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Features of the Shungite Rubble Effect on Medicinal Mineral Waters

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Abstract The results of experimental studies on the effect of shungite crushed stone on the therapeutic mineral waters of the sanatorium "Belokurikha" (Altai), used for the treatment of complex chronic diseases, are presented. The experiment was carried out using various samples of mineral waters pretreated with a natural mineral – shungite (Karelia), which includes fullerene C_{60}, which is a special allotropic molecular modification of carbon. Samples of artificial and natural shungite water were taken as comparison samples. It has been established that the main sensitive indicator of the quality of the studied water systems is their redox potential. Two possible mechanisms of action of fullerenes on mineral waters are presented. The fact of accelerated decay of residual radiation of radionuclides in the presence of fullerene, which performs the function of a mediator-accelerator of decay for them, is noted. The possibilities of practical application of shungite for the effective use of therapeutic natural waters of the Altai are evaluated. The effect of structuring water systems after contact with shungite has been established, based on changes in three main physico-chemical parameters: redox potential, specific electrical conductivity, and pH. The paper presents possible options and mechanisms for structuring water systems based on mineral therapeutic radon waters of Altai in their contact with shungite due to the presence of molecular carbon-fullerene in it. Based on the peculiarities of the RP change, new scientific data on the various effects of interaction of Altai radon therapeutic waters with fullerenes have been established. The possibility of both increasing and decreasing the redox potential has been experimentally proven, which makes it possible, if necessary, to radically change the therapeutic properties and functions of mineral radon waters.

Keywords Therapeutic Radon Waters, Belokurikha, Shungite, Fullerene, Redox Reactions, Redox Potential, Electrical Conductivity, pH

1. Introduction

The release of radon gas from the earth's surface (mountains, soil) is a well-known but rare phenomenon. Thus, only about 300 radon sources are known worldwide, 30 of which are located in the territory of Russia. The most popular of them are located in the resorts of Pyatigorsk (Caucasian MinVody), Belokurikha (Altai), Uvildinsk (Chelyabinsk region), Kranousolsk (Bashkiria) [1].

Currently, the sources of the unique healing natural radon water are located in the Altai region in a small area (1 km^2) of the famous resort town of Belokurikha. These therapeutic mineral waters are represented by complex water systems with low mineralization (below 0.5 g/l) containing various sodium salts (bicarbonates, sulfates, partially chlorides) with an admixture of various mineral components (fluorine, silicon, nickel, chromium, iron, titanium, etc.). These slightly alkaline waters are indicated for the treatment of the musculoskeletal and nervous systems, skin and dental diseases, diabetes mellitus, etc. The flow rates of wells during self-discharge are 1.5-36 l/s within the field. A distinctive feature of these waters is the presence of radioactive isotopes of the inert radon gas with radioactivity of 8-nKu/l [1-3].

It is known that these therapeutic radon thermal (temperature up to 40°C) waters occur when water passes through cracks and fractures of granites containing radioactive elements (uranium).

Radon is a colorless and odorless radioactive element with a half-life of 3.8 days. When released from the ground into the air, radon decays to form radioactive particles-radionuclides. The chain of uranium decay (Z=92), which is associated with the discovery of natural radioactivity by A. Becquerel, begins with uranium-238 and contains 15 radionuclides, including polonium-210, polonium-214, polonium-218 (Z = 84), radium-226 (Z = 88) and ends with the stable lead-206 isotope. During the decay of various radon isotopes, alpha particles (helium nuclei) and beta particles (electrons) are released. The alpha particle is the nucleus of a helium atom, and consists of two protons and two neutrons. In the air, the range of the alpha particle does not exceed several centimeters. In soft biological tissues, the range of Beta rays (which are electrons) is several tens of micrometers. They can fly several meters in the air, and they can penetrate into soft tissues at a distance of several millimeters [4-8].

