RELATIVE CONCENTRATIONS OF IRON, MANGANESE, AND COPPER IN HEALTHY HUMAN SERUM

T. V. Zhernakova

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Iron, copper, and manganese are trace elements essential to life and their metabolism is closely interrelated. Not only the absolute concentrations of these elements in the blood serum, but also the ratio between them, are important in clinical practice [4, 7, 8].

The object of this investigation was to determine the absolute and relative concentrations of copper, iron, and manganese in the blood serum.

EXPERIMENTAL

Iron, copper, and manganese can be determined simultaneously in a sample of serum ash weighing 10-12 mg by the method of emission spectral analysis.

Serum for analysis was taken in a volume of 3-4 ml, tested for latent hemolysis, and dried at 80°; subsequent incineration took place at a temperature not exceeding 400°. The ash was mixed with carbon in the proportion of 8:1, and 12 mg of the sample was introduced into a thin-walled carbon electrode. A type ISP-28 quartz spectrograph was used for the spectral analysis. The samples were ignited twice or three times in a dc electric arc: current 15 A, width of gap 14 μ. The spectra were photographed through a three-step reducer on type I spectrophotometric plates with an emulsion sensitivity of 0.7 GOST (All-Union State Standard) units.

The "three standards" method of spectrum analysis was used. The standards were prepared in the Department of Analytical Chemistry, Leningrad University. They contained iron and copper in concentrations of between 1 and $3 \cdot 10^{-4}$% and manganese in concentrations of between 1 and $3 \cdot 10^{-6}$%. Four or five standards were ignited (each one three times).

Measurements were made with the MF-2 microphotometer: iron at a wavelength of 3025.84 A with the 100% light transmission step, copper at a wavelength of 3273.96 A with the 10% light transmission step, and manganese at a wavelength of 2801.06 A with the 100% light transmission step.

TABLE 1. Correlation between Serum Concentrations of Iron and Copper, Iron and Manganese, and Copper and Manganese (in μg/100 ml)

Elements compared	No. of tests	M	r	$\pm m_r$	P
Iron, copper	150	$\frac{142}{121}$	+0,071	0,08124	>0,2
Iron, manganese	150	$\frac{142}{0,99}$	+0,18	0,08031	<0,05
Copper, manganese	150	$\frac{121}{0,99}$	—0,18	0,08031	<0,05

TABLE 2. Mean Values of the Iron/Copper, Iron/Manganese, and Copper/Manganese Ratios in Donors' Sera

Ratio	No. of subjects tested		$M \pm m$
	women	men	
Iron/copper	92		1,16±0,055
		61	1,34±0,072
Iron/manganese	90		184,0±14,26
		60	185,0±15,22
Copper/magnesium	90		175,0±13,71
		60	163,0±18,50

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The concentrations of the trace elements in the ash were determined from a graph plotted between the following coordinates: horizontally—log C, vertically—S for iron and copper and ΔS for manganese. The value of ΔS for manganese was determined relative to the background. When the values of the concentrations of the trace elements were converted into concentrations in 100 ml of liquid serum, allowance was ±8.33% for manganese, ±7.97% for copper, and ±8.92% for iron.

The blood of 155 donors was investigated.

EXPERIMENTAL RESULTS

The mean content of iron in the serum of men (156 μg/100 ml) was higher than in the serum of women (130 μg/100 ml; $P < 0.01$).

The copper concentration was the same in the serum of men and women (120 μg/100 ml). Similar results were obtained by T. V. Zhernakova and Yu. V. Chichua, who investigated 87 donors (they found iron in concentrations of 129±31.95 μg/100 ml in the serum of women and 148±26.26 μg/100 ml in the serum of men). The serum copper concentration of the women was 117±29.9, and of the men 114±18.85 μg/100 ml.

The serum manganese concentration of the men was not significantly different from that of the women.

As Table 1 shows, a statistically significant correlation exists between the serum iron and manganese concentrations and also between the copper and manganese concentrations. The correlation between the iron and manganese concentrations is positive, and between the copper and manganese concentrations negative.

No statistically significant correlation could be found between the concentrations of iron and copper.

For differential diagnostic purposes it is sometimes important to know the ratios between the trace elements. The mean values of the iron/copper, iron/manganese, and copper/manganese ratios for the donors are given in Table 2.

The iron/copper ratio was found to be higher in men than in women ($P < 0.05$), while the iron/manganese and copper/manganese ratios were practically identical in both.

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