

NOTES ON VITAMINS B₁ AND C LEVEL ALTERATION IN THE BLOOD AND URINE OF SEAMEN, WORKING UNDER CONDITIONS OF ELEVATED TEMPERATURE

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In view of the great importance of vitamins B₁ and C during intense metabolism of substances, observed in heavy physical work under conditions of elevated environmental temperature, we set ourselves the task to investigate their level in blood and urine of seamen working under heavy temperature conditions.

The review of available literature sources reveals a great paucity of informations on the question. The vit. C content in the urine is investigated of seamen making part of the personnel of an overseas ship. (7). It is found out that engineering personnel displays about 50% increase of its level, a fact indicating overexpenditure of the vitamin. The blood levels of vit. C and vit. B₁ content are not studied. The level of vit. C in the urine is studied also in nonacclimatized population of not climate regions (5), but in this case as well, investigations involve merely changes in the vit C content. The level of vit. C in the blood of workers from high temperature shops is established (13) at about 0,3 mg% lower than the normal. Other authors prove the effect of the overheating factor on the ground of clinical observations merely (6, 18).

Method

Subject to our investigations is a group consisting of 5 sailors from the engine departments of ship, affiliated to the „N“ unit. The seamen work under temperature regime between 26–45 degrees C and 35–62% humidity. In the course of two years monthly investigations are carried out of the vit. B₁ and C content in the blood and urine before and after duty activities. The „on duty“ activities are exercised during several hours at high sea in different time of the day (over a 24-hour period). During said period of time the seamen are staying in the engine-room.

In order to establish the influence of food on the level of the vitamins investigated, studies were carried out with respect to composition, calorificity and vitamin (B₁ and C) content, previous to and on the day of departure. Five seamen from the personnel of the same ship are parallely studied as a control group, working and living in the same social and labour conditions as the former. At high sea, however, they are in normal temperature conditions. In the studies this group is indicated as deck personnel.

After a thorough study and discussion of the various methods suggested in literature (1, 2, 3, 6, 12, 15, 16, 17, 18, 22, 23, 24, 26), we made our

choice as follows: Food calorificity was computed on the basis of its quantitative composition — proteins, fats and carbohydrates (without cellulose), determined in accordance to standard methods elaborated by the Scientific Research Institute of Sanitary and Higiene (11) on the average sample of daily ration. Bread calorificity is determined on the basis of mean consumption 800 gr. The vit. C content in food was titrimetrically determined with indophenol according to the SRISH method. Vit. B₁ — fluorometrically by transferring it in thiochrome — method of *P. Petkov* (12). Vit. C assessment in blood was made after *Farmer—Abba* (17), and in the urine — after *Travina* (17). In the blood and urine the vit B₁ content is established according to the thiochrome method as proposed by *Heins-Harris*.

The data of the investigations are grouped in four different periods with a view to including the most characteristic features of annual seasons — temperature changes and diversity of food products, namely: winter — December, January and February, temperature in the engine department 20—25°C, humidity above 62%. Spring — March, April, May — temperature 25—35°C, humidity 50—60%. Summer — June, July and August — temperature 48—52° C, humidity up to 30%. Autumn — September, October and November — temperature 28—30°C, humidity about 55%.

Results

The data obtained during the investigations are grouped in the following tables.

The data reported in the tables represent statistically elaborated results of investigations, and the figures resulting at the end are the mean arithmetics of at least 25 observations. The results are computed with probability $p = 0,05$, sufficient for biological investigations, with $t = 2,06$. The limits of reliability of the mean arithmetical are presented in accordance with the formula $M \pm t m$. The comparative study of the variation lines of the deck engine personnel was carried out according to the test „t“. We received data for t in the columns with probability higher than 0,05, that is, the differences in the lines could be assumed as reliable.

Discussion of results

It is evident from table 1 that the food offered, insofar composition and calorificity is concerned, is not up to the requirements for this particular group of manual labour. On the day of sailing off, a tendency is noted towards decreasing the amount of proteins and fats at the expense of carbohydrates without bearing in mind that their increase brings about greater vit. B₁ needs. By routine rule, on this day the calorificity is higher, conditioned by the heavier physical strain. As regards vit. C content — it is very scanty. Even during summer months, abounding in fruits and vegetables, the vit. C content in the average does not exceed 45—47 mg. Particularly poor in vit. C is the food during spring season, thereby exerting an unfavourable effect on the ascorbinic acid level in blood and urine of sailors of both groups, subjected to study (table 2 and 3). The vit. C content in the food

