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**A STRUCTURAL PARADIGM IN THE GENERALIZATION  
OF INTERMOLECULAR INTERACTIONS REGULARITIES  
IN WATER UNDER THE INFLUENCE OF EXTERNAL  
NON-REAGENT FACTORS**

The world's leading material scientists came to the conclusion that the various properties of substances that people use for their needs depend primarily not on their composition, but on their structure. This is natural, because it applies mainly to substances that are in a solid crystalline state, and the structure, as the spatial arrangement of intermolecular interactions in a substance, clearly affects its physicochemical properties.

Water on the planet is the irreplaceable basis of all living things, it has the unique properties of being in the usual natural conditions simultaneously in three aggregate states and, most importantly, being in continuous, fundamentally important contact with the atmosphere, hydrosphere, geosphere and biosphere of the Earth. The specificity of such contact is that, being at the phase boundary with the substances surrounding water, water turns out to be its integral component

and an equal independent participant in the physicochemical processes that determine the essence of atmospheric, hydrospheric, and biospheric phenomena, which are so rich in nature on Earth. The participation of water in biological life processes is particularly impressive, where awareness of the role of water structure plays a fundamental role and is of great importance for understanding the participation of water in life processes as a mediator between external energy factors of the environment and the physiological state of biomolecules of living cells, tissues, organs and organisms.

It is important to take into account the fact that, apart from water, only two substances are capable of being in a liquid state at room temperature in nature: among non-metals, it is bromine, and among metals, it is mercury. However, it is also a striking fact that contact with them is incompatible with life. At the same time, the peculiarity of the behavior of water around and inside living cells is that protein molecules structure the surrounding water in such a way that it creates a structural framework for the formation and maintenance of the native spatial configuration of the protein in the aqueous bioenvironment, which is fundamentally necessary for the normal physiological functioning of biomolecules in the processes life activities

The necessity and relevance of awareness and correct assessment of the structural and energetic state of water molecules, which everywhere take an active part in natural phenomena that accompany the existence of the environment and the movement of living matter in it, becomes clear and relevant.

Among the variety of substances that make up the natural environment surrounding us, under normal conditions that are familiar to us, only water is in three aggregate states (liquid, steam, ice) at the same time. Even the hardest and strongest rocks can be melted and vaporized if the necessary conditions are created: usually enormous temperatures and pressures. But it is impossible for living organisms to even approach such rocks in the state of liquid and vapor. A clear example is the Sun, at cosmic distances from which it is the main source of life energy for all living things, at least on Earth. But the assimilation of this life-giving energy, and even at a cosmic distance, is possible only in the presence of a special substance in the composition of living matter, which is an integral component of this living matter and at the same time plays an important role as an intermediary between solar energy and between solar energy and a biological «machine» of incomprehensible complexity and perfection, a «machine» capable of consuming this energy to carry out an organized process of biological work, which we used to call the process of vital activity. Water is able to fulfill its biogenic role in nature thanks to its unique and anomalous property – structurogenicity – i.e., the ability of spontaneous and forced by external factors water molecules

to form associates of molecules capable of maintaining the acquired structural organization for a certain time. The basis of the structurogenicity of water is the specific types of interactions between its molecules in the current physical conditions. The generalization of the regularities of intermolecular interactions in water, taking into account its structurogenic properties, combines both purely scientific value and plays a significant role in the use of reagentless (physical) modification of the structural and energetic state of water to optimize biological processes in living organisms and in various technologies where structural and energetic state of water is a critical factor.

1. The structure of water is a basic fundamental phenomenon of nature.

The world in which we live and life itself, which is the way we perceive it and realize it, we owe a lot to the fact that water in normal conditions (and these are the values of temperature and atmospheric pressure in the environment that are usual for our existence) is a liquid with well known for all the complex of strange and anomalous properties. Anomalous compared to other known natural and artificial liquids. The reason for this phenomenon is well known - the peculiarities of the structural construction of the water molecule. Atoms of two hydrogens and one oxygen are held together by electrons shared by O and H atoms. The strong electric field of the oxygen nucleus «pulls» the orbits of two electrons of hydrogen atoms to itself, creating near the nuclei of hydrogen atoms two local spatial zones with unbalanced influence of the electric fields of hydrogen nuclei (with a plus sign). On the contrary, the attraction of the common electrons of hydrogen and oxygen atoms to the nucleus of the oxygen atom, which has a strong electric charge, forms two local spatial zones with increased electron density near the oxygen atom. This is the generally accepted explanation for the presence of two pairs of electric poles in a separate water molecule: one with a plus sign near each of the two hydrogen atoms and two poles with a minus sign near the oxygen atom. Due to this electrostatic non-indifference, water molecules are capable of electrostatic interaction between the negative poles of one water molecule and the poles of other neighboring water molecules. This type of intermolecular connection between water molecules, or between water molecules and molecules of substances that, due to the specifics of their structure, have sources of an uncompensated electrostatic field with a minus sign, the name «hydrogen bond» has been fixed. Hydrogen bonds are stronger than the Van der Waals universal forces of intermolecular interaction. Due to the presence of H-bonds, each water molecule is able to form 4 hydrogen bonds with neighboring water

molecules, creating a structural network of bonds wherever water molecules with free H-bonds are present. The thermal movement of water molecules is able to quickly destroy the formed bonds, which, in turn, are able to easily restore broken hydrogen bonds. Depending on the external conditions, structural associates of water molecules (water clusters) create structurally ordered formations of tens and hundreds of water molecules, which are continuously destroyed and restored (cluster flickering effect). The sensitivity of water molecules to an external electric field determines the possibility of structural electric field stabilization of water clusters, including a stabilizing effect due to the fixation of charged particles in the structure of water associates (cluster). The presence of electric charges and hydrophilic fragments in the structure of their molecules in substances dissolved in water determines the possibility of the formation of hydrated structured water shells around these molecules and particles, which can have a heterostructural multilayer structure. The structural features of hydrated shells largely determine the regularities of the behavior of hydrated molecules, ions, electrons, and nano- and microdispersions in water.

In principle, the structured (associated) state of water in nature is its usual natural state. Separated water molecules are able to exist in this state until other water molecules appear in their environment. Practically, as research has shown, this can only happen for a moment. This means that isolated water molecules, due to its presence everywhere in nature, we can only imagine. For example, at the time of its evaporation from the surface of water, or at the time of the formation of a peptide bond between two amino acids, because the product of such a reaction is also a water molecule.

For us, the presence of water in the liquid phase is a unique event not in this fact itself, but in the fact that the liquid state of water is possible under normal conditions, that is, at atmospheric pressure and temperature, which are common for all living things in the environment.

