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CONTENT OF TOTAL IRON, COPPER AND MANGANESE IN LIVER OF ANIMALS DURING HYPOKINESIA, MUSCLE ACTIVITY AND PROCESS OF RECOVERY

G. M. Potapovich, G. V. Taneyeva and A. B. Uteshev

Translation of "Soderzhaniye obshchego zheleza, medi i margantsa v pencheni zhivotnykh pri gipokinezii, myshechnoy deyatel'nosti i v protesse vosstanovleniya", Izvestiya Akademii Nauk Kazakhskoy SSR, Ser. Biologicheskaya, No. 4, Jul-Aug 1978, pp 63-66

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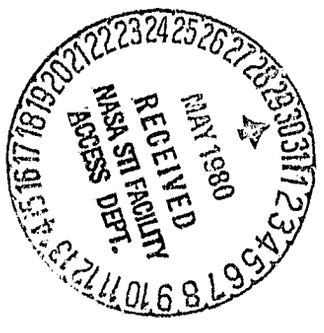

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16. Abstract

It is shown that the content of total iron, copper and manganese in the liver of animals is altered depending on the intensity and duration of their swimming. Hypodynamia for 7 days does not alter the concentration of iron, but sufficiently increases the content of copper and manganese. The barometric factor effectively influences the maintenance of constancy in the content of microelements accumulated in the liver after intensive muscle activity.

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CONTENT OF TOTAL IRON, COPPER AND MANGANESE IN LIVER OF ANIMALS DURING HYPOKINESIA, MUSCLE ACTIVITY AND PROCESS OF RECOVERY

By

G. M. Potapovich, G. V. Taneyeva and A. B. Uteshev*

It is known that such microelements as iron, copper and manganese take active /63** part in different oxidation-reduction processes, which explains their important biological role in the vital activity of the organism [1]. In this respect one should take note of the special position of the liver in metabolism and depositing of these microelements. Iron has the dominant position as the active biological coenzyme [2]. Copper is the only element that is capable of having a hemopoietic effect in the presence of iron [3], while manganese promotes the accelerated maturation of erythrocytes [4].

Despite the important role of these microelements in the physiological processes of the organism, the dynamics of their muscular activity of varying duration has not yet been sufficiently studied. Thus, N. A. Kudryavtsev [5,6] showed that in the liver of rats after fulfillment of a one-hour physical load (swimming) in animals that had been trained for 1.5 months the quantity of iron was increased by 7.2%, and in the untrained after the indicated single load it was reduced by 6.4%. Moreover, the question as to the effect of hypokinesia and the recovery processes on the content of iron, copper and manganese in the liver has not been studied in the literature accessible to use. The positive effect has only been shown of baromassage on the morphohistochemical shifts in the liver of rats after a month of training [7].

*Kazakh Institute of Physical Culture, Institute of Oncology and Radiology of the Kazakh SSR Ministry of Public Health, Alma-Ata.

**Numbers in margin indicate pagination in original foreign text.

We set ourselves the task of studying the effect of hypokinesia, physical loads of varying duration, as well as the recovery processes (baromassage or passive rest) on the dynamics of iron, copper and manganese in the liver of animals.

Studies were made on albino mongrel male rats weighing 180-250 g. The control group (19 rats) was not trained, while the experimental (10-12 rats) swam at 30-32° for varying duration: a single load for 3, 5, 6, 7 and 9 h; the training for two weeks and a month that started with 15 min and was daily increased correspondingly by 10 and 12 min reached on the whole 3 and 5 h. The baromassage was used for the control rats after 6-hour load and a month of training for a week daily for 8 min. (2 min. of negative pressure up to 35 mm Hg was combined with a positive minute). The baromassage was done on the lower part of the torso of the rat that was placed in a special pressure chamber for small animals. The passive rest for 2, 7 and 30 days was employed after the month load. All the animals fulfilled the physical load at a certain time of /64
the day and were on the same food ration, which excluded diurnal biorhythms in the content of microelements in the organs and tissues.

The quantity of microelements in the liver after decapitation of the animals was determined by the method of emission spectral analysis according to the technique of A. O. Voynar [1] in the modification of Z. D. Yegorova [8]. The biological tests were incinerated at 450±20°. The spectra were taken on the ISP-28 spectrograph through the two-stage attenuator with inlet slit equal to 23 μ, exposure time 90 s and distance between the electrodes 2 mm. The source of excitation was an alternating current arc with strength 16 A with voltage in the line 220 V. The use of the single-lens system of illumination promoted the reduction in suspension of the analyzed test without attenuation in the density of the spectral line on the spectrogram. The density (ΔS) of the spectra was measured with the help of the microphotometer MF-2 and the calibration curve $\lg C = f(\Delta S)$ was used to determine the concentration of iron, copper and manganese for the ash (mg% of fresh tissue). The experimental results were statistically processed (table 1,2).

