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INFLUENCE OF EMI EHF ON PLASMA SURFACE TENSION OF RAT BLOOD

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In present work the effect of electromagnetic irradiation with extremely high frequencies (EMI EHF) on plasma surface tension coefficient values of rat blood has been investigated. The irradiation was carried out by two modes: the plasma of rat blood as well as the rats were exposed to the influence of EMI EHF. The obtained results show that EMI EHF effects on studying parameter resulting in plasma surface tension coefficient value increases. At the irradiation of animals the cumulative effect was observed and at plasma irradiation of rat blood the longer is irradiation duration the stronger changes of surface tension coefficient value take place.

***Keywords*:** EMI EHF, rat blood plasma, plasma surface tension coefficient, irradiation.

Introduction. Among numerous external factors electromagnetic irradiation with different frequencies has a significant importance in the surrounding world, since it is a constant component of Earth natural background. Connected with intensive scientific-technical development the background of electromagnetic irradiations constantly rises due to the increasing of artificial irradiation sources [1, 2]. Electromagnetic irradiations with extremely high frequencies (EMI EHF) acquire a special significance, because temporary apparatus, including routine technic, irradiates in this diapason [3, 4]. It is known that EMI EHF with low intensity influences all living organisms, moreover, they effect on biological objects which is not conditioned by thermal effects [1, 4]. Living organisms being on any organization level are exposed to EMI EHF effect and this influence depends on irradiation frequency besides the response reaction of biosystem may be differently-directed [5, 6]. The effect of EMI on living organism is observed at both water resonant frequencies [6] and non-resonant frequencies, despite in the last case the effect is expressed weakly [7, 8]. To reveal the reasons of observed differences, the mechanism of low intensity EMI EHF effect on organism should be found out. From this point of view the studies of low intensity EMI EHF effect on surface tension of plasma of rat blood are important and actual.

Blood state, its physicochemical properties have colossal diagnostic importance. The important physicochemical properties of the blood are blood

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density, blood viscosity, blood reaction, its fluidity, i.e. the ability to reversible deformation under the influence of external forces [9]. Quantitative unit of blood fluidity and the main rheological criterion is its viscosity [10]. The viscosity of the total blood depends on plasma viscosity, hematocrit criterion, deformation ability and erythrocyte aggregation [11]. Blood physicochemical properties significantly depend on those of plasma. It was shown that blood plasma is information carrier about organism state as well. This information may be revealed not only by biochemical content determination, but also through the change of physicochemical characteristics of biological liquids. One of the methods of investigation of liquid physicochemical properties is the determination of surface tension coefficient. In normal conditions almost in all parts of circulatory system the laminar type of bloodstream is observed. Plasma surface tension of blood is the force that conditions adhesion of molecules of internal and external layers and is directed from surface to inner side. The aim of this work is the investigation of EMI EHF effect on plasma surface tension coefficient value change of irradiated blood of rats as well as rats of blood exposed to multiple irradiations.

Materials and Methods. The value of plasma surface tension coefficient was determined by the method of du Nui [12]. This method is based on force measurement necessary for liftoff of solid contour (ring) from liquid surface layer.

In experiments white laboratory, not pedigreed rats with 80–100 *g* weight were used. The blood was stabilized by Na-citrate solution and centrifuged during 15 *min* with 1500 *g* acceleration via electronic centrifuge. The irradiation was carried out *in vitro* (irradiating blood plasma of rats) and *in vivo* (irradiating the animals by 41.8 *GHz* and 42.2 *GHz* frequencies). The irradiation of rats *in vivo* by EMI EHF was carried out during 5 days, every day with 20 *min* duration. The irradiation of plasma *in vitr*o was carried out one-fold with 20, 40, 60, 80 and 100 *min* duration. The blood plasma of non-irradiated rats was used as a control one.

As a source of EMI EHF G4-141 generator was used with 37.5–53.5 *GHz* frequency diapason. The irradiation was carried out in distant working zone of radiation; the power flux density was 0.6 mW/cm^2.