Many specialists (especially among material scientists) believe that water is a close «relative» of  $\text{SiO}_2$  and other crystals based on the structural structure of the molecule, but the latter acquire the liquid phase only at very high temperatures and pressure. Only under such conditions, the energy of the thermal motion of atoms in the structure of solid bodies with a crystalline structure is able to overcome the energy of bonds between atoms in the crystal.

The presence of water in a crystalline state at a temperature below  $0^\circ\text{C}$  and at atmospheric pressure indicates that the energy of thermal motion of hydrogen and oxygen atoms in the crystalline state of water at a temperature below zero (in Celsius) is lower than the energy of hydrogen bonds between water molecules in the state of ice.

## 2. A material science view on the peculiarities of the water structure.

The well-known materials scientist Professor Rustum Roy (USA) and his colleagues in the research of structured water unexpectedly took up the generalization of the behavior of the inorganic phase of substances  $\text{SiO}_2$ , S, P and  $\text{H}_2\text{O}$ <sup>1</sup>. Research achievements on water are analyzed from the standpoint of material science methodological approaches, namely: relations of properties and structure; analysis of phase diagrams (P-T); phenomenon of epitaxy; liquid-liquid phase separation phenomenon; analysis of stability conditions of two-phase colloids; analysis of the influence of weak electric and magnetic fields on the structure of simple inorganic oxides. The effect on the properties of practically pure water, which it acquires due to structural changes, as well as which water acquires under the influence of procedures standard in the technology of homeopathy, is also considered.

The generalization of the array of experimental data analyzed with this approach led the authors of the study<sup>2</sup> to the conclusion that in liquid water under normal conditions there must be structural diversity, which can be properly defined as a complex of monomers and oligomers (clusters) of various sizes up to hundreds of  $\text{H}_2\text{O}$  molecules.

It is emphasized<sup>3</sup> that when considering the structural organization of water, it is important to take into account its similarity to the structure of  $\text{SiO}_2$ , as well as the possibility of epitaxy in the contact zone of water, for example, with the surface of glassware. The authors of<sup>1</sup>, when explaining the structural features of liquid water, propose to the generally recognized decisive role of the structure of water associated with the special nature of hydrogen bonds add consideration of the presence in water of widely branched Van der Waals bonds between different structured (cluster) locations in water. The authors of<sup>1</sup> attribute to these very weak connections the responsibility for the amazing ease of changes in the structure of water, which allows us to understand the nature of several known anomalous properties of water. Taking into account the significant influence of van der Waals forces (together with hydrogen bonds) on the structural features of water also satisfactorily explains the structural changes in water under the influence of low-intensity magnetic and electric fields, as well as the various inherent radiations of water inherent in it in a structured state. The main feature of the materials science

1 Rao, M. L., Roy, R., Bell, I. R., & Hoover, R. (2007). The defining role of structure (including epitaxy) in the plausibility of homeopathy. *Homeopathy*, 96 (03), 175-182.

2 Ibid.

3 Ibid

paradigm regarding water is that «the structure, not the composition, in the vast majority determines their properties, and the structures in inorganic phases can easily change without any change in their composition»<sup>4</sup>.

### 3. Coherence of water and its influence on biochemical processes in living cells.

It is known that thousands of various complex biochemical processes take place every second in a living cell, which occur in coordination with each other in time and space. Nature has given these processes the effect of coherence in the living cell, which we perceive as the correlation between the elements of the system and their coordinated behavior at the macro level. The cytoplasm of a cell is a water system, and water, which is part of the structure of DNA (a natural liquid crystal), significantly affects the functional activity of DNA. Due to these features, the intracellular water medium is able to absorb and emit electromagnetic energy at resonance frequencies very close to the resonance frequencies of endogenous water and is therefore capable of resonant interactions with external sources of field excitations<sup>5</sup>.

The concept of separability in<sup>6</sup> should be understood as the division of parts of the system into completely independent objects – possible only in the absence of interaction between the component parts of the system. Inseparability (quantum entanglement) – the impossibility of dividing the system into separate completely independent components. Mixed state (separable-inseparable) – such a state of a macroscopic system that cannot be described by a single state vector, can be formalized only by considering the density matrix proposed in<sup>7</sup>.

The phenomenon of coherence refers to the description of the physical states of substances united by signs of orderliness and consistency of behavior of a significant number of components of the system (environment). A critical property for coherent substance is its disproportionately strong response to external action. Coherence means consistency in the behavior of system components due to non-local correlational interactions between them. As a consequence of this, in<sup>8</sup> it is proposed to consider water as a mixed separable-inseparable state. It is proposed to consider a water cluster as an inseparable flashing state, and water

4 Rao, M. L., Roy, R., Bell, I. R., & Hoover, R. (2007). The defining role of structure (including epitaxy) in the plausibility of homeopathy. *Homeopathy*, 96 (03), 175–182.

5 Мышкин, В. Ф., Власов, В. А., Хан, В. А., Шиян, Л. Н., & Польченко, В. С. (2012). Структура и свойства воды, облученной СВЧ излучением. *Политематический сетевой электронный научный журнал Кубанского государственного аграрного университета*, (81), 64–75.

6 Ibid.

7 Иванов, М. Г. (2012). Как понимать квантовую механику. *М.–Ижевск: НИЦ «Регулярная и хаотическая динамика»*, 6–11.

8 Ibid.

molecules outside the clusters as a separable state of water. A broad absorption band near 1000.0 Hz is observed for coherent water.

According to the data given in<sup>9</sup>, coherent water activates cellular and humoral immunity factors.

Work<sup>10</sup> proved that water in the liquid state is a set of water coherent domains.

According to<sup>11</sup>, quantum entanglement of states is a special form of correlation of constituent parts of a system that has no analogues in classical physics. Accordingly, the loss of system coherence is the process of loss of quantum superpositions under the influence of the interaction of the system with environmental factors.

Under the action of external electromagnetic fields, the formation of nanoassociates of water with a size of 400–500 nm was observed in<sup>12</sup>. It is estimated<sup>13</sup> that about 500 million water molecules are involved in the formation of a cluster (nanoassociate) with a size of 400 nm.

