

BIOCHEMISTRY AND BIOPHYSICS

EFFECT OF SOME AGENTS ON THE CONTENT AND PHOSPHORYLATION OF VITAMIN B₁ IN THE HUMAN SYSTEM

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In studying the effect of loading with nicotinic acid on the coenzyme content of the blood of healthy people and of those suffering from neuroses and psychoses, we turned our attention to one consistent phenomenon. A gradual decrease in the coenzyme content of the blood was observed in the control group of patients, who did not receive nicotinic acid during their stay in the hospital. However, this decrease of the coenzyme content was more evident in those cases in which the patients, while receiving the same rations, received polyvitamins* (1 tablet 3 times a day (Fig. 1). Although the nicotinic acid content of the polyvitamin tablets is not large - 3 mg per tablet in all, still, the total amount of it received during a day by these patients was higher than that received by patients who did not receive polyvitamins. It was desirable to learn the reasons for the great decrease in coenzyme in the indicated cases.

There are many indications in the literature that the excessive consumption of one of the B group of vitamins impairs the balances of the other vitamins of the same group, probably by increasing the system's requirements of them. It may be, in addition, that an excess of one of the vitamins causes the trapping and expenditure of substances needed for the transformation of the coferments of other, as well as of this, members of this group [2]. Thus, it is pointed out, by using of large doses of Vitamin B₁ in berberi, symptoms of pellagra can be produced in the patient and, on the contrary, symptoms of Vitamin B₁ deficiency can be produced by large doses of nicotinic acid in the treatment of pellagra [3]. All this caused us to begin study of the effect of loading with the usual therapeutic doses of individual vitamins of the B group on the coenzyme content of the blood.

The following circumstance also attracted our attention. Determination of the Vitamin B₁ content of the blood showed that among a certain (small) number of patients with an adequate total content, it was entirely, or for the most part found in a free form. Usually these patients complained of insomnia, poor appetite, extreme irritability and complete loss of efficiency in their work—signs, resembling the complaints of patients with Vitamin B₁ deficiency. The attempt to improve the condition of such patients by loading with Vitamin B₁ usually had no effect. There are indications in the literature that this disturbance of the phosphorylation of Vitamin B₁ can be corrected by the action of several remedies. The application of Vitamin D [4], as well as insulin [5], Vitamin B₂ and adrenocortical hormones [6] has been pointed out.

In the present communication the results of an investigation of the content of coenzyme and Vitamin B₁ under the influence of prolonged loading with vitamins B₂, B₁ and D are presented briefly.

The determination of the coenzyme content was carried out by a modification of the method of Levitas, Robinson, Rosen, Huff and Perlzweig [1]. The determination of the free and combined forms of Vitamin B₁ was by a modification of Ritzert's method [1].

* Polyvitamin content: Vitamin A—1250 international units, Vitamin B₁—0.5 mg, Vitamin B₂—0.5 mg, Vitamin C—10 mg, Vitamin D—250 international units, Vitamin PP—3 mg.

