THE B-VITAMINS IN TROPICAL NUTRITION

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Leprosy and certain other infectious diseases are thought to be influenced in their progress by the general nutritional state of the patient, hence the special attention usually given to the diet in sanitoria for tuberculosis and leprosy victims. Little effort has been made, however, to see how important the widely prevailing undernutrition among tropical peoples is as a factor predisposing to the infections so prevalent among them. Infectious diseases themselves, together with inadequate diet, do play a large part in the tropical malnutrition picture, but recently discovered facts indicate that the problem is complicated by still other factors. Requirements for certain of the B-vitamins are heightened in tropical heat, while the animal products of such regions are poorer in these elements than are similar foods grown in cool climates. The widespread vitamin deficiency thus engendered itself brings on retardation of growth, slow development, and lowered resistance to infection.

Men and other warm-blooded animals seem poorly adapted for a hot climate existence. Cellular combustion, which supplies the energy necessary for all body functions, can go on vigorously only when the body's waste heat can be dissipated readily. With a working efficiency of only 20 to 25 per cent, there must be 3 or 4 units of waste heat given off for every unit used to support functional activity. If this heat dissipation is made difficult by high external temperatures, then internal combustion slows down and all vital activities decline to lower levels.

Acting as catalysts in the combustion processes, the B-vitamins become especially important in this hot weather suppression. Studies on experimental animals have shown that increased intake of certain of them seems to improve metabolic efficiency and to allow more rapid growth and a higher vitality even with the continued difficulty in heat dissipation. Thiamin requirements per unit of food at 90° F. are about twice as high as at 68° F. (1), while for choline the increase is a five-fold one. Pyridoxine needs also seem somewhat higher, while those for pantothenic acid and riboflavin remain unchanged (2). This selectivity of the heat-heightened vitamin requirements—if it also holds for man—greatly complicates the problems of tropical nutrition, for administration in the food or otherwise of sufficient B-complex to meet the high needs of these special factors might give too much of the other B-fractions. A doubled thiamin requirement could conceivably be supplied through dietary channels if whole-wheat or enriched bread were eaten, but no diet could regularly supply five times the normal choline intake. About ½ gram of choline is taken daily in a normal diet; 700 grams of brains or 2500 grams of lean meat would be needed to supply 2½ grams! Really little is yet known of the human needs for choline or other carriers of labile methyl groups.

From animal studies it would seem that much of the tropical malnutrition could be overcome by proper selective intake of the various B fractions—of course in conjunction with an otherwise adequate diet. Instead of this, however, tropical meats and other animal products are thiamin-deficient. It takes 4½ to 5½ years to produce a 1000-pound steer on tropical ranches, as contrasted to the 18 months required in northern United States. Such slow growth means that tropical meats are tough and require prolonged cooking to be properly tenderized—thus still further lessening an already low vitamin content.

Studies conducted last year in Panama indicated that a subnormal thiamin status commonly prevails among people eating native foods. While persons recently arrived from the United States had a daily thiamin excretion of 200-400 micrograms (using the fluorometric method as described by Wang and Harris) (3), permanent residents eating native Panamanian meats and other local foods were usually found to excrete less than 100 micrograms daily. Excretion rates for the newly arrived Americans dropped from 200-400 mcg. level down to 100 mcg. after about 3 weeks on the local foods. Table 1 presents the actual excretion rates. It should be born in mind that the thiamin method used here gave higher

TABLE 1. *Thiamin excretion rates on Panamanian foods*

Subject	Time in Panama	Date	Thiamin excretion micrograms/24 hrs.
American	1 week	2- 5-41	270
		2- 7-41	240
		2- 8-41	225
		2-10-41	190
		2-19-41	90
		2-28-41	80
American	Several years	2- 7-41	85
"	5 weeks	3- 5-41	62
		3- 6-41	84
"	1 year	2-11-41	90
American	3 weeks	2- 8-41	112
"	Many years	2-13-41	70
"	" "	2-13-41	86
Panamanian	Life	2-11-41	77
		2-12-41	93
		2-13-41	60
		2-27-41	80
"	"	2-19-41	104
		2-28-41	112

readings than do more recent procedures, with 100 micrograms considered as the lower limit of a normal output. Americans who ate imported meats (from America and Argentine) usually excreted 200-300 micrograms daily.

