EXTREMELY HIGH FREQUENCY ELECTROMAGNETIC IRRADIATION WITH LOW-INTENSITY ENHANCES ANTIBIOTICS ANTIBACTERIAL EFFECTS ON DIFFERENT BACTERIA

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Coherent electromagnetic irradiation (EMI) of extremely high frequency exists in nowadays environment. EMI of 30 GHz to 300 GHz is widely used in satellite telecommunication and low-orbital system of cosmic communication and can cause stimulating and depressive effects on organisms from all level of organization, including bacteria [1, 2]. Also, EMI is patent for bacterial cell-to-cell communications using water as a medium [1, 2]. Interestingly, EMI has applications in the environment controlling especially of water sources, agricultural wastewater [2]. Because of its disinfecting properties EMI is used in treatment of food at moderately low temperatures and in therapeutic practice [2].

Bacterial growth and survival in different environments have a great significance to understand changed bacterial sensitivity toward physical factors (EMI) or chemical agents (antibiotics). Over the years antibiotics have been widely used in antibacterial therapy, in food industry and also as growth promoters in agriculture and aquaculture, increasing the percentages of antibiotic resistant bacteria [2]. Bacteria become resistant to antibiotics using different mechanisms. EMI can affect the cellular defense system and makes it vulnerable to antibiotic attacks [2].

The bacterial effects of low intensity (flux capacity of 0.06 mW/cm^2) EMI at 51.8 GHz and 53 GHz EMI were demonstrated, particularly when different bacteria, namely *Escherichia coli*, *Enterococcus hirae* and *Lactobacillus acidophilus* were the objects of the study. 51.8 GHz and 53 GHz frequencies are the resonant frequencies for water – the main component of cell and cellular environment [1, 2]. The irradiation with 51.8 GHz and 53 GHz frequencies are suggested to alter the transparency and accessibility of the cell wall, making the cell more vulnerable to various affecting agents [2].

Thus, the point of the present study was investigation of growth, survival and development of antibiotic-vulnerability of these bacteria under extremely high frequency EMI in correlation with different antibiotics. The presented antibiotics with different action mechanisms are commonly used in the treatment of these bacteria. *E. coli* is a gram-negative bacteria; *E. hirae* and *L. acidophilus* are gram-positive ones. These are highly dispersed bacteria, different strains of which emerge almost everywhere; some of the strains are essentially antibiotic-resistant.

The prolongation of lag growth phase duration, the decrease of bacterial growth specific rate and number of colony forming units as well as the increase in bacterial sensitivity towards antibiotics and consequently possible increase in antibiotic-vulnerability after irradiation were demonstrated. The effects of tetracycline, chloramphenicol, kanamycin and cefriaxone antibiotics (4 μM, 0.4 μM, 15 μM and 4 μM, correspondingly) on *E. coli*, ampicillin and dalacin (1.4 μM and 0.1 μM, correspondingly) on *E. hirae*, ceftazidime (16μM) on *L. acidophilus* combined with EMI were shown. The antibiotic minimal inhibitory concentrations were chosen experimentally. Probably the cell membrane modifications and disruptions by EMI cause bacteria to become more sensitive to antibiotics. Enhanced bacterial sensitivity to antibiotics by EMI is similar to the effects of higher concentrations of antibiotics. Combined bactericide effects of EMF and antibiotics were more apparent in the case of 53 GHz.

The study can lead to the more clear understanding of the strict primary action mechanisms of EMI on cellular level. Moreover, the development of new universal antimicrobial therapy with more efficiency might have a further application in therapy and industry.

ЭЛЕКТРОМАГНИТНОЕ ИЗЛУЧЕНИЕМ КРАЙНЕ ВЫСОКИХ ЧАСТОТ МАЛОЙ ИНТЕНСИВНОСТИ УСИЛИВАЕТ АНТИБАКТЕРИАЛЬНЫЕ ЭФФЕКТЫ АНТИБИОТИКОВ НА РАЗНЫЕ БАКТЕРИИ

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В работе обобщены данные о воздействии когерентного электромагнитного излучения (ЭМИ) малой интенсивности с частотами в 51,8 ГГц и 53 ГГц и разных антибиотиков на *Escherichia coli*, *Enterococcus hirae* и *Lactobacillus acidophilus*, выращенных в анаэробных условиях. Результаты показали, что ЭМИ с указанными частотами достоверно усиливает действие антибиотиков в минимально действующих концентрациях на рост и выживаемость бактерий. Механизмы таких эффектов обсуждаются.

References

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