According to V.V. Kuryk and co-authors in work<sup>14</sup>, when H-bonds are formed between H<sub>2</sub>O molecules, the energy state and biochemical properties of water molecules change. It is emphasized that intermolecular interactions in water are correlated with environmental conditions. Electronic and quantum-chemical calculations by the authors of the study<sup>15</sup> indicate the possibility of forming supermolecular clusters and domains based on the interactions of molecules during the formation of hydrogen bonds

Summarizing the aforementioned studies, M.V. Kuryk summarizes in<sup>16</sup> that ordinary water is a two-phase system consisting of zones of a coherent state and ordinary water. From the point of view of established ideas about the structural and energetic state of water, which surrounds the zones of coherent state of water, M.V. Kuryk gives the following simplified interpretation of the process of forming coherence from the standpoint of quantum electrodynamics<sup>17</sup>: «The vacuum

9 Иванов, М. Г. (2012). Как понимать квантовую механику. М.–Ижевск: НИЦ «Регулярная и хаотическая динамика», 6–11.

10 Краснобрыжев, В. Г., & Курик, М. В. (2010). Свойства когерентной воды. *Квантовая магия*, 7 (2), 2161–2166.

11 Мышкин, В. Ф., Власов, В. А., Хан, В. А., Шиян, Л. Н., & Польченко, В. С. (2012). Структура и свойства воды, облученной СВЧ излучением. *Политематический сетевой электронный научный журнал Кубанского государственного аграрного университета*, (81), С. 64–75.

12 Сидоренко, Г. Н., Коновалов, А. И., Лаптев, Б. И., Иванова, Т. Г., Горленко, Н. П., Антошкин, Л. В., & Рыжкина, И. С. (2017). О роли структуры воды в механизме комплексного действия магнитного поля, природных лечебных факторов и высокоразбавленных растворов. *Вестник новых медицинских технологий*, 24 (1), С. 1–81.

13 Ibid.

14 Курик, М. В., & Курик, А. М. (2004). Экспериментальные исследования микроскопических квантовых эффектов воды. *Сознание и физическая реальность*, 9 (3), С. 29–33.

15 Гончарук, В. В., Смирнов, В. Н., Сыроешкин, А. В., & Маляренко, В. В. (2007). Кластеры и гигантские гетерофазные кластеры воды. 29, (1), С. 1 – 17.

16 Гончарук, В. В., Смирнов, В. Н., Сыроешкин, А. В., & Маляренко, В. В. (2007). Кластеры и гигантские гетерофазные кластеры воды. 29, (1), С. 1 – 17.

17 Ibid.

gives a proton to the substance. The process will continue until enough photons accumulate in the substance to form a fairly significant field in this location. The result of the formation of this field will be the appearance of attraction between the same molecules of the substance, which will result in the appearance of a significant increase in density, as is observed for the vapor-liquid phase transition. This will lead to a significant increase in the oscillation of all molecules in this location. This phenomenon was named coherent domain. At the same time, molecules and electrons will lose their primary identity.»

Refraining from evaluating the clarity of the proposed mechanism of formation of coherent domains, we will consciously accept the author's statement that the main feature of water is that the energy of the excited state of the coherent domain is very close to the value of the dissociation energy of a water molecule. In fact, this fact is very important for understanding the electron-donating properties of water in the state of coherent domains. Indeed, if the domains are in the lowest (ground) energy state, then all electrons are securely bound and an excitation energy  $>12.6$  eV is required for water ionization. Having entered the excited state, many electrons in the coherent domain of water are energetically almost in a free state, and for complete separation from the domain they need only a small additional energy. Thus, in contrast to non-coherent water, which cannot be in an electron-donating state, coherent water is a rather strong reducing agent.

The presence of two states in water – coherent (excited) and non-coherent (ground) is responsible for the effect of coherent oscillations, when each water molecule oscillates between the ground state and the excited (metastable) state. According to research<sup>18</sup>, oscillations with amplitude of 12.6 eV correspond to the size of coherent domains of 0.1  $\mu\text{m}$ . Such oscillations explain the appearance of «quasi-free» electrons in a coherent state.

The phenomenon of the formation of coherent domains in water described in the study<sup>19</sup> has important consequences, because coherent domains of water acquire the capacity of accumulators of «quasi-free» electrons. The importance of this effect lies in the fact that any external excitation, which has an energy less than 12.6 eV, cannot transfer an individual molecule to an excited state, however, such energy from an external source of excitation is absorbed by the coherent domain as a whole, forming a collective coherent excited condition<sup>20</sup>. According to the imagination of the authors<sup>21</sup>, clouds of quasi-free electrons surround coherent

18 Курик, М. В., & Курик, А. М. (2004). Экспериментальные исследования микроскопических квантовых эффектов воды. *Сознание и физическая реальность*, 9 (3), С. 29–33.

19 Ibid.

20 Курик, М. В., Марценюк, О. С. & Марценюк, Л. С. (2012). Квантові характеристики води і процеси мембранної фільтрації. *Харчова промисловість*. Вип. 12, С. 102–108.

21 Ibid.

domains, forming an electron plasma. Only 0.2 eV of external excitation energy is enough to transfer such a plasma into an excited state.

The regularities of the accumulation of quasi-free electrons by coherent domains have common features with the mechanism of acquisition of electron-donating reducing properties by water enriched with molecular hydrogen (hydrogen water).

In the first case, the transition from quasi-free electrons from the coherent domain structure to the water phase (a cloud of quasi-free electrons) is possible at values of excitation energy much smaller than the ionization energy of coherent water.

In the case of hydrogen water, the acquisition of reductive electron-donating properties by water occurs (according to the authors of this work) due to spontaneous fluctuations in the energy of the thermal motion of water molecules, or during the interaction of hydrogen molecules with quanta of external electromagnetic energy (for example, cosmic radiation) energetic enough for their dissociation into 2 atoms [1]. The effect of the accumulation of electronic activity of water due to the electron-donating activity of hydrogen atoms occurs because the products of dissociation of hydrogen atoms in water – electrons and protons – fundamentally interact with the surrounding water molecules in different ways. Free electrons in water are hydrated, largely retaining chemical activity in the hydrated state. Protons, interacting with electronegative oxygen in the composition of the nearest water molecule, form hydroxonium ion  $H_3O^+$  with it. The proton in the hydroxonium ion significantly loses its individual chemical activity. In the end, electronic activity will prevail in such water, providing it with the acquisition of a reducing electron-donating state. The binding of a proton by a water molecule to a hydroxonium ion makes every act of dissociation of hydrogen atoms in water irreversible, thereby contributing to the increase of electronic activity in water.

In the effect with coherent water, the peculiarity of the interaction of the excitation energy with the non-coherent water surrounding the coherent domain and the distinct peculiarity of the interaction of the excitation energy with the coherent water correspond to the effect of the accumulation of small portions of excitation energy by the coherent domain.

