Armenia

Report on EMF Activities

10th International Advisory Committee on EMF

June 2005

Period of activity: 2004 - 2005

Institution: UNESCO Chair- Life Sciences International Postgraduate Educational Center

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Activities

1. Education/Training/Research

- Title and expected results for each course, workshop,

1. MS and Ph.D. courses in biophysics (neuroscience, biochemistry, biotechnology, pain study and management and biomedical engineering) and computer science conducted according to the specialization program credits

2. methodological trainings, seminars to teach students the methods necessary for their research studies

3. training on English

- Target groups

Postgraduate students	*(19 Ph.D. students (molecular biophysics – 2, neuroscience - 5, biotechnology - 5, pain study and management – 2, biomedical engineering- 5)*
Academics	*(biophysicist, neuroscientists, biotechnologists, biochemists, bioengineers, computer scientists)*

- Partnership

1. Institute of Radiophysics and Electronics of Armenian NAS, Yerevan State University, Armenian Agricultural Academy, Orbeli Institute of Physiology of Armenian NAS; Yerevan Sate Medical University; Acoustic Center of Armenian Ministry of Health, Yerevan, RA; Center of Radiation Medicine and Burns of Armenian Ministry of Health.

2. European Office of Aerospace Research and Development (EOARD); International Science and Technology Center (ISTC); US Civilian Research and Development Foundation (CRDF), World Health Organization (WHO), International Union for Pure and Applied Biophysics (IUPAB), Bioelectromagnetics Society (BEMS), UN Food and Agriculture Organization (FAO), North Atlantic Treaty Organization (NATO).

2. The following 2 books and 15 research articles has been published:

Title of activity: Book

1. Title: Proceeding of FAO/UNESCO Subregional Workshop "Agricultural Biotechnology and Biosafety for Food Security and Rural Development in the Caucasus Region and Moldova"
Author(s): Karin Nichterlein (FAO), Sinerik Ayrapetyan (Armenia)
Publisher(s): *Noyan Tapan Press;*
Year: *2004*
Number of pages: **175**
Type of document/material: **Book**
Language(s) *English*

FOREWORD:

The publication represents the proceedings of the Workshop on Agricultural Biotechnology and Biosafety for Food Security and Rural Development in the Caucasus Region and Moldova organized in Yerevan, Armenia, from 3 to 6 November 2003. It also includes the report on the needs assessment for agricultural biotechnology and biosafety in selected countries of the Balkans, the Caucasus and Moldova presented to the workshop commissioned by FAO's Research and Technology Development Service (SDRR) and the Regional Office for Europe (REU).
These activities were part of FAO's programme in the 2002-2003 biennium, on partnerships for improving the application of biotechnology in agriculture with the objective to assist countries in ensuring regionally harmonized biosafety regulations for genetically modified organisms, and provide them with a knowledge-base for decision-making.
It is hoped that the lively interaction during the workshop among participants from the subregion or outside of the region as invited speakers will lead to further activities towards improved regional collaboration in agricultural biotechnology and harmonization of the related regulatory frameworks.
The excellent organizational support from the UNESCO Chair in Life Sciences, Life Sciences International Educational Center, Yerevan is greatly acknowledged.

Jutta Krause
Regional Representative for Europe
Regional Office for Europe
Food and Agriculture Organization of the United Nations

2. Title: Proceeding of UNESCO/WHO/IUPAB Seminar "Molecular and Cellular Mechanisms of Biological Effects of EMF" and NATO Advanced Research Workshop on "The Mechanisms of the Biological Effect of Extra High Power Pulses"
Author(s): Sinerik Ayrapetyan
Publisher(s): *Noyan Tapan Press*
Year: *2005*
Number of pages: **110**
Type of document/material: **Book**
Language(s) *English*
Main keywords (4 or 5): EMF; Extra High Power Pulses; Biological Effect

Title of activity: Research article

1. Title: 4Hz EMF–treated physiological solution depressES Ach-induced neuromembrane current
Author(s): Sinerik Ayrapetyan, Arsen Hunanyan, Sergey Hakobyan
Publisher(s): *Bioelectromagentics Journal*
Year: *2004*
Number of pages: *4*
Type of document/material: **Article**
Language(s) *English*
Main keywords (4 or 5): magnetic fields; physiological solution; Ach sensitivity; snail neuron

ABSTRACT: The effect of 4Hz EMF-treated physiological solution (PS) on Ach sensitivity of the snail neuron was studied. The 4 Hz EMF-treated normal PS at room temperature (23^0C) has a depressing effect on Ach-induced current, while in cold medium (12^0C) this effect disappeared. EMF-treated ouabain-containing and K-free PS elevates the Ach-induced current at room temperature. It is suggested that the metabotropic effect of EMF-treated PS is due to the activation of cGMP-dependant Na:Ca exchange, leading to the decrease of the number of functional active receptors in the membrane (through Na-K pump-induced cell shrinkage) and to increase of the receptors affinity to Ach as the result of decrease of intracellular Ca concentration.

