Effect of millimeter range electromagnetic waves on some biophysical characteristics of human serum albumin

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1. Introduction

Nowadays the studies of the impact of millimeter electromagnetic waves (MM EMW) (30-300 GHz) on the biological systems is acquiring an increasing importance and interest, which is directly connected to the environment electromagnetic pollution, i.e. all our daily equipment and devices work in the radiofrequency diapason of EMW and correspondingly irradiate in the same diapason [1,2]. The other side of the intensive studies is conditioned by the fact that MM EMW affect the biological systems being on any level of organization [3,4]. It is worthwhile to mention that the waves show non-thermal effect, in other words they induce biological system response not by heating the system, which is the third no less important peculiarity of these waves. There exist several approaches for the MM EMW effect explanation, but there is no still a single-valued solution of the effect mechanism. Nevertheless, in the separate cases the effect mechanism can be explained either by water participation in response formation or by direct influence on the target.

2. Main body

In the present work the influence of MM EMW on human serum albumin spectral properties and buffer capacity has been studied. Albumin is an important constituent of the blood, which contributes to the transportation of different endogeneous and exogeneous compounds to the target organs and cells [5]. Albumin is consisted of three domains that form heart-wise form through 17 disulfide bonds that in turn stabilize the domains. This form of albumin is established at relatively neutral values of pH and is called N-isoform. Based on the crystallographic analysis albumin has been shown to be consisted of 585 amino-acidic residues and to comprise three homologous α-helices (I-III) and a single tryptophan residue (Trp-214) [6]. Dimensional form of albumin has a key role in transportation of different drug compounds, since it is responsible for the reverse binding with them. Based on the latter insistence it is interesting to reveal how MM EMW can affect the conformation and therefore the function of albumin. For this aim it is important to find out the effect of MM EMW on thermal stability of the protein as well as conformational changes of the latter. The solution of albumin was irradiated by MM EMW with 41.8 GHz and 51.8 GHz frequencies and then these solutions with the one non-irradiated sample were denatured using the spectrophotometer Unicam SP-8-100 (England). The denaturation was realized with 0.5^0C/min rate via Temperature Programme Controller SPX 876 equipment. At sufficient increasing of temperature a conformational transition of protein (denaturation) occurs and for denaturation curve construction denaturation degree (1-ϑ) is used which is determined by the following equation:

$$1-\vartheta=\frac{A_t-A_{nat.}}{A_{denat}-A_{nat.}}$$

where A_t is protein absorption at given temperature, $A_{nat.}$ – native protein absorption, $A_{denat.}$ – denatured protein absorption. The choice of frequencies is conditioned by the fact that 51.8 GHz is a frequency resonant for water dipole molecules; on the other hand there exist results in the literature indicating that the interval 41.8-42.2 GHz has a pronounced effect on biological objects [7,8]. It was shown from the denaturation curves that the irradiation results in stabilization of the protein, since the denaturation curves are shifted to the higher temperature region as compared to non-irradiated sample. Moreover, in the case of irradiation with 41.8 GHz frequency the shift to higher temperatures is more expressed than in the case of irradiation with 51.8 GHz frequency. On the other hand, the results show that in the case of the irradiation by 41.8 GHz the hyperchrome effect is almost twice less than that in the case of the irradiation by 51.8 GHz. Based on these data one can assume that the irradiation by 41.8 GHz leads to the higher stabilization which in turn may be connected to the direct impact of these waves on the protein as compared to the irradiation by 51.8 GHz, when the effect, probably, is mediated through the water. The other group of experiments is done measuring the own

fluorescence intensity change of albumin depending on MM EMW effect. It was shown that the irradiation of the albumin solution by 51.8 GHz and 41.8 GHz frequencies leads to the increasing of the fluorescence maximal intensity, moreover, in this case the irradiation by 41.8 GHz frequency and 30 min duration has higher effect than that by 51.8 GHz. On the other hand, when the irradiation duration is prolonged up to 60 min, the fluorescence intensity increases more in the case of irradiation by 51.8 GHz, than at 41.8 GHz frequency. Irradiation by 51.8 GHz frequency and with 60 min duration leads to the significant conformational changes compared to the case with 30 min duration, which is reflected by increasing of the fluorescence intensity. The other group of experiments is devoted to the studying of the buffer capacity change under the influence of MM EMW. It is well known that the albumin is not the main and important part of the plasma buffer capacity maintenance; nevertheless, it is endowed by some ability and participates in this process. In this series of experiments it was shown that the irradiation by MM EMW changes albumin buffer capacity, though the direction of changes directly depends on the frequency. Thus, at the MM EMW irradiation with 41.8 GHz frequency the albumin buffer capacity decreases, while at the irradiation with 51.8 GHz – it significantly increases.

Based on the above mentioned one can conclude that MM EMW significantly influence the properties of albumin changing its thermostability, conformation and buffer capacity.

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