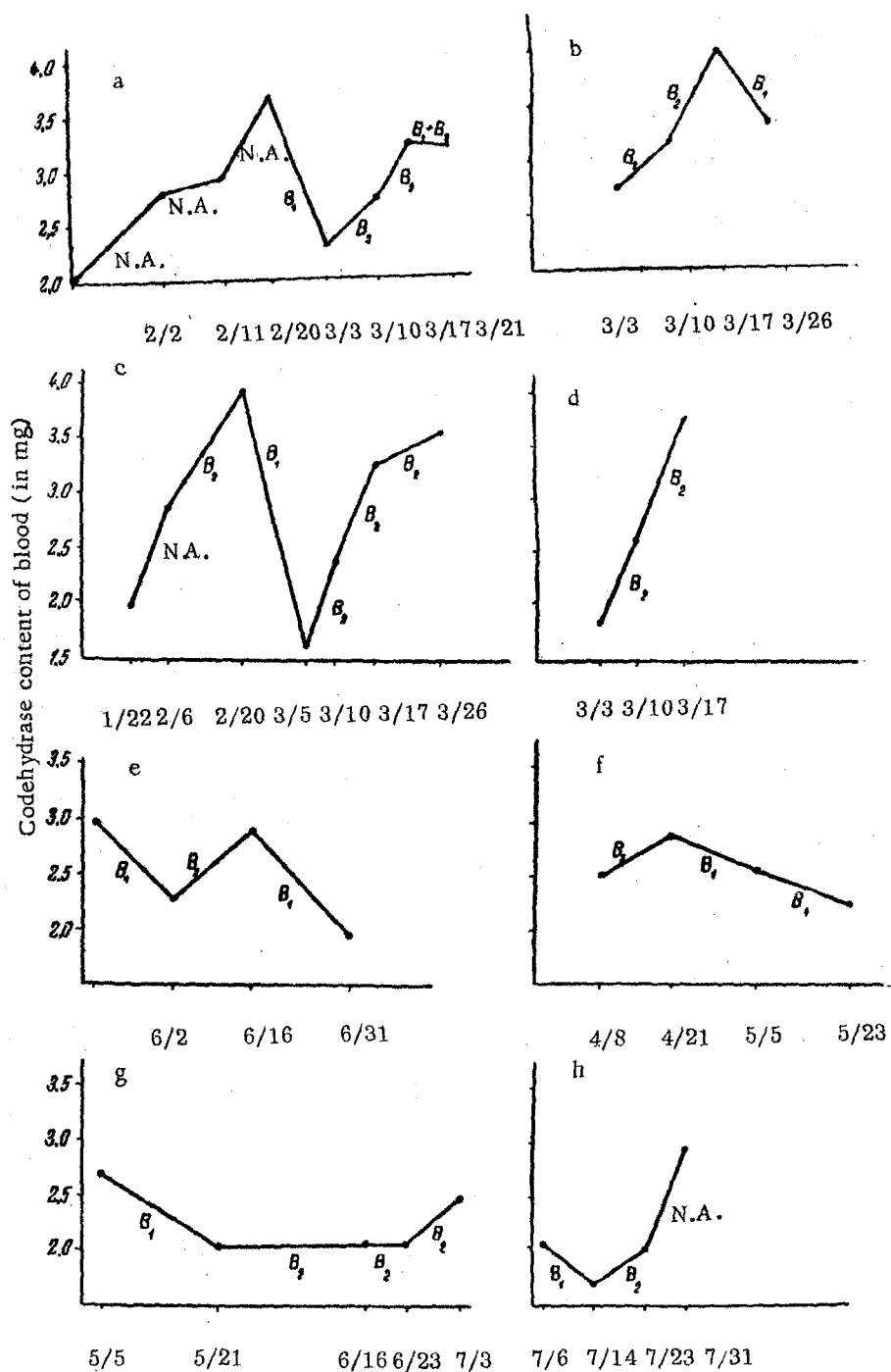


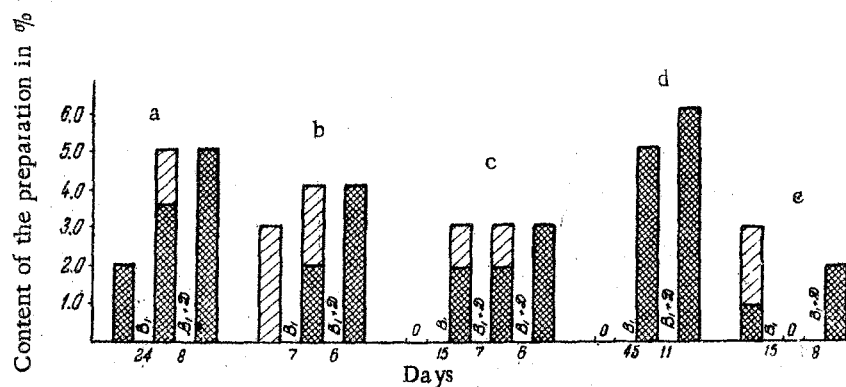
Fig. 1. Changes in the codehydrase content (in mg%) of the blood under the influence of repeated loading with Vitamins B₁ and B₂ or nicotinic acid.
a) patient K., b) patient B., c) patient B-v., d) patient L., e) patient Sh., f) patient R., g) patient D., h) patient Shv.

Repeated loading with small doses of Vitamin B₁ (4-6 mg per day) in the majority of cases led to a decrease in the codehydrase content of the blood. Statistically treated data are presented in Table 1.

TABLE 1

Codehydrase Content of Blood with Repeated Loading with Vitamin B₁

Time of investigation	N	M	σ	m	m ²	t	P
Before loading	43	2.8791	0.4835	0.0737	0.0054	5.40	100%
After loading (all cases)	43	2.3872	0.3503	0.0534	0.0029		

Fig. 2. Changes in the content and form of Vitamin B₁ in the blood of 5 patients suffering from neuroses.

Lined column — free Vitamin B₁, cross-hatched — cocarboxylase. Amounts smaller than 0.5% indicated by 0. a) patient T., b) patient Ya., c) patient M., d) patient S., e) patient K

The data in Table 1 show that the decrease in codehydrase after loading with Vitamin B₁ is significant. On dividing the data into groups according to the various durations of Vitamin B₁ administration, the significance of the groups with small numbers of cases is less. (Table 2).