2. Title**: On the Modulation Effect of Pulsing and Static Magnetic Fields and Mechanical Vibrations on Barley Seed Hydration**
Author(s): Amyan A.M., Ayrapetyan S.N,.
Publisher(s): Physiological Chemistry & Physics and Medical NMR
Year: *2004*
Number of pages: *15*
Type of document/material: **research article**
Language(s) English
Main keywords (4 or 5): water binding, seed swelling, root formation, germination

The changes of wet and dry weights of barley seed in different periods of its swelling in non-treated (control), Extremely Low Frequency Electromagnetic Fields- (ELF EMF), Static Magnetic Fields- (SMF) and Mechanical Vibrations- (MV)-treated cold (4^0C) and warm (20 ^{0}C) distilled water (DW) were studied. The metabolic dependent seed hydration, dry weight dissolving and water binding in seed were modulated by preliminary EMF, SMF and MV-induced treatment of DW. The specific electrical conductivity (SEC) of control and treated DW was measured before the seed incubation. Frequency and intensity “windows” (i.e. range of frequency or intensity) for the effect of EMF, MV and SMF (correspondingly) on seed hydration, solubility and water binding in seed were discovered. These “windows” were different in various phases of seed swelling. It is suggested that water structure modification in the result of valence angle changes (SMF and EMF) and dipole molecules vibration (EMF and MV) has different effects on the process of seed hydration, solubility and water binding in seed. These results are important from the point of understanding the mechanisms of the biological effect of EMF, as well as from the point of agriculture.

3. Title**: The biological effect of extremely low frequency electromagnetic fields and vibrations on barley seed hydration and germination**
Author(s): Amyan A.M., Ayrapetyan S.N.
Publisher(s): TheScientificWorldJOURNAL
Year: *2004*
Number of pages: *14*
Type of document/material: **research article**
Language(s) *English*
Main keywords (4 or 5): water binding, seed swelling, root formation, germination

The changes of wet and dry weights and germination of barley seed in different periods of its swelling in non-treated (control), Extremely Low Frequency Electromagnetic Fields (ELF EMF) and Extremely Low Frequency Vibrations (ELFV)-treated cold ($4\ ^0$C) and warm (20 ^{0}C) distilled water (DW) were studied. The metabolic-dependent seed hydration, dry weight dissolving, germination and water binding in seed were modulated by preliminary EMF and ELFV-treated DW. Frequency “windows” for the effect of EMF and ELFV on seed hydration, solubility, water binding in seed and germination were discovered. These “windows” were different for EMF and ELFV as well as in various phases of seed swelling. It is suggested that EMF-induced water structure modification has different biological effect on the process of seed hydration, solubility, water binding in seed and germination, comparing to ELFV.

4. Title: THE METABOLIC PATHWAY OF MAGNETIC FIELD -INDUCED RELAXING EFFECT ON HEART MUSCLE
Author(s): Gayane Ayrapetyan, Alexander Papanyan, Hovik Hayrapetyan, Sinerik Ayrapetyan
Publisher(s): *Bioelectromagentics Journal (in press)*
Year: *2005*

Number of pages: *4*
Type of document/material: **Article**
Language(s) *English*
Main keywords (4 or 5): water electrical conductivity; membrane Ach; Na-K pump; cGMP

Abstract
The effect of magnetized physiological solution (MPS) on snail heart muscle contractility, ^{45}Ca uptake and intracellular level of cAMP and cGMP was studied. The existence of relaxing effect of MPS on heart muscle at room temperature (22^0C) and its absence in cold medium (less than 10^0C) was shown. The MPS had depressing effect on ^{45}Ca uptake by muscles and intracellular cAMP content, and elevating effect on intracellular cGMP level. It is suggested that the magnetic field-induced relaxing effect on heart muscle is due to activation of cGMP-dependent Ca efflux.

5. Title: Cell Bathing Solution as a Primary Target for EMF
Author(s): Ayrapetyan S. N.
Publisher(s): Noyan Tapan Press; Proceeding of UNESCO/WHO/IUPAB Seminar "Molecular and Cellular Mechanisms of Biological Effects of EMF" and NATO Advanced Research Workshop on "The Mechanisms of the Biological Effect of Extra High Power Pulses"
Year: 2005
Number of pages: 2
Type of document/material: **Article**
Language(s) English
Main keywords (4 or 5): cell functional activity, specific biological effect, EMF, cell bathing solution