Based on the conducted studies it was established that in 3 h of swimming in the liver of the rats there is a reliable increase in the level of iron and manganese by 1.8-fold, and copper 1.5-fold. Further in 6 h of single physical load the concentration of microelements continues to rise (table 1). The

TABLE 1. DYNAMICS OF IRON, COPPER AND MANGANESE IN MUSCLE ACTIVITY

Series of experiments	Statistical indices	Iron	Copper	Manganese
Control	M±m	9,55±1,46	0,495±0,08	0,068±0,0 0
Load 3 h	M±m	17,61±2,15	0,753±0,08	0,123±0,008
	t	3,1	2,2	4,6
Load 5 h	M±m	14,23±3,03	0,753±0,28	—
	t	1,5	0,9	
Load 6 h	M±m	21,80±3,27	0,854±0,12	0,114±0,027
	t	3,4	2,4	1,7
Load 7 h	M±m	11,44±0,37	0,479±0,03	0,115±0,036
	t	1,25	0,14	1,27
Load 9 h	M±m	12,90±0,71	0,650±0,08	0,100±0,010
	t	2,0	1,4	2,2
Training 0.5 month	M±m	6,05±1,07	0,335±0,04	0,043±0,020
	t	1,94	1,8	1,1
Training 1 month	M±m	10,04±0,89	0,420±0,01	0,077±0,010
	t	0,29	0,78	0,6
Hypodynamia	M±m	11,52±1,89	0,728±0,12	0,114±0,024
	t	0,8	1,6	1,8

subsequent increase in the swimming time to 7 h is characterized by normalization of the content of manganese, copper and iron, although their level unreliably ($d<0.1$) exceeds the control amounts. In 9 h after fulfillment of the load a reliable ($d<0.05$) increase was again observed in the quantity of iron and manganese. With a gradually rising load for 2 weeks the concentration of ion and copper is reduced almost reliably ($t=1.94$, $t=1.8$). However, the training for a month is characterized by normalization of the studied indices. An analogous law for iron is characteristic for hypodynamia, but the content of copper and manganese is somewhat increased ($t=1.6$, $t=1.8$).

The use of baromassage in the control rats reduces the quantity of copper /65
and manganese in the hepatic tissue ($t=1.8$, $t=2.2$, table 2), without affecting the level of iron. In the barometric effect after 6-hour load the content of copper is increased 1.5-fold and the content of manganese 2.1-fold, while the concentration of total iron in the hepatic tissue is not altered in relation to the studied load. With the application of baromassage on the torso of the rat after the month training an analogous law is observed for iron, while the quantity of copper and manganese is characterized by a certain increase. The passive rest for 2,7 and 30 days after the month training cycle reliably reduces the concentration of iron, copper and manganese, whose quantity after the reliable reduction on the second day of rest again rises, reaching the content of this microelement in the liver of rats trained for a month.

Thus, based on the conducted experiments one can conclude that the sharply rising quantity of microelements in the liver with a single intensive swimming

TABLE 2. DYNAMICS OF IRON, COPPER AND MANGANESE IN LIVER OF RATS IN RECOVERY PROCESS

Series of experiments	Statistical indices	Iron	Copper	Manganese
Control	M±m	9,55±1,46	0,495±0,08	0,068±0,010
Control + baromassage	M±m	10,52±0,59	0,369±0,02	0,055±0,006
	t*	0,6	1,8	2,2
Load 6 h	M±m	21,80±3,27	0,854±0,12	0,114±0,029
Load 6 h + baromassage	M±m	24,69±3,45	1,286±0,24	0,239±0,060
	t	0,6	1,6	1,37
Training, month	M±m	10,04±0,89	0,420±0,01	0,077±0,010
Training, month + baromassage	M±m	9,79±2,94	0,809±0,47	0,090±0,010
	t	0,8	1,4	1,9
Passive rest 2 days	M±m	2,95±0,49	0,288±0,02	0,024±0,010
	t	6,8	5,7	3,6
Passive rest, 7days	M±m	5,89±0,89	0,450±0,07	0,024±0,010
	t	3,3	0,4	3,6
Passive rest 30 days	M±m	5,44±0,92	0,366±0,03	0,029±0,03
	t	4,4	1,9	1,45

