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EFFECT OF RESONANT ELECTROMAGNETIC IRRADIATION AND ASPIRIN ON SURFACE TENSION OF HUMAN BLOOD PLASMA *IN VITRO*

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In the present work the effect of resonant electromagnetic irradiation (EMI) and acetylsalicylic acid (ASA) on value change of the surface tension coefficient of human blood plasma has been studied. It was shown that both the plasma irradiation and the ASA insertion into plasma result in changing of the surface tension coefficient of human blood plasma, as well as affect the surface buffering. These changes are due to the fact that the mentioned factors invoke conformational alterations in the structures of plasma proteins, though we assume that ASA contributes in stabilization of structural changes of proteins.

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***Keywords*:** electromagnetic irradiation of extremely high frequencies, acetylsalicylic acid, human blood plasma, surface tension coefficient.

Introduction. Natural non-ionizing electromagnetic irradiation (EMI) and electromagnetic fields (EMF) are an essential component of the environment. Under their effect the evolution of all living organisms, including human beings, has been occurring [1]. Observations carried out to date show that biological effects of EMI depend on parameters of influencing fields. One of the most important parameters is the irradiation intensity. To estimate the intensity, either the density of the incident power flux or the intensity of the electric component of the EMF is used. The intensity value determines the nature of the biological effect, which can be thermal or non-thermal. The criterion for such division is the temperature of the biological object induced by EMR. If this temperature increases no more than 0.1 *K* under this effect, then the intensity level is considered as non-thermal and EMI, in this case, is called low-intensive. The next important EMI parameter is its frequency, since non-thermal bio-effects are of a resonant nature [2]. Electromagnetic EHF-oscillations are widely used in medical practice and have shown effectiveness in the treatment of a number of diseases, providing a normalizing (repairing) effect. In EHF-therapy the following wavelengths are permeable and frequently applicable: 4.9 *mm* (60.12 *GHz*), 5.6 *mm* (53.33 *GHz*) and 7.1 *mm* (42.19 *GHz*). Low-intensive millimeter irradiation refers to non-ionizing irradiations, i.e., it cannot have a breaking,

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damaging effect on the biological tissues of the organism. Millimeter waves are strongly absorbed in water and water media. This fact is significant for medical-biological applications, since at penetration into human skin almost by 0.3–0.5 *mm* in depth these waves quench by more, then million times. That is why the effect of EHF-irradiation is accepted to observe as specific bioinformation function of electromagnetic waves, bound to energy resonant absorption, triggering auto-oscillation processes and conformation transformation in biological structures [3, 4].

But nowadays the natural electromagnetic background is added by EMI and EMF, created by technogenic sources, that is multiply higher, than the natural one by its intensity. That is why the actuality of the studies of biological effects of non-ionizing EMI enhances.

At present it is known about multiple studies of EMI effect on both cells and organisms of animals and humans in general. Nevertheless, the mechanisms of development of biological effects of non-ionizing irradiation are not hitherto established [5].

Blood is a liquid connective tissue, the inner medium component of organism and the changes of blood properties can indicate the alterations in organism, induced by the effect of various physical and chemical factors. Blood includes shaped elements and intercellular compound – plasma. Ratio between plasma and shaped elements – hematocrit, is relatively constant. Human's plasma volume is almost 55–60%, cell volume – 40–45% of whole blood volume [6]. Human blood plasma contains more, than 1000 different protein species, though, for a few of them physiological functions are known. Their properties and structures are thoroughly heterogeneous, but their concentration in blood plasma significantly differs. The main proteins of blood plasma are albumins, different fractions of globulins, fibrinogen, lipoproteins, glycoproteins and metalloproteins [7]. Ability of solutions to regain the initial value of the surface tension is called the surface buffering. Proteins in blood plasma and serum, which adsorb surface-active compounds, play no-little role in constancy of attaining of the surface tension.

Thus, due to the presence of proteins and calcium ions, the blood plasma and serum preserve the relative constancy of the surface tension value, sharply changing only in the case of severe diseases (for example, at jaundice in consequence of addition of big amount of bile acids into blood circulation) [8]. Acetylsalicylic acid (ASA) is widely applied for treatment of inflammation processes, rheumatic diseases, pain syndrome and for prophylactics of thrombosis. Pharmacological effects of ASA depend on daily dose value. In small doses (from 50 to 325 *mg*) ASA possesses anti-aggregate action. In doses 1.5–2 *g* ASA has analgesic and fever-lowering action. In high doses (4–6 *g*) it possesses anti-inflammation effect [9].

