5	28	18
Coffee≡milk	10·0	60	189
Bemax	0·5	200	58
Milk	5·0	30	95
Beef (in pie)	2·0	6	96
Pastry	2·0	—	304
Apples (2)	6·0	68	90
Biscuits	0·5	—	74
Milk in tea	1·0	6	19
Steak and kidney pudding:			
Steak	2·0	26	96
Kidney	0·5	28	18
Pastry	2·0	—	304
Potatoes	2·0	17	50
Swedes	4·0	—	22
Apple tart:			
Apple	3·0	34	45
Pastry	2·0	—	304
Raw apple	3·0	34	45
Sugar	0·5	—	58
		751	2474

Ratio vit./cal. = 0·295.

	Diet 2		
Fried fish	6	66	375
Turog bread	2	90	134
Butter	0·5	—	110
Marmalade	0·5	—	40
Grape fruit	2·5	28	18
Milk in tea	2·0	12	38
Orange (1)	—	28	30
Bemax	0·5	200	58
Milk	5·0	30	95
Cheese	1·0	—	118
Biscuits	1·0	—	148
Apple	3·0	34	45
Biscuits	0·5	—	74
Milk in tea	1·0	6	19
Vegetable soup cum Lentils	0·5 lentils	30	45
Ham	2·0	124	244
Tongue	3·0	—	102
Tomato	4·0	44	17
Cucumber	1·0	—	3
Potato	3·0	25	75
Fruit salad	4·0	44	50
Sugar	0·5	—	58
		761	1896

Ratio vit./cal. = 0·412.

EXPERIMENTS

At first the subject took sodium acid phosphate twice daily to ensure urinary acidity, but this practice had to be discontinued and thenceforward 2 drops of concentrated hydrochloric acid were added with the toluene to the winchester quart bottle in which the urine was collected. This addition was

found to produce a *p*H very close to 5·0 and was consequently favourable for the preservation of the whole vitamin B_1 until adsorption. The collection of the 24 hr. specimen terminated daily at 10 a.m., and the adsorptions were usually begun immediately.

It was thought desirable to use a larger number of animals for each test than Harris, Leong & Ungley had been able to employ in their large-scale survey, and for this purpose larger adsorbates were prepared. At first up to 12 g. were collected, 6 g. being adsorbed twice in 600 c.c. of urine. These early adsorbates were fed in 0·4 and 0·6 g. doses and contained 0·9–1·5 units of vitamin B_1 per dose. We have found that the bradycardia method is most accurate when the dose fed contains between 1 and 3 units.[1] It was therefore decided to use the whole volume of urine for adsorption. The urine was used without dilution, and at first two adsorbates of 10 and 5 g., made from each day's output, were assayed separately; more recently we adsorbed four times.

Table I. *Vitamin* B_1 *excretion on a fully adequate diet*

Date	Amount of urine used c.c.	No. of adsorptions made	No. of doses given	Dose in g.	Total daily excretion int. units	
15 Dec.	400	2 mixed	5	0·6	86	
16 ,,	400	2 ,,	5	0·6	57	
17 ,,	400	2 ,,	5	0·4	49	
			5	0·6		
18 ,,	500	2 ,,	5	0·4	43	
			5	0·6		
19 ,,	500	2 ,,	5	0·6	144	
				0·6		
20 ,,	500	2 ,,	5	0·6	180	
21 ,,	500	2 ,,	5	0·6	66	
22 ,,	500	2 ,,	5	0·6	83	
30 ,,	500	2 ,,	5	0·8	45	
31 Jan.	Total excreted	1	6	0·5	77·5	
12 Mar.	,,	1	6	0·5	32	
14 ,,	,,	2	6	0·5	71	
			4	1·0	17	88
25 ,,	,,	2	6	0·5	35	
			5	0·75	25	60
30 June	,,	4	6	0·5	52	
			6	0·5	36	
			5	0·5	12	105
			4	1·0	5	
1 July	,,	3	6	0·5	32	
			6	0·5	24	66
			6	0·5	10	
22 Sept.	,,	4	5	0·5	36	
			5	0·5	20	
			4	0·5	11	72
			4	1·0	5	
23 ,,	,,	4	5	0·5	*31	
			5	0·5	33	
			5	0·5	9·5	78
			4	1·0	4·5	
24 ,,	,,	4	5	0·5	22	
			5	0·5	18	
			5	0·5	5	49·5
			4	1·0	4·5	

* Trouble experienced with the electric motor of the mixer during adsorption.

[1] A statistical survey of results obtained by this method will be published shortly.

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Another subject was also tested after living on this diet for some time, and on two consecutive days was found to be excreting 77 and 84 units.

