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P h y s i c s

EFFECT OF ATHERMAL MILLIMETER ELECTROMAGNETIC RADIATION ON DNA STRUCTURE OF TUMOR TISSUE *IN VIVO*

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In vivo effect of non thermal millimeter electromagnetic waves (MEMWs) with 50.3 *GHz* (which coincides with resonant frequencies of oscillations of water molecular structures) and 48.3 *GHz* (which does not coincide with resonant frequencies) frequencies on DNA primary and secondary structures of liver of healthy rats as well as Sarcoma-45 tumor carrying rats has been studied. It was shown, that under the effect of MEMWs with 50.3 *GHz* during 60 *min*, the content of 5-methylcitosine, the melting parameters of DNA of Sarcoma-45 tumors changed and approached to respective values of DNA extracted from the liver of healthy animals.

***Keywords*:** DNA, millimeter electromagnetic waves, Sarcoma-45.

Introduction. Athermal millimeter electromagnetic waves (MEMWs) are widely used in biology, medicine, radio- and telecommunications. During the last years the MEMWs along with antitumor drugs started to be used in chemotherapy. It has been shown that MEM waves affect levels of organization particularly on molecular level [1–7]. Previous studies indicated that irradiation of DNA water solutions with resonant for water molecular structures 64.5 and 50.3 *GHz* frequencies led to variations in density of DNA solutions and parameters characterizing the secondary structure of DNA [1, 8]. Depending on the duration of exposure, the thermal stability of DNA has been increased, and its tendency was more pronounced for DNA extracted from the Sarcoma-45 tumor cells [8]. Previously, it was shown that the alterations in the methylation process have been manifested at the early stages of malignant cell transformation, and the presence of 5-methylcitosine (5-MC) might be considered as a diagnostic indicator of tumor formation [9]. We have recently demonstrated that the methylation of DNA of Sarcoma-37 cells is reduced under the influence of low intensity MEMWs with the frequency of 48.3 *GHz* [10].

In this study we attempted to clarify the effect of athermal nonionizing coherent electromagnetic radiation of millimeter range on secondary structure of DNA Sarcoma-45 tumor cells *in vivo*.

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Materials and Methods. DNA samples isolated from the liver of healthy white rats (hDNA) as well as from the tumor Sarcoma-45 (tDNA) cells were used in our experiments, according to the protocol described elsewhere [1, 8]. The melting of DNA was carried out in water solution containing 20 *mM* NaCl, 0.5 *mM* EDTA, pH 7.3. The spectrophotometric melting curves were obtained by continuous heating of DNA solutions at the rate $0.3^{\circ}C/min$ using Specord M-40 spectrophotometer. Irradiation of the rats was carried out in a conical-shaped antenna at a distance of 35 *cm* from radiating plane in the mode of continuous generation under conditions described in details elsewhere [1, 8]. The frequencies of 64.5, 50.3 and 48.3 GHz were chosen based on the fact that 64.5 GHz frequencies are considered to be resonant for water [11].

The content of 5*-MC and DNA melting parameters under the influence of MEMWs*

Study subjects	Source of DNA	5-MC, *mol %*	Melting interval $\Delta T,^{\circ}C$	Melting temperature $T_m,^{\circ}C$
healthy rats				
control	liver	1.14 ± 0.03	6.5 ± 0.1	71.9 ± 0.2
irradiated 50.3 GHz		1.11±0.03	6.4±0.1	71.8±0.2
irradiated 48.3 GHz		1.13±0.03	6.6±0.2	71.8±0.2
rats with Sarcoma-45				
control	tumor	1.86±0.03	7.40±0.20	70.80±0.20
irradiated 50.3 GHz		1.32±0.02	7.0±0.20	71.50±0.10
irradiated 48.3 GHz		1.72±0.02	7.3±0.1	71.2±0.2

Results and Discussion. The effect of MEMWs with frequency of 50.3 GHz *in vivo* on DNA secondary structure of Sarcoma-45 was investigated. The melting parameters, melting temperature (T_m) and interval (ΔT) as well as the content of 5-MC in the studied samples of DNA are presented in the Table. As it is shown, the effect of MEMWs for 60 *min* led to the changes in parameters characterizing the primary and secondary structures of DNA. Here we examined the effect of MEMWs on the structure of DNA *in vivo*, based on the nature of the changes in the parameters of melting and the content of 5-MC. As it is shown in the Table, the tDNA is characterized by high level of methylation $(1.86\ mol\%)$, which after 60 *min* of irradiation decreases to 1.32 *mol%* (for frequency 50.3 GHz), which is close to the corresponding value for hDNA $(1.14\ mol\%)$. The results obtained are correlated with the spectrophotometric date (Table). Under the influence of MEMWs the value of T_m and ΔT for tDNA are changed close to the corresponding values of hDNA. Thus, the correlation between the ability of MEMWs to modify the structure and content of 5-MC in tumor DNA *in vivo* and inhibition of tumor growth [9] allows to assume that nonionizing millimeter range electromagnetic radiation with a resonant frequency of 50.3 GHz might have an antitumor activity.

Conclusion. In this work is shown, that MEMWs have antitumor activity for DNA radiation with a resonant frequency of 50.3 GHz: volume of T_m and ΔT for

tDNA are changed close to the corresponding values of hDNA and and content of 5-MC in tumor DNA *in vivo* and inhibition of tumor growth.

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