In the present work we have studied the effect of resonant electromagnetic irradiation on value change of surface tension coefficient and on dependence of this value change on ASA effect time and EMI irradiation duration. Determination of surface tension of plasma, serum, urine and cerebrospinal fluid is applied as diagnostic test and has a relevant value for diagnosis of many diseases.

Materials and Methods. We have studied the EMI EHF effect on the value of surface tension coefficient of irradiated plasma of human blood and the ASA influence on non-irradiated and irradiated plasma. The value of the surface tension

coefficient was determined, using du Nuy method [10]. The method is based on the measurement of the force, necessary for tearing off a solid ring from the liquid surface layer.

In experiments human blood plasma was used from blood bank. It was studied the effect of EMI with 50.3 *GHz* on human blood plasma and the effect of ASA on non-irradiated (control) and irradiated human blood plasma. The surface tension was determined after irradiation and immediately after insertion of ASA dose into plasma after 0, 1, 5, 10, 15, 20, 25, 30, 35, 40 and 45 *min*.

Plasma irradiation by EMI EHF was carried out during 4 days with daily duration 60 *min*. As a source of EMI EHF G4-141 generator was used with frequency diapason 37.5–53.5 *GHz*. The irradiation was carried out in far working zone of the irradiation, with power flux density 0.6 mW/cm^2.

Plasma surface tension coefficient was calculated through the coefficient of water surface tension. First of all, the real strength of tear off from water was determined: $P_{\mathrm{H_2O}} = P - p$, where $P_{\mathrm{H_2O}}$ is a tear off strength of ring from water, *mg*; P is a tear off strength, received in experiment; p is a ring mass with water. The surface tension coefficient of water was calculated by the formula:

$$\sigma = \frac{0.981 \cdot P_{\mathrm{H_2O}}}{\pi \cdot D}, \tag{1}$$

where D is platinum ring diameter; σ is water surface tension coefficient.

To determine the surface tension coefficient of the studying liquid, the ratio of ring tear off strength from the given liquid to ring tear off strength from water at the mentioned temperature was calculated:

$$Q_{\mathrm{det}\,er.} = \frac{P_{pl}}{P_{\mathrm{H_2O}}}, \tag{2}$$

where $Q_{\mathrm{det}\,er.}$ is ratio of ring tear off strength from plasma (P_{pl}) to ring tear off strength from water ($P_{\mathrm{H_2O}}$). $Q_{\mathrm{det}\,er.}$ is connected to relative surface tension of the given liquid by the dependence, which can be expressed by the equation:

$$Q_{true} = (Q_{\mathrm{det}\,er.} \cdot K) - K + 1, \tag{3}$$

where Q_{true} is the relative surface tension of the given liquid. The ratio of the surface tension of the given liquid to the water surface tension is called a relative surface tension. $Q_{\mathrm{det}\,er.}$ is determined from equation (2); K is empiric constant, determined for each ring: the tear off strength of the given ring from water and from the other liquid is determined; by the way, the absolute surface tension of the other liquid should be found in tables. For this aim ethanol is often used (96%).

$$K = \frac{\sigma_{etanol}/\sigma_{\mathrm{H_2O}} - 1}{P_{etanol}/P_{\mathrm{H_2O}} - 1}, \tag{4}$$

where σ_{etanol} is the surface tension of ethanol, P_{etanol} is ring tear off strength from ethanol. The surface tension coefficient of plasma was calculated by the formula:

$$\sigma_{pl} = \sigma_{\mathrm{H_2O}} \cdot Q_{true}, \tag{5}$$

where σ_{pl} is the surface tension coefficient of plasma, *din*/*cm*. All measurements were carried out at room temperature. The experimental error does not exceed 5–10%.

Results and Discussion. Study of the effect of EMI EHF and ASA on the surface tension coefficient of plasma was carried out according to the following scheme: 1 – irradiation effect on plasma surface tension; 2 – ASA effect on this system. Plasma irradiation by EMI EHF was carried out during 4 days with daily duration 60 *min*.

ASA effect was studied during 45 *min* by the aforementioned scheme after single-time insertion of ASA, the plasma surface tension, irradiated by EMI with 50.3 *GHz*, was determined.