Currently, the Belokurikha sanatorium is popular and highly appreciated by residents of the Russian Federation. Therefore, it is being updated and expanded. Thus, currently it is planned to create an additional new resort "Belokurikha Gornaya", which will be designed for 235 thousand tourists per year. It will be built with funds allocated under the national project of the Russian Federation "Tourism and Hospitality Industry". Work on the master plan "Belokurikha Gornaya" is in the final stage. It is planned to build three- and four-star hotels, an aquathermal complex, equip public spaces, including for festivals, as well as create a new eco-trail. The new resort will be able to receive more than 3 thousand vacationers and patients treated for ailments at a time. In this regard, it is necessary to create conditions for proper rest and effective treatment with radon waters of the Altai [9-14].

The purpose of the research is: 1-to evaluate the possibility of the effect of natural material-shungite (Karelia), containing a new nanomaterial-fullerene, on the quality and functional features of natural radon waters. 2-to develop an operational method for evaluating the medicinal properties of natural medicinal waters to increase the effectiveness of hydrotherapy using shungite.

2. Materials and Methods

Materials: samples of natural healing waters of Altai, distilled water, and shungite, a sample of natural shungite water (shungite Marcial waters of Karelia).

Shungite crushed stone from the Zazhoginsky deposit (Karelia) is shown in Figure 1 [15].

Figure 1. Shungite crushed stone from the Zazhoginsky deposit (Karelia)

The shungite used is produced according to TU 2164-006-73698942-08-"Shungite material "ECOFIL" for drinking and technical water supply". The shungite composition includes the main components of the mineral-carbon (contains molecular carbon-fullerene) and silicon with an admixture of compounds of iron, magnesium, aluminum, calcium, etc.

The use of shungite for water treatment is permitted by the Russian Ministry of Health-Sanitary and Hygienic Conclusion No. 10KTs03.5711100427.07.02 dated 02/27/2002.

Devices: Potentiometer, conductometer, laboratory ionomer I-160 (Gomel plant of measuring devices).

The research methods are based on the determination of the electrochemical characteristics of the studied water systems with and without the addition of shungite crushed stone. Preliminary exposure to medicinal waters in contact with shungite was from 24 to 96 hours.

The main electrochemical parameters were determined experimentally for the waters under study:

1. Oxidation-reduction potential ORP - redox potential was measured using a platinum electrode EPV and a glass redox electrode EO-01.
2. The ORP of solutions was recorded automatically and simultaneously on several indicator electrodes. The measurement time was 5 minutes, at a temperature of (25±0.1)°C [16-18];
3. Specific electrical conductivity. The measuring cell (sensor) is rinsed with distilled water, then with the analyzed water sample twice, and the specific electrical conductivity is measured. For each water sample, at least two parallel measurements are carried out at a temperature of (20±0.1)°C [19];
4. Hydrogen index (pH). The electrodes are thoroughly rinsed with distilled water, and the remaining water is removed by blotting them with filter paper. They are lowered into the analyzed sample, and after 1-3 minutes (after a constant value has been established) the instrument readings are recorded. The measurements are repeated after 1 minute, at a temperature of (25±0.1)°C [20].

Each of these indicators characterizes certain properties of water systems. Nevertheless, in scientific terms, RP is considered to be the most important indicator of water suitability for human life [21]. The RP value for drinking water should not exceed the value of +60 mV. The redox potential of water characterizes its ability to enter into biochemical reactions. If the RP has a positive value, then oxidants are present in it. Suppose the potential is negative - reducing agents. But the water has no RP: pure water is neither an oxidizer nor a reducing agent. The RP value of a living healthy cell in our body is approximately (-100 mV). This indicator varies depending on water saturation with chemical pollutants - dissolved metal salts (phosphates, carbonates, sulfates, nitrates, etc.), as well as biological pollutants - bacteria and viruses. All of these affect the electron electromotive force. Therefore, by measuring the RP, it is possible to assess the water quality.

3. Results

Experimental data on the characteristics of laboratory samples of shungite water (water after contact with shungite) are presented in Table 1.