The biological value of drinking water should be related to the features of the structural and energetic state of the coherent and non-coherent part of water. The dominant factor is that water in a non-coherent state cannot act as a reducing agent in numerous biochemical processes in a living organism. On the contrary, coherent water has the inherent properties of a strong reducing agent – an electron donor.

In<sup>22</sup> it is proposed to consider the possibility of the existence of water in an ice-like state in two discrete states: high and low water density. In locations with

22 Эйзенберг, Д., & Кауцман, В. (1975). Структура и свойства воды. Л.: Гидрометеоиздат, 280, 11.

a low density of molecules, the latter are able to form hydrogen bonds between themselves, and in locations with a higher density of water molecules, distortion of regular tetrahedral forms of structural formations is possible.

It is very important to realize that near a hydrated surface, water acquires an exceptional self-organizing (structurogenic) ability. Such a state of water is identified with a new special state of water<sup>23</sup>.

M.V. Kuryk and co-authors in<sup>8</sup> formulate their own approach to understanding the peculiarities of the formation of natural drinking water in the subsoil, which consists in the fact that natural water, in contact with the geological environment, is mineralized and perceives a special type of complex influence of ultra-weak and eddy fields, which causes the formation of such water has a special type of liquid crystalline state. The authors see the structure of these crystalline formations as similar to tetramers, in which four water molecules are combined into a compact tetrahedron with twelve internal hydrogen bonds. The authors of<sup>8</sup> allow the possibility of combining crystals into clusters. It is also assumed that from the point of view of quantum electrodynamics, such crystals are able to be in the state of coherent domains. Such a domain corresponds to the energy of the transition from the ground state to the excited state, which corresponds to the wavelength of a photon of soft X-ray radiation.

4. Peculiarities of the structural and energetic state of water close to phase boundaries. The fourth phase is Pollack's boundary («e-z») water.

Professor Gerald Pollack from Washington State University discovered the ability of water to form a thin (about 100  $\mu\text{m}$ ) layer of water with special structurally ordered properties close to a solid hydrophilic surface. He also discovered the presence of an electric charge in such boundary water, which gives it an electric potential of the order of -130...-150 mV. The peculiarity of boundary water is also the ability to absorb electromagnetic radiation in the range from ultraviolet to infrared and the ability to increase the thickness and size of the charge under the influence of absorbed electromagnetic energy.

Examining the solid surface/stained water interface under a microscope, D. Pollak noticed that the boundary water layer was completely discolored. This means that the dye molecules are displaced (excluded) from the structure of boundary water – a phenomenon inherent in water during its transition to the ice phase during freezing. Pollack called the boundary water layer the exclusion zone (e-z zone «exclusion zone»).

23 Постнов, С. Е., Подчерняева, Р. Я., Мезенцева, М. В., Щербенко, В. Э., & Зуев, В. А. (2009). Необычные свойства воды пограничного слоя. *Вестник российской академии естественных наук*, 3, 12.

Pollack discovered a number of unique and anomalous properties of boundary water. Boundary water is capable of accumulating, storing and transferring its inherent electric charge (potential) to the consumer like a battery. The structural differences of boundary water are illustrated by its increased viscosity compared to the viscosity of water in the volume. The structural difference of the boundary water is also evidenced by its 10 % increased light refraction coefficient (especially in the infrared part of the spectrum).

The fact of displacement of the impurities present in the freezing water helped Pollack to assume that the reason for the unique properties of boundary water is its ice-like crystalline structure. Further, reflecting on the role of water present in muscle tissues during their contractions, Pollack rightly assumed that the water in contracted muscles must have a gel structural state.

Even earlier, Herbert Ling, who was a pioneer in this field of knowledge, discovered that the water in human cells is not ordinary water ( $H_2O$ ), but something else – much more structured and ordered. In the end, it became clear that ordered water, in contact with the surface of biomolecules, acquires the e-z state of water, giving the intracellular environment a charge with a minus sign. According to J. Pollak, the boundary water is formed by building up one layer of e-z water on the previous one and can consist of millions of molecular layers of e-z water. Usually, this is how the natural structuring of water occurs in the environment. For example, ice is not formed directly by crystallization of the surrounding natural water. It is proved that the process begins with the formation of an e-z layer of water in the water on the surface of the nucleus of ice formation and subsequent layering of ice. And when we melt ice, it goes first to the structural state e-z of water and only later to ordinary water. This is why freshly melted water exhibits significant biological activity due to its natural electron-donating state with its inherent antioxidant properties. For the same reason, Pollack points out, melting glaciers are an ideal source of healing e-z drinking water. Pollack found that absorption in the near-ultraviolet region of the spectrum (near 270 nm) promotes the growth of e-z layers of water. This fact explains the reason for the therapeutic effect of heating living tissues with infrared radiation. Dr. Pollak proved that if infrared heating of living tissues is used for therapeutic purposes, the boundary water content in the latter increases. This also explains the healing effect of infrared saunas. After all, infrared radiation penetrates deeply into the cells of the body, which creates and stores water in the body cells in the e-z state. The same goes for light therapy, from exposure to the sun to laser therapy. J. Pollack suggests that the effect of infrared laser therapy is mainly related to the «charging» of damaged cells with e-z water, as well as stimulation of the increase in capillary blood flow.

Pollack's discovery of the connection between the proportion of water in its e-z state and the content of oxygen in such water is very important, namely: there is more oxygen in e-z water than in ordinary water, and vice versa - by increasing the content of  $O_2$  in water, we contribute to an increase in the proportion of water in the e-z state.

The next bright result of J. Pollack's research was the study of the hydrodynamic effect of the excitation of the water vortex, which leads to an increase in the e-z fraction of water on the surface of the dishes.

J. Pollak recommends choosing the deepest underground water as a source of drinking water, since the formation of boundary e-z water accelerates with increasing pressure in the water. He also recommends, along with drinking e-z-enriched drinking water, to feed your body with electrons by grounding it / (including walking on the ground barefoot). The validity of this technique is explained by the fact that atmospheric electricity is dominated by charges with a plus sign, and on the surface of the earth electric charges with a minus sign accumulate - the same as the electric charges in our body, which support the regenerative electron-donating state of numerous biological fluids of the human body (i.e., electronic homeostasis water sector of the body). This is especially true for people suffering from electron deficiency syndrome caused by man-made environmental pollution. In this regard, the replenishment of organisms with electrons from the environment by direct recharging from the charges of the earth's surface looks quite reasonable.

##### 5. Hygienic evaluation of the influence of the structural and energetic state of water on its physical, chemical and biological properties.