TABLE 2

Codehydrase Content of the Blood at Various Durations of Vitamin B₁ Administration

Time of investigation	N	M	σ	m	m ²	t	P
Before loading	5	2.7800	0.5299	0.2370	0.0562	1.63	83%
2 days later	5	2.3000	0.3888	0.1739	0.0302		
Before loading	23	3.0304	0.5030	0.1047	0.0110	4.17	100%
8-14 days later	23	2.4978	0.3476	0.0725	0.0053		
Before loading	15	2.6800	0.5398	0.1394	0.0194	2.77	98%
15 or more days after loading	15	2.2467	0.2735	0.0706	0.0050		

Repeated loading with small doses of Vitamin B₂ (7.5 mg per day) led in the majority of cases, to a significant increase in the codehydrase content of the blood (Table 3).

TABLE 3

Codehydrase Content of the Blood after Loading with Vitamin B₂

Time of investigation	N	M	σ	m	m ²	t	P
Before loading	51	2.3745	0.3428	0.0480	0.0023	4.73	100%
After loading	51	2.7755	0.4982	0.0698	0.0049		

The significance decreased somewhat due to the decrease in the number of cases in each group when the data were divided into groups with various durations of Vitamin B₂ administration (Table 4).

TABLE 4

Codehydrase Content of the Blood at Various Durations of Vitamin B₂ Administration

Time of investigation	N	M	σ	m	m ²	t	P
Before loading	7	2.1357	0.3276	0.1238	0.0153	2.44	95%
2 days later	7	2.5214	0.2596	0.0981	0.0096		
Before loading	28	2.4536	0.3205	0.0606	0.0037	4.29	100%
8-14 days later	28	2.9554	0.5297	0.1001	0.0100		
Before loading	16	2.3406	0.3703	0.0926	0.0086	1.64	87%
15 or more days after loading	16	2.5719	0.4207	0.1052	0.0111		

Thus, Vitamin B₁ facilitates the decrease of codehydrases in the blood, while Vitamin B₂ on the contrary facilitates their increase.

Repeated loading with Vitamin D (500 international units per day) simultaneously with B₁ caused an increase cocarboxylase content in the blood in eight cases, usually with a decrease in free Vitamin B₁. But in one case loading with Vitamin D had no effect on a patient who was known to have been well fed, repeated analysis of whose blood showed that the major portion of Vitamin B₁ in her blood was free. Loading with Vitamin D also effected the cocarboxylase content of the blood of two healthy persons with normal cocarboxylase content, probably in connection with their lack of a deficiency of this vitamin.

To illustrate, we present graphs in which is seen the effect of Vitamins B₁ and B₂ on the codehydrase content of various persons, the effect of loading with Vitamin D on the phosphorylation of Vitamin B₁ in patients with a disturbance of this process.

The data obtained by us show unequivocally that even small doses of one of the vitamins repeatedly administered can effect the balance of the other vitamins greatly and sometimes undesirably. Doses of them which are at all significant should not be administered without repeated blood analyses.

The above data present the question of the expediency of changing the composition of polyvitamin tablets. Thus, in order that their vitamin content correspond better with the relationships of the vitamin contents in a normal well-balanced diet, the amount of nicotinic acid should first of all be increased.

SUMMARY

The authors studied the influence of vitamins B₁ and B₂ upon the content of codehydrogenases in the blood and the influence of vitamin D upon the content and form of vitamin B₁ in the blood of healthy persons and patients with neuroses and psychoses. The following conclusions have been drawn:

- 1) A prolonged administration of the small doses of vitamin B₁ (4-6 mg a day) causes a statistically significant decrease in the content of codehydrogenases in the blood;
- 2) A prolonged administration of the small doses of vitamin B₂ (7.5 mg a day) causes a statistically significant increase in the content of codehydrogenases in the blood;
- 3) An administration of vitamin D facilitates the assimilation and phosphorylation of vitamin B₁.

LITERATURE CITED

- [1] M. L. Petrunkin and A. M. Petrunkina, Practical Biochemistry,* Leningrad, 1951, pp. 346, 329.
- [2] V. Bisceglie, Bull. soc. chim. biol., 1950, t. 32, pp. 162-179.
- [3] Sydenstricker, cited from Bicknell, F. and Prescott, F. Vitamins, London, 1946.
- [4] C. E. Raiha and O. Forsander, Science, 1952, v. 115, pp. 242-243.
- [5] P. P. Foa, J. A. Smith and H. R. Weinstein, Nutr. Abstr. Rev., 1948, v. 17, No. 3, pp. 642-643.
- [6] S. Molnar and J. Petranyi, Klin. Wschr., 1939, pp. 1191-1193.

* In Russian.