It follows from Table 1 that the water being infused with shungite changes its electrochemical properties over time (24-96 hours). An increase in RP was noted with a simultaneous decrease in pH and an increase in electrical conductivity. These facts indicate the creation of a special water structure under experimental conditions (water structuring), which can be explained by nanocomponent presence in shungite - fullerene C_{60}, which belongs to nanocarbon products [21].

Natural shungite fullerene is soluble in water. Pure fullerene C_{60} with a mass fraction of the basic substance 98.00-99.90% is produced according to TU 1916-002-55154581-2009 by laser action on graphite. Fullerene molecules, having conjugated electronic structures, have strong electrophilic properties, due to which they can dramatically change the water properties. In natural conditions, as noted earlier, fullerene is found in the mineral shungite, which is mined in Karelia. Currently, shungite has been found wide application in metallurgy, construction, and alternative medicine, as well as it is used as a substance for water filtration. Having radioprotective properties, it is used for radioprotection. Shungite, as noted earlier, structures water. According to structuring degree, shungite water is similar to such famous mineral waters as Essentuki, Narzan, and Borjomi. From a scientific point of view, this is explained by the interaction of the fullerenes contained in shungite with water and the formation of ordered water molecules around them, called hydrated fullerenes, with properties close to cellular fluid. Shungite containing fullerene is a special natural material, and its possibilities of use and practical significance are currently not fully studied.

To this date, despite a number of discoveries in the field of chemistry and reactivity of fullerenes, there is a lack of in-depth research of practical and theoretical knowledge.

We present a possible mechanism for structuring drinking water with fullerene (Figure 2).

Table 1. The effect of shungite contact time with water on its electrochemical parameters

Electrochemical indicators	Time, hour			
	24	48	72	96
Electrical conductivity, S	$0.335x10^{-3}$	$0.530x10^{-3}$	$0.535x10^{-3}$	$0.540x10^{-3}$
pH	6.7	5.4	4.8	4.7
Redox potential (RP), mV	96.5	127	149	155

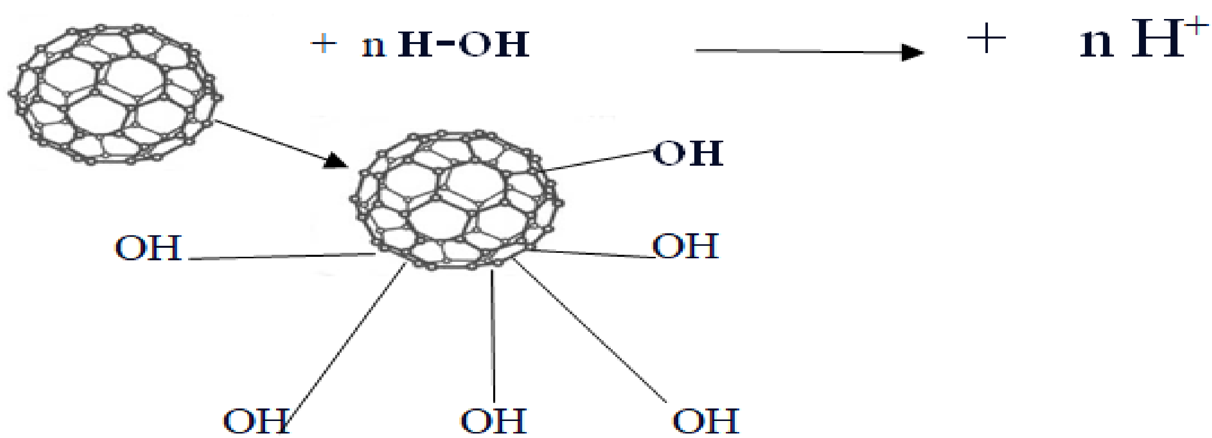

Figure 2. Water structuring

To compare the properties of artificially obtained and naturally structured shungite water (Marcial waters from Karelia), Table 2 is presented.