Plasma surface tension coefficient was calculated throughout water surface tension coefficient. At the beginning the real liftoff force from water was determined: $P_{H_2O} = P - p$, where P_{H_2O} is ring liftoff force from water, *mg*; P is liftoff force obtained in experiment; p is ring mass with water. Water surface tension coefficient was calculated by

$$\sigma_{H_2O} = 0.981 P_{H_2O} / \pi D.$$

Plasma surface tension coefficient was calculated by

$$\sigma_p = \sigma_{H_2O} Q_r,$$

where σ_p is plasma surface tension coefficient, *din*/*cm*; Q_r is relative surface tension determined as:

$$Q_r = Q_1 K - K + 1,$$

where K is experimentally determined constant of ring, Q_1 ratio between liftoff forces from investigated liquid (P_x) and water (P_{H_2O}) respectively. All measurements were carried out at room temperature. Error in experiments does not exceed 5–10%.

Results and Discussion. The effect of EMI EHF on plasma surface tension coefficient value at the irradiation with 20, 40, 60, 80 and 100 *min* duration (irradiation *in vitro*) was studied. The values of σ_p irradiated by different frequencies are presented on Fig. 1. As it is obvious from Fig. 1, at plasma irradiation by 41.8 *GHz* and 42.2 *GHz* frequencies the values of σ_p increase compared with control. The value of the change depends on effect duration: with enhancement of effect duration the dependence on EMI frequency is revealed as well. The irradiation of plasma by 41.8 *GHz* frequency invokes bigger changes of σ_p value compared with control, than the irradiation by 42.2 *GHz* frequency. Thus, after irradiation of plasma by 41.8 *GHz* frequency the value of σ_p increases by 17.46; 18.12; 17.68; 18.98; 18.98% compared with control, after 20, 40 60, 80 and 100 *min* respectively. At irradiation by 42.2 *GHz* the irradiation value of plasma σ_p increases by 16.95; 17.20; 15.78; 16.95 and 16.95% after 20, 40 60, 80 and 100 *min* respectively. Increasing the irradiation duration the value of σ_p change increases, which may be conditioned by EMI effect on plasma proteins that are denaturized resulting in σ_p increase.

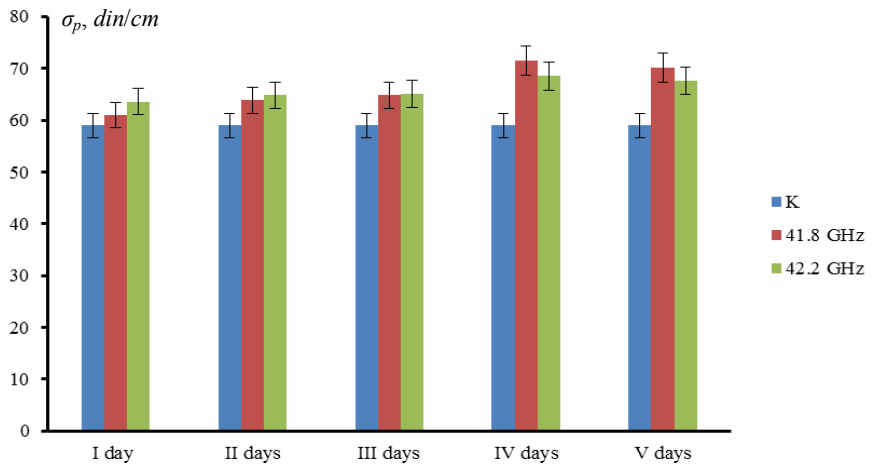

Fig. 1. Dependence of surface tension coefficient value of blood plasma of rats on irradiation duration as well as EMI frequency.