Abstract
At present the biological effect of SMF and LF EMF can be considered as a proven fact, however the question how such a low-energy of EMF radiation could modulate the functional activity of cell and organisms is staying unanswered. A numerous hypotheses on molecular mechanisms of the specific biological effect of EMF have been proposed, but none have provided a reliable and exhaustive explanation of the experimental findings. The oldest hypothesis is that EMF-induced structural changes of cell bathing solution could serve as a primary target for the biological effect of EMF. This hypothesis serves as a subject of investigation for our laboratory during two decades and the present review is devoted to the summary of these results.
The effect EMF on physicochemical properties of water and EMF-pretreated solutions on growth and development of microbes, plant seed germination potential, heart muscle contractility, neuro-membrane chemo-sensitivity and excitability, Na-K pump and Na:Ca exchange activity, cell hydration and proliferation, membrane lipid compositions and behavioral activity of rats was studied. On the basis of the obtained data we came to the following conclusions:
SMF and LF EMF have intensity and expose time dependent depressing effect on specific electrical conductivity (SEC) of distilled water and water solution. The EMF-induced water structure changes were more pronounced at 4Hz. The SMF and 4 Hz EMF-pretreated physiological solution had statistically significant modulating effect on growth and development of microbes, plant seed germination potential, heart muscle contractility, neuro-membrane chemo-sensitivity and excitability, Na-K pump and Na:Ca exchange activity, cell hydration and proliferation, membrane lipids compositions and behavioral activity of rats.

6. Title: The effect of ELF EMF-pretreated distillated water on barley seed hydration and germination potential
Author(s): Amyan A. M.
Publisher(s): Noyan Tapan Press; Proceeding of UNESCO/WHO/IUPAB Seminar "Molecular and Cellular Mechanisms of Biological Effects of EMF" and NATO Advanced Research Workshop on "The Mechanisms of the Biological Effect of Extra High Power Pulses"
Year: 2005
Number of pages: 2
Type of document/material: **Article**
Language(s) English
Main keywords (4 or 5): Extremely Low Frequency EMF, distilled water structure, Specific Electrical Conductivity, valence angle changes

Abstract
It is suggested that Extremely Low Frequency (ELF) EMF-induced changes of distilled water structure could be the result of valence angle changes between protons in water molecules and mechanical vibration of water dipole molecules. Therefore, it could be predicted that the first pathway of water structure changes could be imitated by exposure to SMF of distilled water (Klassen 1982), while the second one - by mechanical vibration (MV) of distilled water. Previously it was shown that ELF EMF, SMF and ELF MV have depressing effects on Specific Electrical Conductivity (SEC) of distilled water. However the question on the specificity of the biological effect of these factors still remains unclear.
The obtained data have shown that ELF EMF and MV have frequency dependant effect on DW, which has different biological effect on seed germination potential. These data shows that the valence angle changes (EMF) and dipole molecules vibration (EMF and MV) have different biological effect on seed germination potential.

7. Title: Cell bathing aqua solution as a target for non-thermal effect of Extremely High Power Pulses
Author(s): Ayrapetyan S. N.
Publisher(s): Noyan Tapan Press; Proceeding of UNESCO/WHO/IUPAB Seminar "Molecular and Cellular Mechanisms of Biological Effects of EMF" and NATO Advanced Research Workshop on "The Mechanisms of the Biological Effect of Extra High Power Pulses"
Year: 2005
Number of pages: 2
Type of document/material: **Article**
Language(s) English
Main keywords (4 or 5): specific (non-thermal) biological effects of MW, Extremely High Power Pulses, water structure changes, Specific Electrical Conductivity

Abstract
While the biological effects of low frequency (LF) EMF can be considered as a proven fact, the existence of specific (non-thermal) biological effects of MW still remains discussable. It is known that energy absorption is decreased when frequency is increased, so that at very high frequencies over 10 GHz RF absorption becomes superficial. However, it has modulating effect on the functional activity of different organs. The fact that Extremely High Power Pulses (EHPP) can certainly produce a thermal effect makes it technically difficult to discriminate its possible specific effect in experiments.
The working hypothesis for our work was to consider the cell bathing solution as a target through which the possible non-thermal biological effect of EHPP could be realized. The theoretical basis for such suggestion is that the water molecules are polar and they vibrate when subjected to microwave, causing considerable friction between molecules leading to the possible water structure changes causing the adequate biological effect.
To check this hypothesis the effect of EHPP on Specific Electrical Conductivity (SEC), thermal capacity and thermal anomaly properties of water and water solutions, as well as EHPP-pre-treated water effect on yeast growth, plant seed germination potential, snail heart contractility and neuronal activity were studied.
On the basis of the obtained data it is suggested that EHPP-induced water structural changes in result of its molecule vibration can serve as one of the main pathway through which the specific (non-thermal) biological effect of EHPP is realized.