Table 2. Properties of natural shungite water

Electrical conductivity, S	pH	RP, mV
0.2.43x10^{-3}	3.74	193.2

It follows from Table 2 that natural healing shungite water has an acidic environment with a high positive RP and increased electrical conductivity (used in a sanatorium for external therapeutic effects). Shungite water has special properties. Thus, at the Academy of Cosmonautics n.a. K.E. Tsiolkovsky entire nutrition for astronauts is created only on the basis of shungite water. Research conducted with various institutes at home and abroad has proved that when the structure of water changes dramatically (several times), its chemical and biological activity changes.

4. Discussion

Experiments based on the natural radon waters of Altai. Four types of medicinal water of different compositions from different sources with a shelf life of 5 days were taken for research. To assess the effect of shungite on medicinal waters, the electrochemical parameters of the initial samples and water samples that were infused for 2 days on shungite crushed stone were measured. The results of comparative tests are presented in Table 3, which confirm the special and different effects of shungite material on various natural radon mineral waters from sources: Dunyashkin Klyuch, Staraya Belokurikha, Khram Panteleimona, Istochnik 1.

It follows from Table 3 that the contact of the initial mineral water with shungite dramatically changes its electrochemical characteristics. The most important of them is the redox potential (RP).

It was found that all initial samples of mineral waters have a negative RP of different values, and the most active water is water from source 1 (-58 mV). The negative potential of water indicates its ability to transfer electrons to surrounding objects (reducing the potential of RP). The RP value of a living healthy cell in our body varies around -100 mV. RP is used to assess the water quality in a particular system. Further results analysis of the experiment using shungite revealed its different effects on various samples of therapeutic radon water. The infusion of this water on shungite changes the operator and value of RP.

The effect of shungite on the properties of mineral waters. An increase in the negative potential is observed in the water sources "Staraya Belokurikha" (shift of the RP to the negative value by 10 mV) and "Khram Panteleimona" (shift to the negative value by 23 mV).

An increase in the positive potential (RP) - the greatest shift to the positive value is observed in water from 2 sources: "Dunyashkin key" (shift to the positive value is 50 mV), "Istochnik 1" (RP shift to the positive value is 52 mV). Other indicators (pH and electrical conductivity) correlated with the magnitude and RP shift, but were complex. But with an increase in the negative potential, the pH value of the medium increased as well as the electrical conductivity. These experimental data indicate the possibility of controlling the activity of Altai mineral therapeutic waters of different compositions with the help of shungite. An increase in the negative potential in radon waters indicates the presence of residual radioactivity with beta decay: according to the reaction:

$$^{219}\mathrm{Rn} \text{ ------ } \alpha \text{ -----} {}^{215}\mathrm{Po} \text{----- } \alpha \text{ -----} {}^{211}\mathrm{Pb} \text{------ } \beta \text{ ---- } {}^{211}\mathrm{Bi}$$

Table 3. Electrochemical properties of the healing waters of the Belokurikha sanatorium

No.	Water source	Redox-potential, RPm S, mV	pH	Specific electrical conductivity, S
1	Staraya Belokurikha	-29.1	7.5	0.5 x 10^{-3}
2	Staraya Belokurikha with shungite	-41.6	7.8	0.6 x 10^{-3}
3	Dunyashkin Klyuch	-21.5	7.4	0.31 x 10^{-3}
4	Dunyashkin Klyuch with shungite	32.7	6.5	0.38 x 10^{-3}
5	Khram Panteleimona	-28.5	7.6	0.41 x 10^{-3}
6	Khram Panteleimona with shungite	-51.3	8.0	0.45 x 10^{-3}
7	Istochnik 1	-58.0	8.0	0.45 x 10^{-3}
8	Istochnik 1 with shungite	-6.4	7.0	0.49 x 10^{-3}