Suspecting a low thiamin content in the meat of the slow-growing tropical animals, we compared the effects of native and imported pork loin on excretion rates. Subjects abstained from pork for a week and then ate ½ lb. of lean pork loin, with the results depicted in Table 2. In every case greater thiamin excretion followed the eating of the imported meat. Samples of various animal products were then sent to an American laboratory for thiamin assay and all values (see Table 3) were found to be below the Wisconsin levels described by Waisman and Elvehjem. (4)

TABLE 2. *Effect of American and Panamanian pork on thiamin excretion*

Thiamin excretion for 24 hrs. before and after eating ½ lb. lean pork

Subject	Native Panamanian pork			Imported American pork		
	Before	After	Rise	Before	After	Rise
American	250	390	140	180	610	430
"	230	240	10	140	230	90
"	210	250	40	200	520	320
"	160	190	30	170	460	290
Panamanian	60	120	60	70	210	140
"	110	110	00	90	220	140
"	100	210	110	110	480	370

Analysis of Texas meats by Williams and his co-workers (5) has

TABLE 3. *Thiamin content of animal products* from different regions*

Product	Thiamin content in micrograms/gram (fresh)		
	Panama	Texas (5)	Wisconsin
Pork muscle	13.6	3.1	15.2
Beef muscle	0.4	0.5	2.3
Beef liver	1.8	1.7	3.8
Poultry (light)	0.7		1.6
Eggs (native foods)	0.5		1.0
Eggs (imported foods)	0.8		

* These analyses were made on a single sample of each product and should be further checked when the opportunity is available. Advent of the war prevented further prosecution of these and other tropical studies.

yielded thiamin findings almost uniformly below those reported from Wisconsin, while the preliminary results reported above for Panama products show in the main similar low values. It is interesting to note that eggs from hens fed wholly on imported mash contain definitely more thiamin. This effect of enriching the feed has previously been described (6).

Various reports in the literature (7, 8) have indicated low thiamin excretion values for the tropical natives. Blood ascorbic acid, on the other hand, has been found normal (9), probably because of the ready availability of citrus fruits there; analyses on some 30 Panamanians gave blood values entirely within the normal range in 1940 (author's unpublished findings).

To get a rough idea of the thiamin unsaturation existing in the Panamanians eating tropical meats, 3 milligrams a day of the vitamin were administered and the rise in excretion rate observed. Three Americans eating imported meats excreted almost half the ingested thiamin on the first day (see Table 4). Panamanians on

TABLE 4. *Thiamin saturation tests on Panamanians and Americans*

	Before giving thiamin	After giving 3 mgm. thiamin daily for		
		1 day	2 days	4 days
5 hospital patients with a-febrile tuberculosis (average)	87	502	1000	
5 patients with leprosy (average)	92	543	790	
3 laboratory helpers (average)	126	256	625	760
3 Americans (average)	272	1870		

native diets took almost a week to reach the excretion rate achieved by the Americans in one day. There is thus an indication of considerable tissue unsaturation in the latter case.

Considering these various facts, it seems quite likely that a definite deficiency exists for certain of the B-vitamin fractions in the diets of tropical residents, and that this deficient intake is made even more serious by being coupled with a heightened requirement in the prevailing heat. Thiamin and choline are two factors for which the increased need is most evident from animal studies, the thiamin supply of native meats is subnormal and no diet could supply the amounts of choline apparently needed in such continuous warmth (at least as judged by the findings upon laboratory animals). There is thus posed a serious nutritional problem to be faced by those workers dealing with the health and welfare of tropical peoples.

Recent findings indicate that such vitamin deficiency plays a part in lowering resistance to infection, particularly with reference to the progress of lesions in rat leprosy (10, 11). Here may indeed lie an important factor responsible for a large part of the devastation wrought by infectious diseases among residents of tropical regions.

Studies in the author's laboratory (as yet unpublished) have shown resistance to infection to be markedly lowered by adaptation to tropical warmth, using Type I pneumococcus inoculations in white mice. Immune body production after vaccine injections is moderately but significantly depressed in the heat, while white cell phagocytic activity is sharply lessened. This takes place even with the animals on an adequate diet; just how much vitamin inadequacy would accentuate this heat depression of the phagocytic cells is a question now receiving further close study.

Conclusion

Moderate B-vitamin deficiency is probably widespread among tropical peoples. Thiamin excretion rates are at or below the lower limits of normal.

Slow growing tropical meats are deficient as sources for thiamin, as compared to meats grown in cooler climates. This, coupled with a heightened requirement for certain of the B fractions in tropical heat, poses a serious nutritional problem for tropical residents to consider.

These various facts may have a bearing upon the handling of the leprosy problem.

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