8. Title: The Non-thermal effect of Extremely High Power Pulses on Specific Electrical Conductivity and thermal capacity of distilled water
Author(s): Tsaturyan A. A, Amyan A.M., Simonyan R.H., Avanesyan A.S., Ayrapetyan S.N.
Publisher(s): Noyan Tapan Press; Proceeding of UNESCO/WHO/IUPAB Seminar "Molecular and Cellular Mechanisms of Biological Effects of EMF" and NATO Advanced Research Workshop on "The Mechanisms of the Biological Effect of Extra High Power Pulses",
Year: 2005
Number of pages: 2
Type of document/material: **Article**
Language(s) English
Main keywords (4 or 5): Specific Electrical Conductivity, Extremely High Power Pulses, water structure, thermal capacity

At present the existence of non-thermal effect of Extremely High Power Pulses (EHPP) remains

discussable. As water is the main medium, where the measure part of biochemical reactions of different metabolic cascades of cell and organism take place, it allows us suggesting that EHPP-induced water structure changes could serve as one of the targets through which the non-thermal biological effect of EHPP is realized. However, the effect of EHPP on water structure remains unclear, although it is well known that because water molecules are polar, i.e. they have positively and negatively charged ends; they vibrate when subjected to microwave energy, causing considerable friction between molecules. Therefore, the comparative study of the Specific Electrical Conductivity (SEC) and thermal capacity of EHPP pre-treated and adequately pre-heated distilled water, could allow us to conclude on the existence of the specific (non-thermal) effect of EHPP on water.
Presented date clearly demonstrate that the "trace" effect of EHPP exposure on water properties (SEC and thermal capacity), which can be recorded as the SEC changes after freezing in liquid N2 and melting at room temperature significantly varies from the adequately heated DW. Thus, it is suggested that the mentioned "trace" effect of EHPP could underlay on the ground of the generation of non-thermal biological effect of EHPP.

9. Title: High-precision device for the measurement of the Specific Absorption Rate of Extremely High Power Pulses
Author(s): Simonyan R. H., Ghulyan A. G., Ayrapetyan S. N
Publisher(s): Noyan Tapan Press; Proceeding of UNESCO/WHO/IUPAB Seminar "Molecular and Cellular Mechanisms of Biological Effects of EMF" and NATO Advanced Research Workshop on "The Mechanisms of the Biological Effect of Extra High Power Pulses"
Year: 2005
Number of pages: 2
Type of document/material: **Article**
Language(s) English
Main keywords (4 or 5): high-precision device, Specific Absorption Rate, Extremely High Power Pulses, power measurement

Abstract
The aim of the present work was the elaboration of the high-precision device for measuring the Specific Absorption Rate (SAR) of Extremely High Power Pulses (EHPP).
The main working principle of the device is based on the leveling of the EHPP-induced temperature increase of the studying object (biological object, liquid) and the temperature increase by alternating low frequency supercurrent on the comparison object, having the same thermo-physical parameters and mass.
The high precision tracking of the temperature of the comparison object to the temperature of working object was provided by the controlling thermostat. Simultaneously, the power of the alternating low frequency supercurrent, necessary for heating the comparison object for receiving the equilibration with the temperature of the working object, was also measured. After it the ratio between measuring power to the mass of the bio-object was determined.
The main privilege of the elaborated device is the big range of power measurement (1 mW – 500 kW), wide frequency band (from ELF EMF to visible light), high precision (the error is determined by the differenced between the mass of the working and comparison objects and is about 1-2 %).
The device was developed on the basis of the early patents: N 1557458 (USSR) "The device for temperature measurement" and N 1501006 (USSR) "The device for temperature regulation and measurement".

10. Title: Non-thermal effect of extremely high power pulses yeast growth
Author(s): Baghdasaryan N. S., Ayrapetyan S. N.
Publisher(s): Noyan Tapan Press; Proceeding of UNESCO/WHO/IUPAB Seminar "Molecular and Cellular Mechanisms of Biological Effects of EMF" and NATO Advanced Research Workshop on "The Mechanisms of the Biological Effect of Extra High Power Pulses"
Year: 2005
Number of pages: 2
Type of document/material: **Article**
Language(s) English
Main keywords (4 or 5): Extremely High Power Pulses, wort, growth and development of yeasts, physico-chemical properties of wort

Abstract
The existence of possible non-thermal biological effect of Extremely High Power Pulses (EHPP) still remains discussable. Recent studies at our laboratory were shown that EHPP-induced heat treatment of water and water solution caused different effect on their physico-chemical properties than similar heat-treatment one. Such differences were demonstrated by studding their biological effect on plant seeds germination potential and neuronal cell volume. However, EHPP-induced non-thermal effect on other biological objects could be the subject for future investigations.
The objective of the present work was to study the effect of adequate heat and EHPP-induced wort treatment on growth and development of yeasts.
The obtained data could be considered as strong evidence on the existence of specific (non-thermal) effect of EHPP on wort medium, which has activation effect on yeast growth. However, which physico-chemical properties of wort are changed upon the EHPP exposure leading to the generation of non-thermal stimulation of yeast growth is the subject for future investigation.