The structural and energetic state of water largely depends on the influence of various non-reagent factors on water, that is, external physical influence<sup>24</sup>. At the same time, changes in the structural and energetic state of water lead to noticeable changes in its biological activity<sup>25</sup> and, ultimately, to an increase in the biological value of drinking water<sup>26</sup>. The sensitivity of the structural and energetic state of water to the influence of external physical factors determines its special role as a mediator between the influence of the environment and the physiological state of living organisms that consume reagent-free modified water<sup>27</sup>. Accordingly, the number of

24 Бецкий, О. В., & Яременко, Ю. Г. (1998). Вода и электромагнитные волны. *Биомедицинская радиоэлектроника*, № 2, С. 3–6.

25 Гуляев, Ю. В., Еремин, С. М., Марков, И. А., Новоселова, Е. Г., Новиков, В. В., Тен, Ю. А., & Фесенко, Е. Е. (2005). Физико-химические свойства безреагентно-модифицированной воды и её биологическая активность. *Журнал радиоэлектроники*, 11, 1684–1719.

26 Высоцкий, Е. И. Биосфера – живая вода организма. (2010). Донецк, 459 с.

27 Бецкий, О. В., & Яременко, Ю. Г. (1998). Вода и электромагнитные волны. *Биомедицинская радиоэлектроника*, № 2, 3–6 с.; Гуляев, Ю. В., Еремин, С. М., Марков, И. А., Новоселова, Е. Г., Новиков, В. В., Тен, Ю. А., &

studies related to the hygienic assessment of the consequences of water treatment methods that affect the structural and energetic state of water is increasing<sup>28</sup>.

According to modern concepts, the endogenous water of biological organisms is in a special structured state (boundary, associated, e-z) of water, which is characterized by a biologically important increased activity of electrons<sup>29</sup>. It was shown that changes in the structural and energy parameters of water, as a result of the influence of non-reagent physical factors, cause changes in metabolic processes in the body by increasing the permeability of cell membranes<sup>30</sup>. It has been established that dosed use of water with a changed structure helps to increase the body's immunoreactivity and improve lipid and carbon metabolism<sup>31</sup>.

The study<sup>32</sup> developed a methodology for determining the proportion of structured water (in percent) in water treated by various reagent-free methods. It has been experimentally proven that an excess (more than 0.778 %) and a decrease (less than 0.553 %) of the content of the bound phase in water leads to a significant change in the biological activity of water in relation to the physiological state of various biotest organisms. It has also been shown that during long-term consumption of water with an increased share of its structured phase by warm-blooded animals, a change in morphofunctional, specific immunological and cytogenetic indicators is observed<sup>33</sup>. In this work, changes in the structural state of water and its electrochemical parameters were studied after water treatment with electromagnetic radiation, a stationary magnetic field, filtration through carbon sorbent materials, after treatment with infrared radiation and a vortex electromagnetic field. An increase in the content of the structured (bound) fraction in the treated water is accompanied by an increase in the pH value and specific electrical conductivity of water with a simultaneous decrease in the value of redox potential and viscosity, which correlates with the known regularities of the formation of ECAW.

Фесенко, Е. Е. (2005). Физико-химические свойства безреагентно-модифицированной воды и её биологическая активность. *Журнал радиоэлектроники*, 11, 1684–1719.

- 28 Кузубова, Л. И., & Кобрина, В. Н. (1996). Химические методы подготовки воды (хлорирование, озонирование, фторирование). *Экология. Серия аналитических обзоров мировой литературы*, (42), 1132; Большак, Ю. В., Воронов, С. В., Каганов, В. Я., & Солнцева, Т. А. (2016). Безреагентная активация среды обитания человека, питьевой воды и продуктов питания – фактор оптимизации электронного состояния клеточных сред, улучшения здоровья и долголетия. *Проблемы старения и долголетия*, (25, № 1), 40.
- 29 Ланин, Д. В. (2014). *Научные основы гигиенической оценки воздействия химических факторов окружающей и производственной среды на состояние процессов иммунной и нейроэндокринной регуляции* (Doctoral dissertation, Перм. гос. мед. акад. им. акад. ЕА Вагнера). 268 с.
- 30 Рахманин, Ю. А., Стехин, А. А., Яковлева, Г. В., & Татаринов, В. В. (2013). Новый фактор риска здоровья человека-дефицит электронов в окружающей среде. *Стратегия гражданской защиты: проблемы и исследования*, 3 (1), С. 39–51.
- 31 Стехин, А. А., & Яковлева, Г. В. (2009). Методологические проблемы изучения электронного состояния системы «окружающая среда-человек». *Гигиена и санитария*, (5), С. 79–82.
- 32 Высоцкий, Е. И. Биосфера – живая вода организма. (2010). Донецк, 459 с.
- 33 Ibid.

The research results show the importance of implementing new methods of monitoring changes in the structural and energetic state of water in the water treatment process and, accordingly, of developing methods for assessing structural changes in reagent-free treated water. As it was done in<sup>34</sup>, where a new cryophysical method of estimating the content of the structured phase in water was developed, which is based on the determination of the volume of gas released during the freezing of water. The method ensures the accuracy of determining the structural parameters of water at the level of 5% based on the average values of the measured values.

The structurogenic nature of water is the reason for the continuous formation of both random associates that do not have a stably ordered structure, as well as clusters – associates that have a certain stable structure over time. It is believed that ordinary water consists of 60 % of individual molecules and random associates, and 40 % of structured clusters. The peculiarities of the formation of structures in water are associated with the fact that water is continuously under the external influence of numerous energy-informational factors, and the structural features of cluster formations to a certain extent correspond to the nature of these external factors. According to research<sup>35</sup>, a short-lived associate of 35 water molecules, when combined with another equally short-lived associate, can form a structure whose lifetime is no longer 10–15 s, but two orders of magnitude longer. Theoretical calculations indicate the possibility of the existence of crystalline formations in water, which consist of 912 molecules, the lifetime of which is minutes or even hours<sup>36</sup>. According to the imagination of the author<sup>37</sup>, there are many similar crystals in water, and on the surface of each face of each crystal, a unique, random geometric distribution of charges is formed.

The response of water, depending on its structural and energetic state at the time of external physical factors acting on it, affects many technological processes in which water participates, for example, in food production technologies. It is known that ice at normal pressure above 0 °C melts, and water below 0 °C can be in a supercooled state<sup>38</sup>. Food products freeze at temperatures slightly below 0 °C<sup>39</sup>, and the bound water in them does not freeze at minus 20 °C and does not

34 Высоцкий, Е. И. Биосфера – живая вода организма. (2010). Донецк, 459 с.