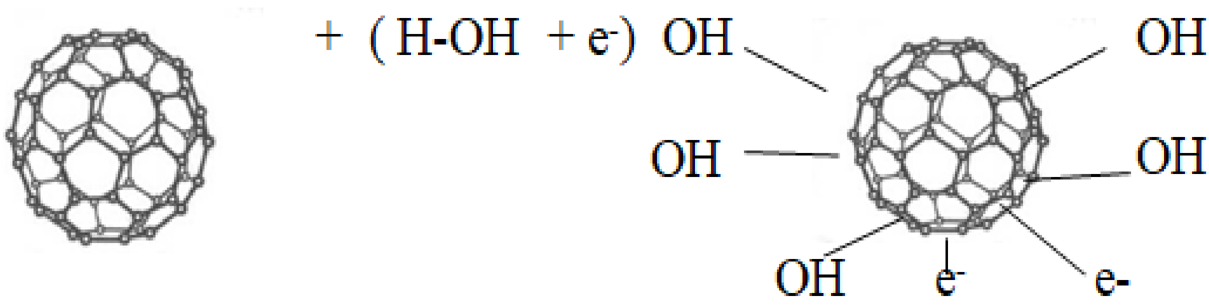

Figure 3. Diagram of the structure of the adsorption layer on a fullerene molecule

This is due to the fact that upon contact with shungite, due to the presence of an electrophilic component in it, fullerene, the decay of radionuclides is accelerated. Fullerene is a mediator of this process. In the presence of residual radioactivity in mineral water, accelerated beta decay of radionuclides with the release of electrons (the last stage of the radioactive decay process) is most likely in the presence of shungite. These results indicate the presence of residual radioactivity in the therapeutic water. It should be noted that the electrons released during beta decay from radionuclides are attracted by the strong electronic structure of conjugated fullerene electronic systems (Figure 3), which are subsequently spent on the reduction of some metal cations, oxidation of organic radicals, and active oxygen radicals.

It follows from Figure 3 that electrons from the beta decay of radionuclides are attached to the active points of fullerene. The higher the deviation of the RP into the negative region, the higher the residual radioactivity in the water under study. When the RP increases and shifts to the positive value (there is no residual radiation), structuring proceeds according to the mechanism shown in Figure 2. The experimental data found indicate the possibility of increasing the efficiency of using Altai mineral therapeutic waters and assessing the quality of water systems. Work in this direction continues.

5. Conclusions

1. The results of studies on the electrochemical properties of various samples of water systems (distilled water, natural shungite water, and various samples of mineral waters of the Belokurikha sanatorium) after contact with natural material shungite, which is a mineral with a wide range of useful properties, are presented.
2. The effect of structuring water systems after contact with shungite has been established, based on changes in three main physical-chemical parameters: redox potential, specific electrical conductivity, pH.
3. Possible variants and mechanisms of structuring water systems based on mineral therapeutic radon waters of Altai therapeutic radon waters in their contact with shungite due to the presence of molecular carbon-fullerene in it are presented.
4. Based on the peculiarities of the change in RP, new scientific data on the various effects of interaction of Altai radon therapeutic waters with fullerene have been established. The possibility of both increasing and decreasing the redox potential has been experimentally proven, which makes it possible, if necessary, to drastically change the therapeutic properties and functions of mineral radon waters.

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REFERENCES

[1] Lagutkina A.A., Dzhappuev D.D., Kudzhaev A.U., Kuleshov D.A., Kurinov K.O., Miklailova I.I., Stenkin Yu.V., Shchegolev O.B., "Analysis of variations in the concentration of radon decay products in the near-surface layer of the atmosphere", Izvestiya Akademii nauk SSSR. The series is physical, vol. 87, no. 7, pp. 1048-1051, 2023. DOI: 10.31857/S0367676523701880.

[2] Vikhareva I.N., Zaripov I.I., Kinzyabulatova D.F., Minigazimov N.S., Aminova G.K., "Biodegradable polymer materials and modifying additives: state of the art Part I." Nanotechnologies in Construction, vol. 12, no. 6, pp. 320–325, 2020. DOI:10.15828/2075-8545-2020-12-6-320-325.

