

## THE COMPARATIVE EFFECTS OF LOW INTENSITY ELECTROMAGNETIC IRRADIATION OF DIFFERENT EXTREMELY HIGH FREQUENCIES RANGES ON *ESCHERICHIA COLI* GROWTH: THE ROLE OF SURROUNDING LIQUID MEDIUM (WATER)

Trchounian A., Torgomyan H.<sup>1</sup>

<sup>1</sup>Department of Biophysics, Department of Microbiology and Microbes and Plants Biotechnology, Biology Faculty, Yerevan State University, 1 A. Manoukian Str., 0025 Yerevan, Armenia, **E-mail:** Trchounian@ysu.am

Nowadays electromagnetic irradiation (EMI) of extremely high frequencies (a range from 30 GHz to 300 GHz frequencies), or millimeter waves (length of a wave from 10 to 0.1 mm), with low-intensity (power flux density till 10 mW/cm<sup>2</sup>) is widely spread environmental factor [1, 2]. EMI at these frequencies of higher degree of coherence are utilized in satellite communication, radiometry, radar and remote sensing technologies so it exists in almost any environment. This EMI can cause biological response resulting with stimulating and depressive effects on organisms from all level of organization, including bacteria. The bacterial effects mainly depend on irradiation intensity and frequency, composition of growth and irradiation media, and have a resonance character [1-4]. Due to the feature to cause bactericidal effects, EMI is used in therapeutic practice as a mono-therapy or combined one with drugs (such as antibiotics). Moreover, this EMI has disinfecting applications at moderately low temperatures in treatment of agricultural wastewater and meat, rice, juices and other food products [4]. Besides, this EMI is used for long-range interactions between bacteria and different cells using water as a medium [1, 2].

Water is the major constituent of surrounding liquid medium and of biological systems as well. The low intensity extremely high frequencies EMI affects on water, which may be the first mechanism in creation of conditions for biological response [2]. EMI absorbs by water, and the effects on bacteria can be mediated by the changes of its clusters structures. These effects might be specific and long-term [2]. It was shown with bi-distilled water that coherent EMI of 51.8, 53, 70.6 and 73 GHz frequencies have different effects on the changes of water molecules properties (absorbance, conductivity and pH) and have bactericide effects as well [3, 4].

The aim of this study was to understand the role of bi-distilled water and surrounding liquid medium (assay buffer or growth (peptone) medium) in bactericidal effects of 51.8, 53, 70.6 and 73 GHz EMI (0.06 mW/cm<sup>2</sup> power flux density) on *E. coli*. Bacterial growth properties (lag-phase duration, log-phase specific growth rate) were determined to reveal EMI mediated and direct influence on cells. The *E. coli* growth properties changes by EMI with the most probability occur by water (liquid medium) mediation at the frequencies of 51.8 GHz and 53 GHz. The clear effects on bacterial growth with 51.8 GHz and 53 GHz also indicated that the growth depression was more strong with 53 GHz. Interestingly, for 51.8 GHz and 53 GHz the growth depression after suspension irradiation was less compared with the direct irradiation of bacteria on solid medium, especially with 53 GHz. These differences could be connected with the EMI energy partial absorbance by the surrounding medium, which depends on a specific frequency. The mediated effects by 70.6 GHz and 73 GHz irradiated water or assay buffer and growth medium on *E. coli* growth were insignificant. Moreover, there were no noticeable differences in the results of bacterial growth inhibition obtained from irradiation performed in water or on solid medium with 70.6 GHz and 73 GHz.

The results suggest that EMI at 51.8 GHz and 53 GHz, resonant frequencies for water, induces more strong effects on *E. coli* than those obtained with 70.6 GHz and 73 GHz frequencies (not resonant frequencies for water). The role of water in EMI mediated effects on bacteria is discussed.

## СРАВНИТЕЛЬНЫЕ ЭФФЕКТЫ ЭЛЕКТРОМАГНИТНОГО ИЗЛУЧЕНИЯ КРАЙНЕ ВЫСОКИХ ЧАСТОТ МАЛОЙ ИНТЕНСИВНОСТИ НА РОСТ *ESCHERICHIA COLI*: РОЛЬ ОКРУЖАЮЩЕЙ ЖИДКОЙ СРЕДЫ (ВОДЫ)

Торгомян Э.<sup>1</sup>, Трчунян А.

<sup>1</sup>Кафедра биофизики, Кафедра микробиологии и биотехнологии микробов и растений, факультет биологии, Ереванский государственный университет; Республика Армения, 0025 Ереван, ул. А. Манукяна 1; **E-mail:** Trchounian@ysu.am

В настоящей работе проводились исследования по изучению прямого и опосредованного воздействия когерентного электромагнитного излучения крайне высоких частот (ЭМИ КВЧ) при частотах 51,8; 53; 70,6 и 73 ГГц на *E. coli*, выращенных в анаэробных условиях.

Результаты показали, что резонансные частоты для воды - 51,8 ГГц и 53 ГГц вызывали наиболее выраженное бактерицидное воздействие на *E. coli*, чем нерезонансные частоты - 70,6 ГГц и 73 ГГц. Однако, эффекты ЭМИ КВЧ на бактерии требуют дальнейшего изучения.

### References

1. Banik S., Bandyopadhyay S., Ganguly S. // Bioresource Technology, 2003, v. 87, pp. 155–159.
2. Belyaev I. // Electromagnetic Biology and Medicine, 2005, v. 24, pp. 375-403.
3. Tadevosyan A., Trchounian A. // Biofizika, 2007, v. 52, pp. 893-898 (in Russian).
4. Torgomyan H., Kalantaryan V., Trchounian A. // Cell Biochemistry and Biophysics, 2011, v. 60, pp. 275-281.