11. Title: On the depressing effect of EHPP-pretreated physiological solution on ach –sensitivity of snail neurons.
Author(s): Hunanyan A.Sh., Ayrapetyan S. N
Publisher(s): Noyan Tapan Press; Proceeding of UNESCO/WHO/IUPAB Seminar “Molecular and Cellular Mechanisms of Biological Effects of EMF” and NATO Advanced Research Workshop on “The Mechanisms of the Biological Effect of Extra High Power Pulses”
Year: 2005
Number of pages: 2
Type of document/material: **Article**
Language(s) English
Main keywords (4 or 5): Extremely High Power Pulses, physiological solution, voltage clump experiment, Ach-induced current

Abstract

At present the existence of specific (non-thermal) biological effects of RF-EMF still remains discussable. However, by resent study at our laboratory it was shown that at room temperature specific electrical conductivity (SEC) of distilled water (DW) exposed to EHPP was higher comparing to the control one [1]. On the basis of these data it was suggested that EHPP- induced structural changes of physiological solution (PS) could modulate neuromembrane chemosensitivity. To check this hypothesis the effect of preliminary EHPP-treated PS on Ach-induced current in snail neuronal membrane was studied.

The comparative study of the effect of preliminary EHPP-treated and heat-treated PS at room temperature on Ach-induced current in snail neuronal membrane in voltage clump experiment was performed.

The obtained data on existence of depressing effect of preliminary EHPP-treated PS on amplitude of Ach-induced current in A-type neurons and the absence of such effect in heat-treated PS allow us to suggest that EHPP-treated PS has specific (non-thermal) effect on Ach-induced current in snail neuronal membrane. The membrane mechanism of damaging effect of EHPP-treated PS is a subject for current investigation.

12. Title: THE PRELIMINARY DATA ON THE EFFECT OF STATIC MAGNETIC FIELD -TREATED PHYSIOLOGICAL SOLUTION ON NA-K PUMP –INDUCED HEART MUSCLE RELAXATION
Author(s): Ayrapetyan G. S., Grigoryan A.S, Ghazaryan S.D., Ayrapetyan S.N
Publisher(s): Noyan Tapan Press; Proceeding of UNESCO/WHO/IUPAB Seminar “Molecular and Cellular Mechanisms of Biological Effects of EMF” and NATO Advanced Research Workshop on “The Mechanisms of the Biological Effect of Extra High Power Pulses”
Year: 2005
Number of pages: 2
Type of document/material: **Article**
Language(s) English
Main keywords (4 or 5): cAMP, Na-K pump, K-free MPS, heart muscle

Abstract

Previously, it was shown that Na-K pump activation by preliminary Na-enrichment in cold K-free solution causes the relaxation of heart muscle (1). At the same time it was shown that SMF-treated physiological solution had relaxation effect on heart muscle which was accompanied by the elevation of intracellular concentration of cGMP and decreasing of cAMP as well as depressing of Ca uptake by muscle (2). However, the contribution of electrogenic Na-K pump in SMF-induced heart muscle relaxation is staying unclear.

The objective of the present work is to study the effect of magnetized physiological solution on Na-K pump induced relaxation of isolated snail heart muscle.

Comparing the obtained data with the resent our data on relaxation effect of K-free MPS solution (2) allow us to conclude that MPS has dual effect on heart contractility: from one hand, it activates the cGMP-dependent Na:Ca exchange (1), leading to the relaxation of the muscle, from the other hand it stimulates the heart contractility by activation of Na-K pump. The mechanism of the latter is the subject for the present investigation.

13. Title: The Non-thermal Effect of Extremely High Power Pulses on Physical Properties of Distilled Water

Author(s): Tsaturyan A. A., Amyan A.M., Simonyan R.H., Avanesyan A.S., Ayrapetyan S.N

Publisher(s): The Bioelectromagnetics Society (BEMS) 27th Annual Meeting (Dublin, Ireland)
Year: 2005 *(in press)*
Number of pages: 1
Type of document/material: **Article**
Language(s) English
Main keywords (4 or 5): Extremely High Power Pulses, Specific Electrical Conductivity, water, “trace” effect of EHPP

Abstract

At present the existence of non-thermal effect of Extremely High Power Pulses (EHPP) remains discussable. As water is the main medium, where the measure part of biochemical reactions of different metabolic cascades of cell and organism take place, it allows us suggesting that EHPP-induced water structure changes could serve as one of the targets through which the non-thermal biological effect of EHPP is realized. However, the effect of EHPP on water structure remains unclear, although it is well known that because water molecules are polar, i.e. they have positively and negatively charged ends; they vibrate when subjected to microwave energy, causing considerable friction between molecules. Therefore, the comparative study of the Specific Electrical Conductivity (SEC) and thermal capacity of EHPP pre-treated and adequately pre-heated distilled water, could allow us to conclude on the existence of the specific (non-thermal) effect of EHPP on water.