*Reliability of differences t computed in relation to effect.

in animals in the space of 3 and 6 h is linked to the absence of adaptation to such a load, which, as N. N. Yakovlev [9] indicates, is "the ability to survive." The drastic accumulation of iron(up to 21.8 mg%) in the 6-hour load in the hepatic cells indicates the incapacity to discharge part of the iron into the blood and as a result leadsto its depositing in the form of ferritin and hemosiderin [2,9,10].

The reliable increase in the microelements in the liverof rats with an increase in the physical load to 3 and 6 h promotes an increase in the level of erythrocytes and hemoglobin in the blood that we observed in the same effects.

A further increase in the single load, not leading to a considerable change in the quantity of microelements for iron and manganese has a unidirectional nature. The two-week training, characterized by a certain reduction in the content of iron and copper in the liver and normalized in a month, indicates the development of /66 the adaptation shifts to such training.

From the unreliable shifts in the concentration of iron, copper and manganese in the liver of the animals during baromassage after single 6-hour and month loads one can judge the effectiveness of the effect of the barometric effect to maintain constancy in the content of microelements accumulated in this tissue after the muscle activity. At the same time the passive rest even for 2,7 and 30 days for iron and 7 and 30 cays for copper and manganese, in which a decrease is observed in the concentration of the microelements, is characterized by a slow

restoration of them in the hepatic tissue due to the inflow of the indicated microelements into the blood channel, apparently, for the restoration of their level in the muscle tissue.

Conclusions

1. The increase in time of single physical load promotes a sharp accumulation of iron, copper and manganese in the liver of rats that after 7-hour swimming of the animals is slightly reduced.

2. Training for 2 weeks is characterized by a reduction in the concentration of the microelements in the liver with subsequent normalization of their level after a month training.

3. Hypodynamia for 7 days does not alter the quantity of iron, but reliably increases the content of copper and manganese in relation to the control.

4. The barometric effect efficiently influences the maintenance of the constant level of microelements accumulated in the liver after intensive activity of the animals.

References

1. Boynar, A. O. Biologicheskaya rol ' mikroelementov v organizme zhivotnogo i cheloveka ["Biological Role of Microelements in the Organism of Animals and Man"], Moscow, 1960.

2. Verbolovich, P. A.; and Uteshev, A. B. Zhelezo v zhivotnom organizme ["Iron in the Animal Organism"], Alma-Ata, 1967.

3. Kolomiytseva, M. G.; and Gabovich, R. D. Mikroelementy v meditsine ["Microelements in Medicine"], Moscow, 1970.

4. Shkol'nik, M. I. Vliyaniye medi i margantsa na nekotoryye biokhimicheskiye protsessy v organizme zhivotnogo ["Effect of Copper and Manganese on Certain Biochemical Processes in the Organism of the Animal"], Author's abstract of doctoral dissertation, Kazan', 1963.

5. Kudryavtsev, N. A. Izmeneniye soderzhaniya nekotorykh bioelementov v organizme pod vliyaniyem myshechnoy deyatel'nosti ["Change in the Content of Certain Bioelements in the Organism under the Influence of Muscle Activity"], Author's abstract of candidate dissertation, Sverdlovsk, 1969.

6. Kudryavtsev, N. A. "Exchange of Iron in the Organism in Muscle Activity," Teoriya i praktika fizkul'tury, No. 10 (1971), p. 39.

7. Bugubayeva, S. "Effect of LOD on Morphohistochemical Indices of Liver of Rats after Physical Load," in Mediko-biol. probl. fizicheskoy kul'tury i sporta [Medical-biological Probl. of Physical Culture and Sports], No. 4 Alma-Ata, 1976, p. 3.

8. Yegorova, Z. D. Metodika kolichestvennogo spektral'nogo analiza biologicheskikh prob na med' i zhelezo ["Technique of Quantitative Spectral Analysis of Biological Tests for Copper and Iron"], Alma-Ata, 1968.

9. Shcherba, N. N.; and Petrov, V. N. Zhelezodefitsitnyye sostoyaniye ["Iron-Deficit States"], Leningrad, 1975.

10. Yakovlev, N. N. Biokhimiya sporta ["Biochemistry of Sports"], Moscow, 1974.