35 Хан, В. А., Власов, В. А., Мышкин, В. Ф., Ижойкин, Д. А., & Гамов, Д. Л. (2012). Анализ структуры и свойств разбавленных водных систем. *Политематический сетевой электронный научный журнал Кубанского государственного аграрного университета*, (81), С. 11-25.

36 Ibid.

37 Ibid.

38 Хахалин, А. В., & Королёва, А. В. (2014). Исследование температурной зависимости спектров переохлажденной воды в средней ИК-области. *Вестник Московского университета. Серия 3. Физика. Астрономия*, (1), С. 61–66; Антонченко, В. Я. (1983). *Микроскопическая теория воды в порах мембран*. Наукова думка. 100 с.

39 Харенко, Е. Н., Архипов, Л. О., & Яричевская, Н. Н. (2019). Установление функциональной зависимости количества вымороженной воды от индивидуальных криоскопических температур рыбы. *Труды ВНИРО*, 176, С. 81-94.

evaporate at 100 °C. The authors<sup>40</sup> consider the peculiarities of the behavior of water molecules and thermophysical parameters of water for its various phase states: liquid water, ice, and «bound» (boundary) water. At the same time, they see the key point in the study of the behavior of water molecules in the consideration of changes in the nature of their vibrations in different phase states.

For protein molecules, the structure of which is quite mobile and capable of rearrangements, their structure will be additionally strengthened by water molecules adjacent to them in the associated state (boundary water). In close proximity to protein molecules, immobile associates of boundary (hydrate) water form structuring protein molecules, so-called «coats». Such ice-like hydrate structures form a crystalline framework/corset inside and around the biopolymer molecules, maintaining their native shape, providing them with a natural structure. If the distances and angles between bonds are not optimal and the strength of the hydrogen bond network in the hydrated structures is weakened, the biopolymer molecule will lose part of the strength of its crystal-like «framework/corset», which ultimately leads to a change in its spatial configuration<sup>41</sup> destruction of its structure and form. The structuring «fur coat» around protein molecules and other macromolecules is their hydrated shell.

Its thickness depends on the number of ionized groups (with a negative charge sign) on the surface of macromolecules unfolded in water<sup>42</sup>.

Summarizing the data obtained in work<sup>43</sup> allows the authors to formulate the following conclusions: a decrease in the number of rotational or libration modes of vibration of water molecules in the state of ice or in the associated ice-like state leads to a strengthening of hydrogen bonds between molecules and to a decrease in the number of vibrational degrees of freedom and magnitude heat capacity of water.

The state and structure of macro- and biomolecules in aqueous solutions is determined by the strength of the structures of their hydration shells. In<sup>44</sup>, the primary mechanism of the therapeutic action of extremely high-frequency (EHF) therapy was investigated. The author believes that the primary mechanism of the therapeutic effect of EHF irradiation of tissues (organs) is the energy-informational interaction of the structure of endogenous water and the body as a whole, which has changed under the influence of EHF waves. The

40 Третьяков, Ю. М. (2013). Вода. Структура и теплофизические параметры. Ижевск: регулярная и хаотическая динамика. 552 с.

41 Лошицкий, П. (2009). Взаимодействие биологических объектов с физическими факторами. Киев, КПИ. 267 с.

42 Неклюдов, А. Д. (2016). Иванкин А. Н. Экологические основы биотехнологии. М. : МГУЛ, 416 с.

43 Третьяков, Ю. М. (2013). Вода. Структура и теплофизические параметры. Ижевск: регулярная и хаотическая динамика. 552 с.

44 Лукьяница, В.В. (2013). Первичный механизм воздействия при КВЧ-терапии. *Медицинский журнал*. № 1. С. 97-104.

proposed phenomenological model of the primary mechanism of action of EHF radiation, which recognizes the main active factor of the effect of EHF therapy as the action of the electrostatic field, which is created under the action of EHF radiation by large associates of water molecules, due to the deep penetration of the electrostatic field into the human body.

The reason for the appearance of increased chemical and biological activity in reagent-free treated water is its transition due to the absorption of external excitation energy from a thermodynamically balanced state to a quasi-non-equilibrium excited state. Quasi, because after the termination of the action of the energy source of external excitation, the water will self-flow towards the restoration of the state of primary equilibrium (relaxation process). In the process of relaxation, the excess free energy acquired by water during excitation will be dissipated. If such an excited water molecule gets inside a living cell, then the released energy of excitement will be able to be perceived in accordance with its nature and purpose by the consumer of this energy, and which will eventually go to perform certain biological work in the cell.

Thus, excited (activated) water in the human body performs the role of an energy receiver of external non-reactive influence, that is, a battery and a distributor of this acquired energy, which is ultimately spent on meeting the energy needs of living organisms. From this, it becomes clear the presence of a variety of therapeutic effects from the use of activated water directly, or through drinks and food products, which are part of it. The most thoroughly biological (including therapeutic) effects were studied in the study of the processes of electrochemical activation of water<sup>45</sup>. It was established that aqueous solutions after unipolar (anodic or cathodic) electrochemical treatment in a diaphragm electrolyzer acquire a non-equilibrium state and abnormal physicochemical properties compared to anolyte and catholyte models obtained by dissolving the corresponding chemical reagents in water. By changing the conditions of electrolysis, aqueous solutions with predetermined redox properties are obtained in an extremely wide range of redox potential values in the reduced and redox state<sup>46</sup>. Electrochemically activated water (ECAW) goes into a metastable activated state, maintaining increased reactivity in various physicochemical processes for tens of hours.

Electrochemically activated (ECA) aqueous solutions are used in numerous industrial technologies for the production of various products.

45 Бахир, В. М. (1992). Электрохимическая активация. М.: ВНИИИМТ, 2, С. 29-30.

46 Прилуцкий, В. И., & Бахир, В. М. (1997). Электроактивированная вода. Аномальные свойства, механизм биологического действия. Труды ВНИИИМТ. Р. 228.