As these figures were considerably higher than the level of 12–35 units which Harris, Leong & Ungley had found to be the normal range of healthy controls in Cambridge and London, it was thought of interest to follow the vitamin excretion after exclusion of the main vitamin B_1-containing foods from the diet.

Three representative diets

Food	Quantity oz.	Vitamin B_1 int. units	Calories
Diet 3			
Egg whites	3 = 2	0	54
White biscuits (5)	1	4	148
Butter	0·5	—	110
Grape fruit	2·5	28	18
Milk in tea	1·0	6	19
Curry and rice = rice	1·0	—	101
Haricot beans	2·5	28	70
Cabbage (café cooked cum soda)	2·0	0	6
Golden pudding: Flour	1·0	4	104
Suet	0·5	—	110
Syrup	0·5	—	47
Cake ≡ bread	1·0	4	76
Lamb	4·0	56	230
Potato	3·0	25	75
White roll	1·5	6	114
Cheese	1·0	—	118
Orange	3·0	28	30
Milk in tea	1·0	6	19
		195	1449
Ratio vit./cal. = 0·135.			
Diet 4			
Herrings	5·0	—	330
White bread	1·5	6	114
Butter	0·5	—	110
Milk in tea	1·0	6	19
Marmalade	0·5	0	40
Mutton pie: Mutton	1·0	14	58
Pastry	2·0	—	304
Orange (1)	3·0	28	30
White roll	1·5	6	114
Butter	0·5	—	110
Cheese	1·0	—	118
Milk	10·0	60	189
White scone	1·0	4	76
Butter	0·5	—	110
Lamb	4·0	56	230
Beetroot	0·5	10	4
White bread	1·0	4	76
Cheddar	1·0	—	118
Orange (1)	3·0	28	30
Milk in tea	1·0	6	19
		228	2199
Ratio vit./cal. = 0·102.			
Diet 5			
Herrings	5·0	—	330
White bread	1·5	6	114
Butter	0·5	—	110
Milk in tea	1·0	6	19
Marmalade	0·5	0	40
Orange	3·0	28	30
Cold lamb	4·0	56	230
Cheese	1·0	—	118
Bread	1·5	6	114

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Food	Quantity oz.	Vitamin B_1 int. units	Calories
	Diet 5 (*continued*)		
Butter	0·5	—	110
White scone	1·0	4	76
Butter	0·5	—	110
Milk in tea	1·0	6	19
Steamed smoked haddock	4·0	44	74
White biscuits	1·0	—	121
Cheese	1·0	—	118
White roll	1·5	6	114
Orange	3·0	28	30
		190	1877

Ratio vit./cal. = 0·133.

Table II. *Vitamin B_1 excretion on a diet low in vitamin B_1*

Date	Amount of urine used	No. of adsorptions made	No. of doses given	Dose in g.	Total daily excretion int. units
27 Mar. after 48 hr. on a low B_1 diet	Total excreted	2	6	0·5	34
			6	0·5	14 } 48
28 Mar.	,,	2	6	0·5	15
			6	0·5	8 } 23
29 ,,	,,	2	6	0·5	13
			5	0·5	9 } 22
30 ,,	,,	2	5	0·5	12
			5	0·5	9 } 21
31 ,,	,,	2	5	0·5	10
			5	0·5	3·5 } 13·5

Discussion

Harris & Leong found that on diets containing 420 units of vitamin B_1 the average daily output was 24–35 units and that the relationship between excretion and intake at all levels tested between 360 and 1250 units varied between 5 and 8%. The excretion in the present experiment ranges from 43 to 180 units, most of the figures being between 60 and 80 units. On the diet low in vitamin B_1 the relationship between intake and excretion also varied from 4·5 to 8%, but on the higher levels the ratio was nearer 10–12%.

When a deficient diet supervened upon a fully adequate diet, the B_1 excretion was reduced to 22 units in 4 days and 13·5 units in 6 days. On return to a normal diet the B_1 excretion was trebled in 24 hr.

Summary.

1. The daily urinary excretion of vitamin B_1 by a healthy subject on a good mixed diet was found to vary between 40 and 180 units, being frequently between 60 and 80 units.

2. One week on a low vitamin B_1 diet reduced the excretion to about 13 units daily. On the higher vitamin B_1 diets the vitamin calorie ratio was 0·3 or over: on the low vitamin B_1 diet it was approximately 0·1.

3. On the low vitamin B_1 diets the excretion was 4·5–8% of the intake: on the higher vitamin B_1 diets the excretion was 10–12% of the intake.

REFERENCES

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