Table 1
Composition, calorificity and vitamin content of the food

Periods	Winter		Spring		Summer		Autumn	
	before sailing	after sailing	before sailing	after sailing	before sailing	after sailing	before sailing	after sailing
Proteins	101.60 g	84.74 g	112.04 g	65.56 g	68.58 g	72.91 g	81.11 g	87.91 g
Fats	75.58	74.94	100.58	79.94	76.34	65.74	102.46	111.32
Carbohydrates	471.92	557.65	535.65	370.00	497.15	529.67	537.92	540.79
Calorificity	3054.31 cal.	3603.21 cal.	2530.34 cal.	3028.02 cal.	3635.06 cal.	3081.96 cal.	3490.90 cal.	3611.88 cal.
Vitamin C	34.4 mg	21.88 mg	11.95 mg	7.93 mg	46.81 mg	44.64 mg	26.02 mg	34.12 mg
Vitamin B ₁	432.8 Y	450.57 Y	389.29 Y	270.01 Y	427.36 Y	435.78 Y	350.69 Y	369.23 Y

Table 2
Vitamin C level mg % in the blood

Periods	Deck personnel		Engineering personnel	
	before duty	after duty	before duty	after duty
Winter	0.71 ± 0.02	0.57 ± 0.04	0.65 ± 0.001	0.37 ± 0.004
Spring	0.42 ± 0.003	0.30 ± 0.003	0.10 ± 0.001	0.17 ± 0.001
Summer	0.69 ± 0.001	0.53 ± 0.001	0.68 ± 0.001	0.30 ± 0.001
Autumn	0.70 ± 0.001	0.56 ± 0.001	0.57 ± 0.001	0.23 ± 0.001
		difference		difference
		0.14 ± 0.001		0.28 ± 0.001
		0.10 ± 0.001		0.21 ± 0.004
		0.16 ± 0.001		0.38 ± 0.002
		0.14 ± 0.001		0.33 ± 0.003

Table 3
Vitamin C level mg % in the urine

Periods	Deck personnel		Engineering personnel	
	before duty	after duty	before duty	after duty
Winter	0.10 ± 0.005	0.33 ± 0.003	0.89 ± 0.007	0.29 ± 0.002
Spring	0.61 ± 0.001	0.84 ± 0.001	0.52 ± 0.001	0.87 ± 0.001
Summer	0.72 ± 0.001	0.99 ± 0.001	0.63 ± 0.001	1.48 ± 0.001
Autumn	1.32 ± 0.001	1.54 ± 0.001	1.00 ± 0.001	1.45 ± 0.001
		difference		difference
		0.23 ± 0.005		0.40 ± 0.036
		0.23 ± 0.001		0.35 ± 0.0001
		0.27 ± 0.001		0.85 ± 0.004
		0.27 ± 0.001		0.45 ± 0.0003

Vitamin B₁ level % in the blood

Periods	Deck personnel			Engineering personnel		
	before duty	after duty	difference	before duty	after duty	difference
Winter	4.14 ± 0.0006	3.24 ± 0.02	0.90 ± 0.007	3.36 ± 0.03	2.10 ± 0.004	1.26 ± 0.03
Spring	4.18 ± 0.01	3.26 ± 0.01	0.92 ± 0.01	3.99 ± 0.001	2.36 ± 0.003	1.65 ± 0.002
Summer	3.20 ± 0.014	2.37 ± 0.005	1.17 ± 0.003	3.32 ± 0.016	1.49 ± 0.012	1.83 ± 0.02
Autumn	4.48 ± 0.007	3.96 ± 0.007	0.52 ± 0.004	3.60 ± 0.003	1.89 ± 0.012	1.71 ± 0.0005

Table 5

Vitamin B₁ level % in the urine

Periods	Deck personnel			Engineering personnel		
	before duty	after duty	difference	before duty	after duty	difference
Winter	81.84 ± 1.40	69.98 ± 0.60	12.86 ± 0.45	59.50 ± 0.35	34.04 ± 1.46	25.46 ± 0.70
Spring	79.16 ± 0.15	67.99 ± 0.40	11.17 ± 0.05	80.48 ± 0.17	47.70 ± 0.50	32.78 ± 0.05
Summer	77.88 ± 0.22	65.78 ± 0.24	12.10 ± 0.82	69.65 ± 0.18	32.33 ± 0.024	37.32 ± 0.11
Autumn	78.69 ± 0.413	68.32 ± 0.001	10.37 ± 0.01	66.16 ± 0.01	32.38 ± 0.29	33.80 ± 0.004

during the winter and autumn seasons is nearly equal, which is explained with its being varied during said seasons with pickled vegetables and very rarely with fresh apples. As regards vit. B₁ content, the food meets daily needs.

The data reported in tables 2, 3, 4 and 5 unequivocally demonstrate the increased expenditure of vitamins B₁ and C in seamen working in the engine department. The vit. B₁ and C levels in the blood are decreased following the „on duty“ period with nearly one half. In the urine the level of vit. C is considerably increased, indicating heavy impoverishment of the organism in ascorbinic acid (18), fully coinciding with literature reports (7). Vit. B₁ level is decreased in a lower degree. The alterations of blood and urine levels of the above mentioned vitamins among the deck personnel is insignificant. The greatest decrease of vitamin levels in seamen of the engine department is observed, as anticipated, during the not summer season.