Interesting and promising biomedical effects of the use of EXA were also obtained, among which the high antibacterial activity of anolyte<sup>47</sup> stands out, which was widely used in medical practice for effective disinfection procedures<sup>48</sup>. The effectiveness of disinfection ensures the presence of chlorine oxide, hypochlorous acid, sodium hypochlorite in the anolyte, which is synthesized during the electrolysis of weakly mineralized sodium chloride solutions. Experiments<sup>49</sup> showed the high efficiency of neutral anolyte in the treatment of diarrhea in newborn calves caused by pathogens such as *Escherichia coli*, *Protens Vulgaris*, *Sulmonella Dublin*, etc. The death of these types of bacteria was observed after 5 minutes of contact with the anolyte, and staphylococcus died after 7 minutes. Neutral anolyte was given to calves with diarrhea 2 times a day, 200 ml per dose. Recovery was observed on the third day of treatment. When pigs are treated with anolyte (pH=2.5-3.4), the causative agent of erysipelas on various fragments of inflammatory zones dies after 6–7 minutes<sup>50</sup>. The work<sup>51</sup> describes the effective treatment of dogs with plague by taking anolyte (pH=2-3) and catholyte (pH=11). The authors<sup>52</sup>, summarizing the features of the effect of the use of catholyte on the health indicators of the body, conclude that the catholyte, which is characterized by an increased electron-donating state of biological environments, defines itself as a factor of antioxidant protection, that is, as a classic antioxidant<sup>53</sup>.

Catholyte with restorative electron-donating properties compensates the body for charges and energy lost during pathology<sup>54</sup>. In the study<sup>55</sup> observations of antimutagenic and anticancer properties of the use of

47 Бахир, В. М. (1999). Современные технические электрохимические системы для обеззараживания, очистки и активирования воды. М.: ВНИИИМТ, 84 с.

48 Бурак, И. И., Миклис, Н. И., Ширякова, Т. А., Григорьева, С. В., Черкасова, О. А., & Юркевич, А. Б. (2014). Гигиеническая оценка дезинфицирующего средства «Анолит нейтральный». Вестник Витебского государственного медицинского университета, 13 (5), С. 105-111.

49 Миклис, Н. И. (2007). Токсикологические свойства электрически активированных растворов. Вестник Витебского государственного университета. Том 6. №1. С. 1–7.

50 Золотухин, С., Пульчеровская, Л., & Барт, Н. (2019). Нейтральный анолит при желудочно-кишечных заболеваниях телят. Ветеринария сельскохозяйственных животных, (7), С. 34–40.

51 Детцель, Н. И. (2007). Особенности эпизоотического процесса чумы собак в ставропольском крае, совершенствование методов диагностики, профилактики и лечения. специальность 16.00.03 Ветеринарная эпизоотология, микология с микотоксикологией и иммунология. 157 с.

52 Бахир, В. М. (1992). Электрохимическая активация. М.: ВНИИИМТ, 2. С. 29–30.

53 Nakagava, S. (1998). Spectroscopic Characterization and the pH Dependence of Bactericidal Activity of the Aqueous Chlorine Solution. V.14.P. 691-698; Мирошников, А. И. (2004). Исследование причин биологического действия электрохимически активированных растворов по изменению роста клеток *E. coli*. Биофизика, 49(5), 866–871; Українець, А. І., Большак, Ю. В., & Маринін, А. І. (2017). Застосування безреагентно модифікованої води для підвищення ефективності харчового виробництва і поліпшення якості продукції. Наукові праці Національного університету харчових технологій, (23, № 5 (1)), С. 186–199

54 Голохваст, К. С., Рыжакон, Д. С., Чайка, В. В., & Гульков, А. Н. (2011). Перспективы использования электрохимической активации растворов. Вода: химия и экология, (2), 23–30; Щетинский, И. М., Педь, Б. П., Клубань, В. А., Майдич, А. В., & Ткачёва, К. В. (2014). Биологически активная вода (БАВ): материалы по новым способам её получения и применения. Проблеми зооінженерії та ветеринарної медицини, (29 (2)), С. 55–64.

55 Прилуцкий, В. И., & Бахир, В. М. (1999). Электрохимически активированная вода: аномальные свойства, механизм биологического действия. «МИС- РТ» №10-1.

catholyte are given. It is also known from literary sources<sup>56</sup> that the use of catholyte by experimental animals leads to an increase in their immunity and a decrease in the incidence of colds and infectious diseases. There is also a positive effect on the reproductive performance of animals, their metabolic functions and, ultimately, on weight gain<sup>57</sup>. In a meticulous and generalizing work<sup>58</sup>, the author proves that catholyte is a non-specific activator of the body's protective functions. Catholyte disrupts the dynamic balance and thereby gives an additional stimulus to the growth and development of the animal organism by affecting the electrolyte composition of the blood serum. Increasing its buffer alkalinity, increasing calcium content, optimizing the composition of the intracellular environment of the mucous membranes of the gastrointestinal tract. According to the authors<sup>59</sup>, catholyte has the properties of an immune response modulator. The author<sup>60</sup> notes that catholyte also has probiotic properties, the effectiveness of which is comparable to the effect of probiotic preparations. In experimental dysbacteriosis caused by long-term administration of an antibiotic (10 times higher than therapeutic doses), catholyte helps to accelerate the normalization of the physiological state and restore the number and functional activity of the intestinal microflora of animals compared to the effect of well-known probiotics of the «Astra» type.

6. Experimental studies of the acquisition of changes in the structural and energetic state by water upon contact with the surface of a rock crystal dispersion and its evolution due to the hydrodynamic excitation of the system.

According to the modern structural paradigm, when assessing the patterns of intermolecular interactions in water, when considering the interaction of water molecules with the hydrophilic surfaces of highly ordered crystalline structures (silicon dioxide, flint, rock crystal, etc.), the structure of water in the boundary layer acquires a crystalline ice-like order. The transition of

56 Прилуцкий, В. И., Бахир, В. М. Электрохимически активированная вода: аномальные свойства, механизм биологического действия. Москва, 1995. С. 1-151.

57 Мазаев, Ю. В., & Кравченко, В. Н. (2015). Применение электроактивированной воды в животноводстве. *Общественная научная организация «Наука и хозяйство»*, №4, 9 с.

58 Сибирцев, В. С., Кулаков, Л. Ю., Строев, С. А. (2016). Кондуктометрическое биотнствирование в применении к оценке про- и антибактериальных свойств католитов и анолитов. *Научно-технический вестник информационных технологий, механики и оптики*. Т. 16, №3. С. 573-576.

59 Бахир, В. М. (1992). Электрохимическая активация. М.: ВНИИИМТ, 2, 29-30; Сибирцев, В. С., Кулаков, Л. Ю., Строев, С. А. (2016). Кондуктометрическое биотнствирование в применении к оценке про- и антибактериальных свойств католитов и анолитов. *Научно-технический вестник информационных технологий, механики и оптики*. Т. 16, №3. С. 573-576.