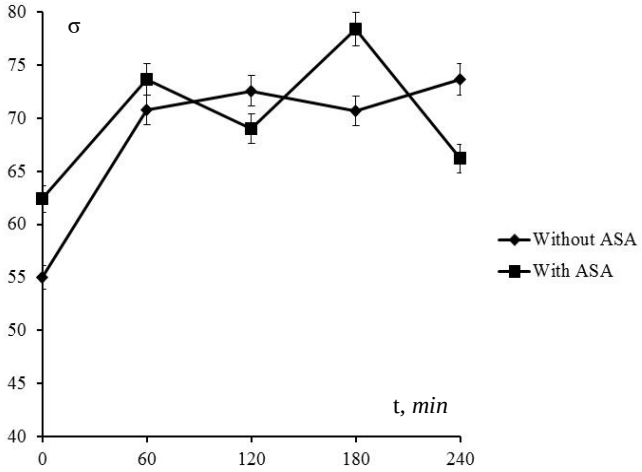

Fig. 1. Dynamics of the surface tension coefficient change of human blood plasma in absence and presence of ASA, depending on duration of EMI EHF exposure.

It was shown that after 60 *min* irradiation of plasma by 50.3 *GHz*, the value of σ_{pl} increases by 29%. After 120 *min* irradiation of plasma by 50.3 *GHz* the value of σ_{pl} increases by 32%, after 180 *min* – by 28.5% and after 240 *min* – by 34%.

Analyzing the results, we assume that the change of the surface tension coefficient depends on EMI EHF effect duration. As it is obvious, the surface tension of human blood plasma changes after irradiation by 50.3 *GHz*, which results from the alteration of hydration layer of proteins, particularly albumin [11].

At addition of ASA with concentration 2 *mg*/*mL* into blood plasma, the surface tension coefficient value changes.

As it is obvious from Fig. 1, the addition of ASA into non-irradiated plasma results to the following alteration of plasma surface tension, which increases by 13.4%. After plasma irradiation 60 *min* and ASA addition into plasma, the surface tension coefficient increases by 4%, after 120 *min* it decreases by 4.9%, after 180 *min* the mentioned value increases by 11% and after 240 *min* it decreases by 10.1%. From the aforementioned data one can assume that addition of ASA into non-irradiated and irradiated plasma results in changing of the surface tension. It should be mentioned that relevant changes are observed at ASA addition into irradiated plasma

during 180 *min* exposure. It means that together the physical and chemical factors result in changing of the surface tension buffering. At addition of ASA 2 *mg*/*mL* into non-irradiated plasma the value of the surface tension coefficient starts altering (Fig. 2).

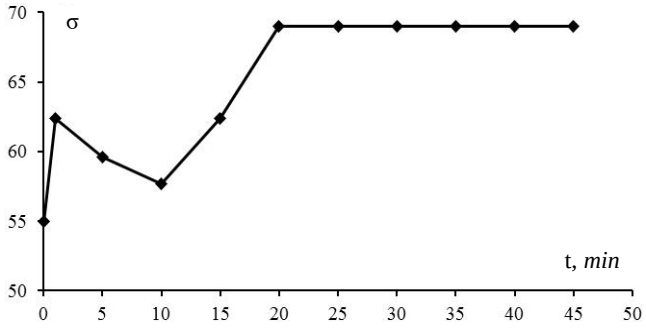

Fig. 2. Dynamics of the surface tension coefficient change of non-irradiated plasma of human blood under the action of ASA.

Through a minute after insertion of ASA the surface tension coefficient increases by 13.4%, and then we observe a change of this factor. Through 20 *min* after ASA insertion the plasma is higher, than that of the control by 25.4%, it comes out on the plateau and further does not increase up to 45 *min*.

From the obtained data we assume, that under the effect of ASA the surface buffering of human blood plasma changes.

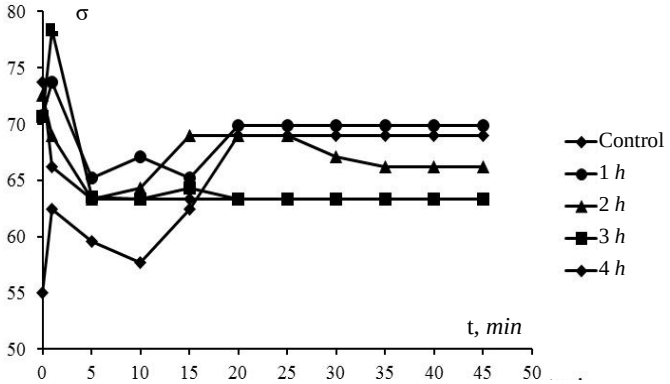

Fig. 3. Dynamics of the surface tension coefficient change of human blood plasma under the action EMI EHF with 50.3 *GHz* and ASA.

