

INFLUENCE OF AN ALTERNATING ELECTROMAGNETIC FIELD ON MARINE MICROBIOTA

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The effect of an electromagnetic field (EMF) on the infectious titer of Black Sea algal viruses and on the sensitivity to viral lysis of their hosts, microalgae cultures (*Tetraselmis viridis* and *Dunaliella viridis*), was studied. The experiments were carried out using a laboratory setup that makes it possible to study the effect of electromagnetic exposure in the frequency range of 25–150 Hz and generate an alternating magnetic field of 0.1–0.545 G for up to several days.

A change in the biological characteristics of the marine microbiota (viral infectious titer and sensitivity of microalgae to viral lysis) by 1-2 orders of magnitude was revealed.

Keywords; Electromagnetic field (EMF), infectious titer of Black Sea algal viruses, cultures of microalgae *Tetraselmis viridis* and *Dunaliella viridis* and their sensitivity to viral lysis

Introduction

The problem of the influence of electric, magnetic and electromagnetic fields (EF, MF and EMF) on the representatives of the Earth's biosphere is of particular relevance and interest for the researchers, which is reflected in scientific reviews [Shaev et al., 2022; Shashurin, 2015].

It is known that all life on our planet is constantly under the continuous influence of electromagnetic radiation of natural origin (Earth's magnetic field, the electrostatic field of the atmosphere, cosmic and solar radiation). However, the production and consumption of electricity, which has increased over the past 100 years by more than 1500 times, has led to the emergence of artificial EF, MF and EMF, as well as radiation of various frequencies and powers, which have other than natural intensities. It is logical that artificial fields can change various characteristics of living organisms adapted in the course of evolution only to natural radiation, which is confirmed by many experimental studies, incl. and by our studies. Thus, our first experiments recorded the effect of permanent MF on the change in the infectious titer of Black Sea algal viruses and the sensitivity of microalgae cultures to viral lysis [Stepanova et al., 2021; 2022].

The **purpose** of our further experiments was to establish the fact of the effect of EMF on representatives of the marine microbiota (algal viruses and their hosts - marine algae) using a laboratory setup created by our scientific group.

Materials and methods

The laboratory setup was developed on the basis of the Laboratory of Hydrophysical and Bioelectronic Measuring Systems and Technologies of the Center for Environmental Instrumentation and Eco-Energy of the Institute of Natural and Technical Systems. The installation (laboratory setup) is described in detail, incl. in terms of creating an EMF with characteristics set at the discretion of the experimenters, as well as the methodology for conducting experiments, in the article [Pen'kov et al., 2022]. Basically, the experiments were carried out both with a minimum frequency of 25 Hz and a signal level of 24 mV ($B = 0.1$ G), and with a maximum frequency of 150 Hz and a signal level of 100 mV ($B = 0.11$ G); in isolated cases, the field level reached 0.545G.

Microalgae cultures *Tetraselmis viridis* and *Dunaliella viridis*, as well as strains of algal viruses to these microalgae, TvVSI-1 and DvVS20-1, were used as the biological material under study - marine microbiota. Information about the properties of these algal viruses and their hosts is presented in [Stepanova, 2016]. Changes in the infectious titer of the algal viruses used in the experiments, as well as changes in the sensitivity of microalgae cultures, were determined according to the method (scheme) described by us earlier [Stepanova et al., 2021; Stepanova et al., 2022]. The method used is based on the author's patented method [Stepanova, 2004].

Results and its discussion

The results obtained in the course of experiments on studying the effect of EMF on the infectious titer of algal viruses and the sensitivity of their hosts - microalgae cultures to viral lysis, showed a decrease in the infectious titer in the studied strains of algal viruses to 1-2 orders of magnitude, and an increase to 1-2 orders of resistance of microalgae cultures to viral lysis.

For example, in the viral strain of microalgae *Dunaliella viridis* (DvVS20-1), when exposed to EMF with a frequency of 25 Hz and a signal level of 24 mV ($B = 0.1$ G), after 24 h were recorded no changes of the viral infectious titer, if were using a viral suspension with an initial infectious titer 10^9 IE/ml and 10^7 IE/ml.

However, at an initial titer of 10^5 IE/ml after 24 hours, a decrease by 1 order was noted, and after 4 days by 2 orders of magnitude compared with the initial infectious titer of this strain of the algal virus of the *Dunaliella viridis* microalgae. The use of EMF in experiments with other characteristics – a frequency of 150 Hz and a signal level of 100 mV ($B = 0.11$ G) made it possible to record a decrease in the infectious titer by 2 orders of magnitude in the DvVS20-1 strain on day 5 with an initial titer of 10^5 IE/ml.

For the TvVSI-1 strain, after exposure to EMF with a frequency of 150 Hz and a signal level of 100 mV ($B = 0.11$ G), a decrease in infectious titer by 2 orders of magnitude after 72 hours was recorded at an initial titer of 10^4 IE/ml.

After exposure to EMF with different characteristics of frequency and voltage on cultures of microalgae used in experiments, a decrease in their sensitivity to viral lysis by 1-2 orders of magnitude was recorded.

The results obtained indicate the effect of EMF on the marine microbiota, which is accompanied by a decrease in the infectious titer for algal viruses and a decrease in the sensitivity (sensitivity) of microalgae to viral lysis. However, for a more thorough assessment, it will need for further systematic studies, incl. studying the sensitivity seasonally relating of marine microbiota to the acting of EMF.

Conclusion

The influence of EMF (decrease in the infectious titer of algal viruses and the sensitivity of microalgae to viral lysis by 1-2 orders of magnitude) was established in the given by investigators characteristics with a frequency of 25–150 Hz and a signal level of 24 mV ($B = 0.1$ G) - 100 mV ($B = 0.11$ G) on the marine microbiota.

Based on the results obtained, it was found that the values of the changes in marine microbiota depended mainly on the duration of the electromagnetic load (from a day or more) and its physical characteristics (frequency and signal level) generated by the EMF laboratory installation (setup), as well as on the value of the initial infectious titer of algal viruses and species accessories of microalgae cultures used in experiments.

Research in this direction will be continued.

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