The dependence of plasma surface tension coefficient value of blood of rats irradiated by EMI (*in vivo* irradiation) with 41.8 *GHz* and 42.2 *GHz* frequencies is presented on Fig. 2. It is obvious from Fig. 2, that the irradiation of animals results is increasing of studying parameter compared with control. At the irradiation of rats by 41.8 *GHz* frequency on the first day the value of σ_p increases by 3.22; 8.13; 9.83; 21.19 and 18.81% compared with control for the first, second, third, fourth and fifth day, respectively. At the irradiation of rats by 42.2 *GHz* frequency in the first day the value of σ_p increases by 7.80; 9.83; 10.34; 16.10 and 14.58% compared to control on the first, second, third, fourth and fifth day, respectively.

As it is seen from presented data, the value of σ_p increases every day, which indicates about the cumulative character of EMI EHF effect on animal organism. Moreover, on the fifth day a decreasing of σ_p value is observed compared with the precursor day. This fact indicates that the chain of processes triggers in organism that are directed to external physical factor effect decreasing as well as outlet of stress invoked by this factor. At the irradiation of rats by 42.2 *GHz* frequency the increasing of σ_p value is observed as well. Analysis of obtained results makes possible to assume that the multiple effect of EMI with 41.8 *GHz* frequency induces more significant changes of studying parameter than EMI with 42.2 *GHz* frequency.

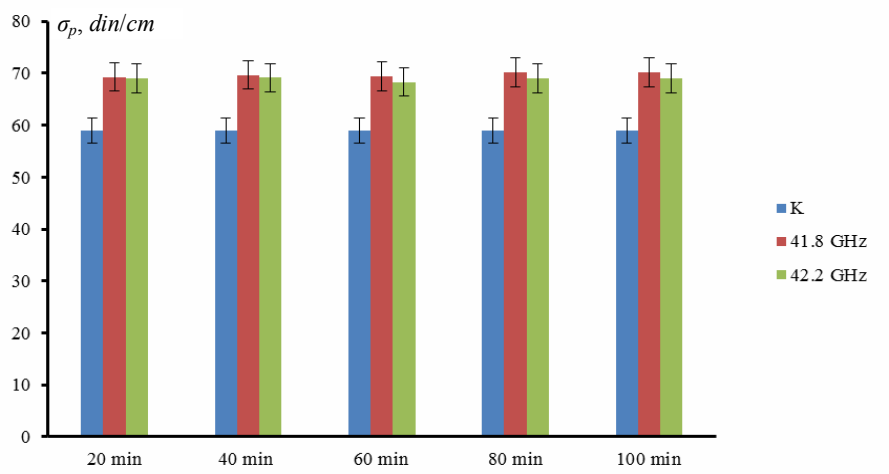

Fig. 2. Dynamics of surface tension coefficient value changes of blood plasma induced by irradiation of rats by 41.8 *GHz* and 42.2 *GHz* frequencies.

As it is obvious, EMI EHF influences on σ_p value of blood plasma of rats. Blood plasma irradiation of rats results in more significant increase of σ_p value compared with control, than the irradiation of rats. At plasma irradiation the energy of radiation transits immediately into biological liquid and at animal irradiation the energy penetrating through the layers of different tissues is absorbed partially. Energy absorption of permeating radiation as well as self-regulation mechanisms triggered in irradiated organism explain the fact that in experiments *in vitro* the degree of surface tension coefficient value change is bigger.

Therefore, it may be assumed from obtained data, that EMI EHF effects on plasma physical properties of rat blood and results in surface tension coefficient increase, the change of which may indicate about homeostasis disorder. In experiments in vivo EMI energy transmitting through tissues is partially absorbed, irradiation intensity decreases, moreover, even at lower intensities, the regularities of this effect on biological system are preserved. This fact indicates that biological system is extremely sensitive to EMI external effect. At the irradiation of animals

the cumulative effect is observed and at plasma irradiation of rat blood the longer is irradiation duration the stronger changes of σ_p take place that may be conditioned by denaturation of plasma proteins.

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