The purpose of the present work is to check the above-mentioned hypothesis, for which the effect of EHPP on SEC and thermal capacity of distilled water was studied.

Obtained date clearly demonstrate that the “trace” effect of EHPP exposure on water properties (SEC and thermal capacity), which can be recorded as the SEC changes after freezing in liquid N2 and melting at room temperature significantly varies from the adequately heated DW. Thus, it is suggested that the mentioned “trace” effect of EHPP could underlay on the ground of the generation of non-thermal biological effect of EHPP.

14. Title: The Non-thermal Effect of Extremely High Power Pulses on barley seed germination

Author(s): Amyan. A. M., Ayrapetyan S.N.

Publisher(s): The Bioelectromagnetics Society (BEMS) 27th Annual Meeting (Dublin, Ireland)
Year: 2005 *(in press)*
Number of pages: 2
Type of document/material: **Article**
Language(s) English
Main keywords (4 or 5): Non-thermal Effect, Extremely High Power Pulses, barley seed germination, water structure changes

Abstract

The existence of non-thermal biological effect of Extremely High Power Pulses (EHPP) still remains discussable. The fact that EHPP can certainly produce a thermal effect makes it technically difficult to discriminate its possible specific biological effect in experiments. Although it is well known that because water molecules are polar, they vibrate when subjected to microwave energy, causing

considerable friction between molecules, the effect of EHPP on water structure remains unclear. By resent studies at our laboratory it was shown that EHPP and an adequate heating have different effects on physico-chemical properties of water (SEC, melting point and thermal capacity). Therefore, it is suggested that EHPP-induced water structure changes could serve as the main mechanism through which the possible specific (non-thermal) biological effect of EHPP is realized. Previously it was shown that plant seed metabolic-dependent hydration, root formation and germination in preliminary EMF-treated and non-treated aqua bathing solution could serve as an extremely convenient experimental model for this purpose.
To find out whether EHPP-induced water structure changes could have a non-thermal effect on seed hydration, root formation and germination process, the comparative study of the effects of preliminary EHPP-treated and heat-treated distilled water (DW) on seed germination process (72 hours incubation) were performed.
The obtained data on the opposite effects of EHPP-and heat pretreated DW on seed dry and wet weights, comparing to the non treated DW, as well as on the process of root formation and germination could serve as strong evidence on the existence of specific (non thermal) biological effect of EHPP on seed germination potential.

15. Title: The Temperature-dependent Effect of Static Magnetic Field on Growth and Development of Yeasts.
Author(s): Baghdasaryan N.S., Ayrapetyan S.N.
Publisher(s): The Bioelectromagnetics Society (BEMS) 27th Annual Meeting (Dublin, Ireland)
Year: 2005 *(in press)*
Number of pages: 2
Type of document/material: **Article**
Language(s) English
Main keywords (4 or 5): Static Magnetic Fields, growth and development of yeasts, spectrometer, calorimeter

In literature there is a number of contradictious data on the biological effects of Static Magnetic Fields (SMF) and Electromagnetic Fields (EMF) on growth and development of yeasts: activating, inactivation and no effect. Our weal knowledge on the cellular and molecular mechanisms of the biological effect of static and pulsing magnetic fields is the main barrier for understanding the reason of the variability of these data. At present there is a number of data on the modulating effect of SMF on the metabolic activity of different cells and organisms. It was also documented that SMF effect could be reversed by changing of the initial functional state. As the yeast functional state is highly variable depending on the physical and chemical compositions of the environmental medium, it is suggested that the character of SMF effect on their growth could depend on their initial functional state. To check this hypothesis the effect 0,5 mT SMF on yeast growth at 20 and 36 ^{0}C was studied by means of spectrometric and calorimetric methods.
The objectives of the present work was to study the effect of SMF on growth and development of yeasts at 20 and 36 ^{0}C.
The presented date on the temperature dependence of SMF effect on yeast growth could be considered as evidence on the dependence of SMF effect on metabolic state of the yeast, however the study of the target of SMF effect on yeast will the subject for future investigation.

3. Current Research Activities

1. **Research Project** on “Molecular and cellular mechanisms of possible non-thermal biological effect of extremely high-power microwave pulses (EHPP)” funded by EOARD through ISTC has started in November 2002 and lasted until July 31 2004. The project was founded by the European Office of Aerospace Researches and Development (EOARD).
2. **Research Project** on “The Design and Development of a Device for Accurately Determining Post Mortem Duration” for 2004-2006, founded by US Civilian Research and Development Foundation.
3. **Research Project** on “The study of the nature of the membrane target of the biological effect of EMF” founded by the Armenian Government.