As it is obvious from Fig. 3, the value of this change depends on the EMI EHF effect duration and ASA influence.

It was shown that after 60 *min* of the EMI EHF irradiation with frequency 50.3 *GHz*, the value of σ_{pl} increases by 28.7%. Through a minute after ASA insertion the surface tension coefficient increases by 4%, and then we again observe a change of the surface tension coefficient. Through 20 *min* after insertion of ASA the surface tension coefficient of plasma is less, than that of the control by 5.1%, it comes out on the plateau and then does not change up to 45 *min*.

At the plasma irradiation during 240 *min* with 50.3 *GHz*, after insertion of ASA the value of σ_{pl} decreases by 14.1%, but after 5 *min* of ASA insertion the value of σ_{pl} comes out on the plateau and further does not change up to 45 *min*.

Conclusion. Analyzing the results, we conclude that both the plasma irradiation and the ASA insertion into plasma result in changing of the surface tension coefficient of human blood plasma, as well as they both affect the surface buffering. In all appearances, these changes are due to the fact that these factors invoke conformational alterations in the structures of plasma proteins, though we assume that ASA contributes in stabilization of structural changes of proteins.

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ՌԵԶՈՆԱՆՍԱՅԻՆ ԷԼԵԿՏՐԱՄԱԳՆԻՍԱԿԱՆ ՃԱՌԱԳԱՅԹՄԱՆ ԵՎ ԱՍՊԻՐԻՆԻ ԱԶԴԵՑՈՒԹՅՈՒՆԸ ՄԱՐԴՈՒ ԱՐՅԱՆ ՊԼԱԶՄԱՅԻ ՄԱԿԵՐԵՎՈՒԹԱՅԻՆ ԼԱՐՎԱԾՈՒԹՅԱՆ ՎՐԱ *IN VITRO* ՊԱՅՄԱՆՆԵՐՈՒՄ

Աշխատանքում հետազոտվել է ռեզոնանսային էլեկտրամագնիսական ճառագայթման (ԷՄՃ) և ացետիլսալիցիլինային թթվի (ԱՍԹ) ազդեցությունը մարդու արյան պլազմայի մակերևութային լարվածության գործակցի արժեքի վրա: Ցույց է տրվել, որ և պլազմայի ճառագայթումը, և ԱՍԹ-ի ներմուծումը պլազմա հանգեցնում են մարդու արյան պլազմայի մակերևութային լարվածության գործակցի փոփոխությանը, ինչպես նաև ազդում են մակերևութային բուֆերայնության վրա: Այս փոփոխությունները պայմանավորված են նրանով, որ նշված գործոնները պլազմայի սպիտակուցների կառուցվածքում հրահրում են կոնֆորմացիոն փոփոխություններ, և մենք ենթադրում ենք, որ ԱՍԹ-ն նպաստում է սպիտակուցների կառուցվածքային փոփոխությունների կայունացմանը:

М. С. МИКАЕЛЯН, М. А. ШАГИНЯН, С. В. ГРИГОРЯН, М. А. ПАРСАДАНЯН

ЭФФЕКТ РЕЗОНАНСНОГО ЭЛЕКТРОМАГНИТНОГО ИЗЛУЧЕНИЯ И АСПИРИНА НА ПОВЕРХНОСТНОЕ НАТЯЖЕНИЕ ПЛАЗМЫ КРОВИ ЧЕЛОВЕКА В УСЛОВИЯХ *IN VITRO*

В работе исследовано влияние резонансного электромагнитного излучения (ЭМИ) и ацетилсалициловой кислоты (АСК) на значение коэффициента поверхностного натяжения плазмы крови человека. Показано, что и облучение плазмы, и внедрение в плазму АСК приводят к изменению коэффициента поверхностного натяжения плазмы крови человека, а также воздействуют на поверхностную буферность. Эти изменения обусловлены тем, что вышеотмеченные факторы вызывают конформационные изменения в структуре белков плазмы, однако мы предполагаем, что АСК способствует стабилизации этих структурных изменений.