60 Сибирцев, В. С., Кулаков, Л. Ю., Строев, С. А. (2016). Кондуктометрическое биотнствирование в применении к оценке про- и антибактериальных свойств католитов и анолитов. *Научно-технический вестник информационных технологий, механики и оптики*. Т. 16, №3. С. 573-576.

boundary water molecules to a crystalline ordered state is accompanied by the acquisition of an electrical charge with a minus sign by the structured water. At the same time, in liquid water, which according to modern ideas is a heterophase liquid-cluster system, the value of the redox potential of the system shifts in the direction of negative redox potential (RP) values, and the pH value increases accordingly. In order to experimentally verify the correctness of such considerations, we investigated the parameters of the structural and energetic state of distilled water (pH, redox potential, and total dissolved solids (TDS)) before contact with dyspeptic rock crystal (3...5 mm), during contact of water with a mineral in a static mode (table. 1), as well as after a cycle of mixing the dispersion with a dielectric (glass) stick with an intensity of 100 rpm, Fig. 1.

Table 1

**Parameters of the structural and energetic state of distilled water before and after contact with rock crystal dyspepsia**

| Indicator                               | pH   | RP, mV | TDS, mg/l |
|-----------------------------------------|------|--------|-----------|
| Control sample                          | 6,75 | 223    | 2         |
| After pouring the dispersion with water | 7,43 | 147    | 27        |

Under hydrostatic conditions of contact of distilled water with the surface of dispersed particles of rock crystal, the parameters of the structural-energy state of the liquid phase of water, as a result of the formation of a crystalline layer of boundary water on the surface of the rock crystal, changed slightly, namely by the value: pH=+0.67; RP=-76 mV; TDS =+25 mg/l. That is, the acid-alkaline balance of the liquid phase of water shifted towards the alkaline state of water, the redox balance shifted towards the reducing state of water, and the indicator of the total salinity of water increased by 25 mg/l.

After a cycle of 200 intensive stirrings of the rock crystal dispersion for 2 minutes at a room temperature of 21.5 °C, the indicators of the structural and energetic state of water acquired values corresponding to the starting points of Fig. 1.

It can be seen from the given data that relative to the parameters of water during its hydrostatic contact with the dispersion surface, the hydrodynamic excitation of the system led to an additional change in the parameters of the structural-energy state of water in the same direction as the changes during the hydrostatic mode of water contact with the rock crystal dispersion surface.

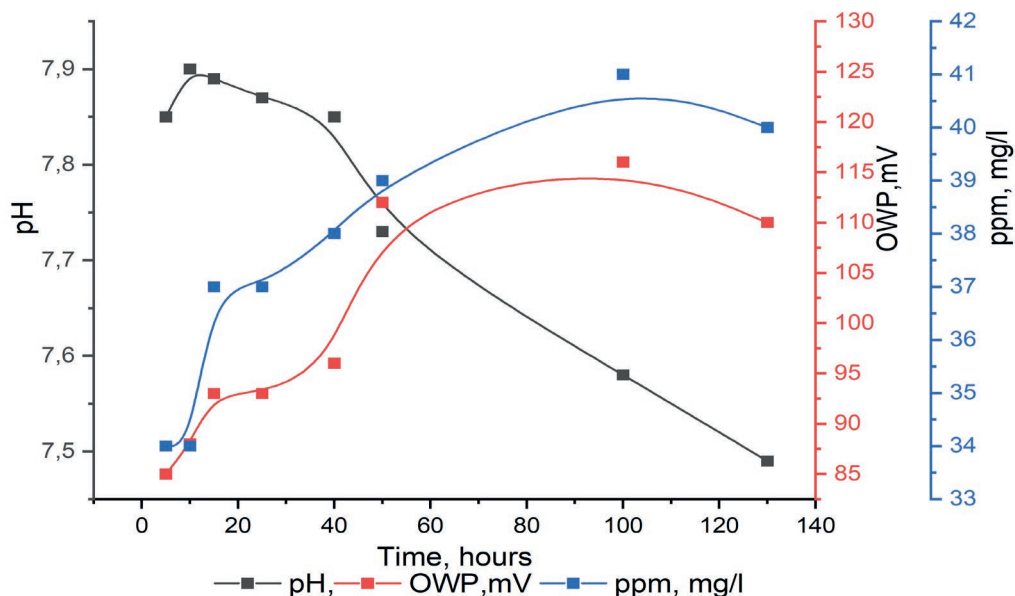


Fig. 1. The nature of changes over time in the parameters of the structural and energetic state of water in the relaxation process after the termination of external hydrodynamic excitation in the system.

To assess the nature of changes in the thermodynamic state of the system after its hydrodynamic excitation (non-equilibrium or quasi-non-equilibrium), the parameters of the structural and energetic state of water over time from the moment of termination of its hydrodynamic excitation by mechanical mixing of the dispersion were investigated.

In fig. 1 shows the values of pH, RP, and TDS value of water over a certain period of time from the moment the mixing of the dispersion was stopped. As can be seen, the value of the pH of the water automatically goes towards the initial (before the water is excited) values, which characterize a slightly more acidic state of the initial water. The value of RP spontaneously increases to the side of the oxidative redox state, which indicates that water has acquired a quasi-non-equilibrium state as a result of mechanical action on the rock crystal dispersion.

Thus, the results of the experiment fully correspond to modern ideas about the regularities of changes in the structural and energetic state of water during its interaction with the surface of hydrophilic solid highly ordered crystals. The presence of the relaxation process in the crystal-water system also indicates the

energetic excitation of water molecules during the transition to the structured state of boundary water.

Thus, the effects of the influence of external field factors on the structural and energetic state of water established by us are in full accordance with the ideas of modern science about the inextricable connection between the patterns of intermolecular interactions of water molecules and their interaction with hydrophilic molecules of foreign substances and the structure of water and the nature of energy excitations its molecules.

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## ФУНКЦІОНАЛЬНО-ТЕХНОЛОГІЧНІ ВЛАСТИВОСТІ ГОРОХОВОГО БІЛКУ

Білки гороху вважаються функціональними інгредієнтами для підвищення вмісту білка в раціоні, забезпечуючи при цьому певні функціонально-технологічні властивості (ФТВ) м'ясних і м'ясомістких систем. Інгредієнти гороху використовуються в різних формах у технології фаршевих продуктів залежно від рецептури та відповідності нормативним вимогам.

Білки гороху зв'язують вогугу і жир, і створюючи тверду текстуру завдяки вмісту амілози, ретроградації крохмалю та утворенню гелю. М'ясні продукти традиційно збагачуються різноманітними інгредієнтами (білками, клітковиною, крохмалем тощо) завдяки їх функціональності та текстурі.