2. Conferences/Congresses/Meetings

1-5 March 2005 UNESCO Chair in Life Sciences, in collaboration with WHO, International Union for pure and applied Biophysics, European Office of Aerospace Research and Development and NATO organized 2 international meetings: UNESCO/WHO/IUPAB Seminar on "Molecular and Cellular Mechanisms of Biological Effects of EMF" (1-2, March 2005) and NATO Advanced Research Workshop on "The Mechanisms of the Biological Effect of Extra High Power Pulses" (3-5 March,2005).

The UNESCO/WHO/IUPAB Seminar consisted of the following 3 sessions:
Session 1: Molecular and cellular mechanism of SMF and ELF EMF effects
Session 2. Neurochemical mechanisms sensitive to EMF
Session 3: EMF dosimetry and standards worldwide

In framework of the Seminar IUPAB organized a **Round Table on "Postgraduate Education in Biophysics in the Developing World".** The Round Table was headed by Prof. Raul Grigera (head of IUPAB Task Force on Education and Capacity Building in Biophysics) and Prof. Sinerik Ayrapetyan (Chairholder of UNESCO Chair in Life Sciences).

The active participants of the Round Table: Kazuyuki Akasaka (Japan), N.R. Jagannathan (India), Abdelfattah Badawi (Egypt), Zurab Kometiani (Georgia), Platon Kostyuk (Ukraine), Nikolay Chemeris (Russia), Nesrin Seyhan (Turkey) and other biophysicists from Egypt, Kuwait, Nigeria, Cameroon, Ethiopia discussed the organization of joint program for postgraduate education in Biophysics for the regional countries.

The **NATO Advanced Research Workshop** consisted of the following 5 sessions:
Session 1. Theory of Biological Effect of Extra High Power Pulses
Session 2. Microwave effect on the Cells and Tissues
Session 3. EMF-induced pathology: cancer, nervous and cardiovascular disorders
Session 4. EMF therapy and diagnosis
Session 5. The Biological Effect of Ultra short Electrical Pulses

20 lectures were presented by distinguished scientists on different aspects of EHPP effect on various experimental objects. 47 scientists from 21 countries (10-NATO, 5-partner and 6 others countries) participated in NATO ARW.

UNESCO/WHO/IUPAB Seminar on "Molecular and Cellular Mechanisms of Biological Effects of EMF" (1-2, March 2005) preceded the NATO ARW, the subject of which was the biological effect of ELF EMF. It served as a preliminary step for estimation of non-thermal and thermal effect of EMF. It is known that, in case of ELF EMF non-thermal biological effect prevails over the thermal one, while in case of EHPP, the thermal effect is more pronounced than the specific one.

The main conclusions of ARW are the followings:

a) EHPP has non-thermal (specific) biological effect, which was clearly demonstrated on different experimental models. However, the metabolic pathways through which this effect is realized could serve a subject for future investigations.

b) The cell bathing aqua solution could serve as one of the primary targets for the biological effect of EHPP.

c) Non-thermal biological effect of EHPP has therapeutic properties, which already could be considered as a proven fact, although the nature of its metabotropic effect is not clear yet.

d) As radiofrequency electromagnetic fields exposure guidelines developed by ICNIRP and WHO are only based on its thermal effects, they should be revised also from the point of its non-thermal effect. Therefore, it is necessary to create a joint international project to find out the cellular marker through which the specific (non-thermal) effect of EHPP could be estimated.

e) As SMF, ELF EMF and EHPP have modulation effect on cell hydration in norm and pathology, the EMF-induced changes of cell hydration (cell volume) is recommended as candidate for cellular marker for estimation of the biological effect of EMF. However to check this hypothesis the future investigations are necessary.

f) Considering the promising future of the study of cellular and molecular mechanisms of non-thermal effect of EHPP as well as the effect of ultra short electrical pulses, to stimulate the study in these fields by developing international joint projects in these fields and the results of planning studies to discuss in 2007 in Yerevan the next NATO ARW.

g) To publish the presented lectures and discussions in NATO ARW as a separate volume which will reflect the modern approaches to the cellular and molecular mechanisms of EHPP and could serve as a methodological handbook for studying the non-thermal effect of EHPP.

3. Missions/ Travels abroad

Prof. Sinerik Ayrapetyan
1. Destination: Washington DC. (USA)
Purpose: Participation in BEMS 26th Annual Meeting
Duration: 20-24 June 2004
Funding sources: US CRDF
Outputs: Poster presentation

2. Destination: Istanbul, Turkey
Purpose: Participation in the WHO International Advisory Committee meeting and Workshop on Sensitivity of Children to EMF Exposure
Duration: 7-11 June 2004
Funding sources: WHO
Outputs: Report

IV. Impact

Please describe shortly (one page maximum) the impact of the mentioned activities on the human, social, economical and cultural development at national, regional or international level.

