Influence of Electromagnetic Waves with Extremely High Frequencies on Some Criteria of Blood Plasma

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Abstract. The effect of electromagnetic waves of extremely high frequencies (EMW EHF) on the blood plasma surface tension coefficient and the albumin denaturation parameters was studied. It was shown that blood plasma irradiation, taken from rats, results in significant increasing of its surface tension coefficient value compared to that of non-irradiated samples. It was also shown that a reliable difference between irradiated samples by 41.8 GHz and 51.8 GHz frequencies was not noticed. Albumin solution denaturation parameters under to irradiation were studied. It was shown that protein denaturation curve shifting to high temperature region occurs which means that stabilization of protein structure takes place. It was shown that protein denaturation curve shifts to high temperature region, which means that stabilization of protein structure, takes place.

Keywords: high frequencies (EMW EHF) electromagnetic waves, blood plasma, irradiation

Introduction

Living organisms acquire different types of adaptation to numerous external factors of surrounding medium. Among them electromagnetic irradiation has a certain role first of all due to the Earth natural electromagnetic background. Nowadays in result of anthropogenic change of environment the intensity of electromagnetic waves with extremely high frequencies (EMW EHF) is raised [1,2]. This fact is valuable because the natural background of these waves is sufficiently low that is why the increasing intensity of them is one of important tasks to be paid attention and studied. A number of works proving that EMW EHF influences on living material being on any level of organization [3-5]. Different mechanisms of EMI EHF effect, the permeability of which is sufficiently low, are discussed and the mediation of EMI EHF effect on biological systems through water is considered to be the most accepted hypothesis [6-9]. In this case the irradiating frequency is important as well, because water resonant frequencies are in that region [7]. Besides in literature there exist some representations about EMW EHF effect on living material through immediate absorption of irradiation energy, there are non-resonant frequencies that are also worthy to study, because they cause a pronounced effect on living organisms as well [10,11].

One of number of questions relating to EMW EHF effect on biosystem is that on the blood. Blood state, its physicochemical properties have enormous diagnostic importance. Blood physicochemical properties mainly depend on those of plasma, which carry the information 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 methods to study liquid physicochemical properties is a 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. In other words, plasma surface tension is conditioned by intermolecular interactions between constituents of blood plasma. Discussing blood plasma content one can definitely mention about one of its valuable components is

albumin. Hence, a model experiment was carried out as well, which represents a thermal denaturation of albumin. Albumin is one of important macromolecules in blood of animals that is why the effect of this irradiation on its structure and behaviour alteration is worthy to investigate. The study of irradiation effect on one of numerous components of plasma does not indeed reveal what occurs in such complicated system, but in any case it has a model character and will somehow help us to figure out this effect results. In the present topic, the effect of EMW EHF on rat blood plasma surface tension coefficient as well as on albumin denaturation parameters was studied.

Materials and methods

The value of plasma surface tension coefficient was determined by the method of du Nui [12]. This method is based on strength measurement necessary for liftoff of solid contour (ring) from liquid surface layer. White outbred laboratory rats (Rattus norvegicus, "Vistar") were used in experiments. Animals were kept in single-type conditions and fed by combined food. Animals were decapitated and blood was gathered in glass where previously 1-2 ml 5% solution of Na⁺-citrate prepared by physiological solution was added. From each animal 3-3.5 ml blood was extracted. Animal blood was centrifuged during 10 min with 1500g acceleration (Electronic Centrifuge Capacity). Erythrocytes were separated from supernatant that was used as plasma.

Human serum albumin (Sigma, USA) and physiological solution were used in experiments. Protein melting was carried out on UV-VIS Unicam-SP-8-100 spectrophotometer (England). Preparations were heated in quartz cuvettes with hermetically closed Teflon caps, 1 cm optic pathway length, 3 ml volume. At melting, the heating was realized with 0.5° C/min rate via Temperature Programme Controller SPX 876 equipment. Plasma and albumin solutions were irradiated by 41.8 GHz and 51.8 GHz frequencies. As a source of EMW 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/cm².

Results and Discussion

The values of rat blood plasma surface tension coefficient (σ_p (dyn/cm)) when plasma radiation was carried out by two frequencies are presented in Fig. 1.



Fig. 1. Dependence of surface tension coefficient value of rat blood plasma on irradiation duration and frequency.

Blood plasma irradiation of rats results in significant increasing of σ_p value compared to that of the control. Although the reliable increase of value of σ_p is observed the differences between σ_p values of irradiated samples by 41.8 GHz and 51.8 GHz frequencies are not quite noticeable. In any case there takes place an expressed enhancement of plasma surface tension coefficient, which most probably indicate the homeostasis disorder. Such changes of σ_p conditioned by irradiation may be a consequence of structural changes in plasma components.

To reveal the molecular level peculiarities of the effect of EMW EHF on blood, the study of this factor influence on human blood albumin was carried out which made it possible to reveal some kind of changes in it at irradiation.



Fig. 2. Denaturation curves of non-irradiated (1) and irradiated by 51.8 GHz (2); 41.8 GHz (3) frequencies albumin in physiological solution.

Denaturation curves of albumin are presented in fig. 2. It is obvious from presented figure that irradiation results in shifting of denaturation curves to higher temperature region compared to non-irradiated sample. It is also seen that in the case of irradiation by 41.8 GHz frequency the shift to higher temperature region is more expressed compared to that of irradiated by 51.8 GHz samples. The values of denaturation parameters of albumin non-irradiated samples are presented on table 1. Presented results show that in the case of irradiated samples the denaturation temperature is raised, the values of denaturation interval width are raised as well. Moreover, there is a difference between irradiated samples. The results in Table 1 show that the melting parameters of irradiated by 41.8 GHz frequency samples are higher than that of irradiated by 51.8 GHz one. Based on the obtained data it may be concluded that at the irradiation, the changes of albumin structure take place, which results in increasing of folding of the albumin structure, due to which the stabilization of protein enhances and during denaturation the hyperchrome decreases.

	Denaturation temperature, T _m	Denaturation interval width, ΔT
	(⁰ C)	(⁰ C)
Non-irradiated albumin	80.7	7.9
Irradiated albumin by 41.8 GHz	83.4	9.66
Irradiated albumin by 51.8 GHz	81.8	7.94

 Table 1. Values of albumin denaturation parameters.

Taking into account that hyperchromic effect of macromolecules (nucleic acids and proteins) is conditioned by conformational transition, we suppose that under irradiation by 41.8 GHz protein is subjected to such conformational transformation which does not occur in the cases of non-irradiated sample and irradiated by 51.8 GHz samples. Most probably, EMI EHF energy by 41.8 GHz frequency is absorbed immediately by protein molecules, while at irradiation by 51.8 GHz frequency energy of these waves is absorbed being mediated through water. Structuration of water in the vicinity of albumin results in more screening of its molecule by hydration layer. In that case protein structure becomes stable to denaturing factor compared to non-irradiated sample.

Thus, it has been shown that albumin solution irradiation results in protein melting curve shifting to high temperature region, which means that stabilization of protein structure takes place. Albumin structure stabilization makes possible to conclude that the changes of total blood plasma are conditioned by structural alterations induced by EMI EHF effect on protein components.

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