The average annual change in levels of water soluble vitamins B₁ and C could be illustrated with the following table:

Table 6

Percentage annual alteration of vit. B₁ and C in mg

	Deck personnel	Engineering personnel
Vitamin C in blood	-19.60	-53.63
Vitamin C in urine	+31.60	+57.14
Vitamin B ₁ in blood	-20.76	-58.13
Vitamin B ₁ in urine	-17.74	-45.49

The results of the investigations show, that primarily the vitamin level in blood and urine of seamen from the engine department is lower than that in the control group, in the average for vit. C in blood with about 7,14%, in urine — with 20%; for vit. B₁ in blood with 10,75 % and in the urine — with 9,50%, which is an indication for a permanent B₁ and C avitaminosis among these sailors. Thus the fact of their being very frequently affected with cold diseases is explained. They are the most frequently affected group by grippe epidemics, exhibit hypotonia, transitory tachycardia, complaints of weakness, headaches, bleeding gums etc. In many instances, injuries sustained during work heal more difficultly than in other seamen, which fact, though yet unproved, could be ascribed to the vit. C avitaminosis (20, 21, 22).

With the aim of establishing relationships between the albumin content and globulin content in the blood plasma on one hand, and vit. C on the other, twofold paper electrophoresis was carried out of blood plasma of the deck and engineering personnel before and after sailing. The investigations proved that the content of the mentioned components with respect to deck personnel remain unaltered — normal both before and after sea sailing. Albumin content among engineering personnel shows a decrease of nearly 3% after sailing, remaining within the limits 6—7%, whereas that of the globulins is increased. Their content fluctuates between 92,78—93,29%. Undoubtedly, these results couldn't be considered as fully reliable

because the investigations carried out are very restricted (10 for each group), but anyway, they could serve as indication in further researches on the problem.

Repeated investigations were performed also (2 series by 10 each) on the hemoglobin blood content of the seamen under study. They proved that the content in sailors working in the engine department is lower (mean 60—64%) in comparison to that of deck personnel (72—78%), which could be similarly partially assumed as an effect of the B₁ and C avitaminosis, regardless of the presence of other factors exerting influence upon this reduction — air pollution in the engine room etc.

Regardless of the fact that in our investigations the side factors which could possibly effect expenditure of the vitamins studied have not been considered as for instance great humidity, tension during rough sea and so on, we feel that the substantial decrease of the vitamin level established among the seamen of the engine department is almost entirely due to the effect of the high temperature environment in which they work.

Inferences

1. The level of vit. B₁ and C in the blood of seamen from the engine department falls abruptly after sailing off, i. e. after working in conditions of high temperature. Of particular significance appears to be the decrease during the not summer months.

2. Seamen from the engine department exhibit constant B₁ and C avitaminosis because prior to sailing off as well, the level of thiamine and ascorbic acid in the blood is beneath the acceptable norm (4, 8).

3. Vit. C contained in food is far beneath the possibilities for satisfying the needs of this vitamin (75—100 mg for men working heavy physical labour). Adding the increased expenditure under the conditions of elevated temperature, this need should also be increased. As regards the content of vit. B₁, the food offered satisfies the daily needs (2.5—3 mg), but here too, considering the overexpenditure under conditions of elevated temperature, this need is increased.

4. The data available concerning the composition of nutritive rations demonstrate that reconsideration of the problem is required for the composition (with respect to quantity and quality of nutritive ingredients) and feeding regime of the groups of seamen investigated. Measures must be taken for improving culinary preparation of ready food with a view to better preservation of vitamin content of food stuffs used.

5. With a view to preventing decrease in vit. B₁ and vit. C concentration in the blood of the seamen investigated, a special vitamin-prophylaxy is recommended, specific for a particular working process. The amount of vit. C should be increased up to 150—170 mg, and that of vit. B₁ — up to 4—5 mg.

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**ОТНОСИТЕЛЬНО ИЗМЕНЕНИЯ УРОВНЯ ВИТАМИНОВ В₁ И С
В КРОВИ И МОЧЕ У МАТРОСОВ, РАБОТАЮЩИХ
ПРИ ПОВЫШЕННОЙ ТЕМПЕРАТУРЕ**

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РЕЗЮМЕ

Сообщают результаты исследования уровня вит. В₁ и С в крови и моче матросов машинного отделения, которые работают при температурном режиме 26—45°C и влажности 35—62% в течении 2 лет. Одновременно исследована и пища их на калорийность и содержание этих витаминов. Как контрольная группа параллельно исследованы матросы того же корабля, работающие при нормальных температурных условиях.

Установлено, что уровень витаминов В₁ и С резко падает в крови у матросов машинного отделения после работы их при высокой температуре. Получаемая пища не восполняет расхода вышеуказанных витаминов.