Because of more and more extensive use of Extremely High Power Pulses (EHPP) in both civil life and for military purposes, the clarification of the question whether it has non-thermal effect on organisms, seams extremely important for adequate estimation of their beneficial and harmful effects on cell and organism from the point of public health, as well as for decrease of the international terror risk.

The technical difficulty in condition of biological experiments to separate the EHPP-induced non-thermal effect from its thermal one makes the data on non-thermal effect of EHPP an ambiguous interpretation by researchers. Therefore the main purposes of NATO ARW organized by UNESCO Chair in Life Sciences (Yerevan, Armenia) was, on the basis of multidisciplinary discussion of the theoretical and experimental data obtained by different laboratories on EHPP effect on various experimental models (from water molecules to behavioral activity of mammals), to develop unique methods and criteria for determination of the possible non-thermal biological effect of EHPP, to determine the cellular parameter, which could serve as an adequate marker for estimation of the biological effect of EHPP that could be used for standard harmonization of microwaves.

The materials of UNESCO/WHO/IUPAB Seminar on “Molecular and Cellular Mechanisms of Biological Effects of EMF” and NATO Advanced Research Workshop on “The Mechanisms of the Biological Effect of Extra High Power Pulses” would be published in NATO Science Series as a separate volume which will reflect the modern approaches to the cellular and molecular mechanisms of EHPP and could serve as a methodological handbook for studying the non-thermal effect of EHPP.

V. Forthcoming activities

RESEARCH

Research project: In 2005-2007 the UNESCO Chair will perform a research project founded by the Government of Armenia: “The study of the cellular and molecular mechanisms of the biological effect of extremely high power pulses”
Research project: International project: “The Study of Cell Hydration as a Possible Marker for Estimation of the Hazardous Effect of Electromagnetic Fields from the Point of Public Health” was presented to EC FP6. The project participants are:

1. UNESCO Chair- Life Sciences International Educational Center (Armenia)
    a) Group of Cell biophysics
    b) Group of Cell physiology
    c) Group of Cell biochemistry
2. Tbilisi State Medical University (Georgia)
3. Belarus Medical Academy of Postgraduate Education (Belarus)
4. University of Ioannina (Greece)
5. Institute of Experimental Endocrinology, Slovak Academy of Sciences (Slovak Republic)
6. Institute of Biochemistry, Lisbon Medical School (Portugal)
7. Polyclinique Maymard (France)

Conferences/Congresses/Meetings

Not yet specified

TRAVEL

1. UNESCO Chairholder Prof. Sinerik Ayrapetyan is also planning to participate in IUPAB congress in Montpelier (France).
2. Prof. Sinerik Ayrapetyan is also planning to visit Boulder (Colorado, USA) to visit the collaborator of our CRDF project Prof. Howard Wachtel. This visit is foreseen in the framework of CRDF collaborative project recently awarded to our UNESCO Chair.

VI. Development prospects

The Center, thorough the Armenian National Commission for UNESCO, has applied to UNESCO Headquarter with the request to establish at our Center a UNESCO Chair in Agricultural Biotechnology the objectives of which will be to promote an integrated system of research and post-graduate education in the field of advanced Agricultural Biotechnology, food safety and rural development. It will serve as a means of facilitating collaboration between high level, internationally recognized researchers and teaching stuff of the Center and other institutes in the Region. The establishment of this Chair will promote the creation of Capacity Building in Agricultural Biotechnologies and Biosafety in countries of Caucasus and Moldova for sustainable agriculture, patronized by FAO and supported by the Ministry of Agriculture of Armenia, Georgia and Moldova.

During the NATO ARW the participants suggested to prepare a joint project on “Cellular and Molecular Mechanisms of non-thermal effect of micro- and nanosecond pulses” and in 2007 to organize the next NATO ARW on “Molecular mechanism of non thermal biological effect of ultra-short electrical pulses”.

It is planned to publish the lectures presented during UNESCO/WHO/IUPAB and NATO ARW in NATO Science Series as a separate volume which will reflect the modern approaches to the cellular and molecular mechanisms of EHPP and could serve as a methodological handbook for studying the non-thermal effect of EHPP.

During the IUPAB Round Table on “Postgraduate Education in Biophysics in the Developing World” the participants decided to apply IUPAB and UNESCO headquarters for their support in development of a joint regional Center on the basis of UNESCO Chair in Life Sciences (Yerevan, Armenia) for organization of the postgraduate education in Biophysics for Asia Minor and African countries, using the research and educational potential of Armenia, Russia, Ukraine and Georgia.