[3] Kormanovskaya T.A., Romanovich I.K., Vyal'cina N.E., Gaevoj S.V., Kononenko D.V., Saprykin K.A., Kokoulina E.S., Koroleva N.A., "Public exposure in the Orenburg region due to natural sources of ionizing radiation. Part 2: Doses to the population of the eastern districts of the Orenburg region", Radiation hygiene, vol. 16, no. 2, pp. 7-18, 2023. DOI: 10.21514/1998-426X-2023-16-2-7-18.

[4] Timmons S., Lunn.D., "Behaviourally-informed household communications increase uptake of radon tests in a randomised controlled trial ", Sci Rep., vol. 13, no. 1, p.20401, 2023. DOI: 10.1038/s41598-023-47832-z.

[5] Chalofsky, N. L. et al., "The effectiveness of health information for radon gas awareness and testing varies depending on the age, gender and profession of the audience", Sci. Rep, vol. 11, no. 1, p.11906, 2021. DOI: 10.1038/s41598-021-91479-7.

[6] Stanifer S. R., Rainis M. K., Wiggins A. and Khan E. D., "Social Determinants of Health, Environmental Exposures and Home Radon Testing", West. J. Mors. Res, vol. 44, no. 7, pp. 636–642, 2022. DOI:10.1177/01939459211009561.

[7] Abdelhamid, A. A., Badr, M. H., Mohamed, R. A., and Saleh, H. M., " Using Agricultural Mixed Waste as a Sustainable Technique for Removing Stable Isotopes and Radioisotopes from the Aquatic Environment " *Sustainability*, vol. 15, no. 2, p. 1600, 2023. DOI: 10.3390/su15021600.

[8] Daoud, M. M. A., Hegazi, M. M., Saleh, H. M., and Al Helu, V. K., "Removal of stable and radioisotopes from wastewater using modified microcrystalline cellulose based on Taguchi L16", Int. J. Environ. Sci. Technol., vol. 20, pp. 1289–1300, 2023. DOI: 10.1007/s13762-022-04073-3.

[9] Fesyun A.D., "Current Status and Prospects for the Development of Health Resort Complex of the Russian Federation", Bulletin for Rehabilitation Medicine, vol. 22, no. 1, pp. 8-15, 2023. DOI:10.38025/2078-1962-2023-22-1-8-15.

[10] Fesyun A.D., Aleksanin S.S., Bobrovnickij I.P., Bykov A.T., "Updating scientific approaches of restorative medicine to improving sanatorium and resort treatment", A monograph under the general editorship. Moscow: LLC “Grin PrinT”. p. 224, 2022.

[11] Scientific and practical guide for doctors “Sanatorium-resort treatment”. under the general editorship of A. D. Fesyun. - Volume 1. Basics of spa treatment. Moscow. LLC «RenovaciYA». 2022: 496 s.

[12] Borodulina I.V., Gerasimenko M.Yu., Poberskaya V.A., "Principles of sanatorium-resort treatment of adults and children of childhood who have suffered COVID-19", Russian Journal of Physiotherapy, Balneology and Rehabilitation, vol. 20, no. 5, pp. 461-471, 2021. DOI: 10.17816/rjpbr107839.

[13] Fesyun A.D., Yakovlev M.Yu., Litvinyuk Ya.A., "Prospects for the development of the sanatorium and resort industry of the Russian Federation", Vopr Kurortol Fizioter Lech Fiz Kult., vol. 97, no. 4, pp. 52–57, 2020. DOI: 10.17116/kurort20209704152.

[14] Bobrovnickij I.P., Prilipko N.S., Turbinskij V.V., Yakovlev M.Yu., "Environment and public health: current issues in the organization of healthcare and medical education", Healthcare Manager, no. 1, pp. 5–14, 2021.

[15] Shigaeva T.D., Polish M., Kudryavtseva V.A., "Redox potential as an indicator of the state of environmental objects", Biosphere, vol. 12, no. 3, 2020, pp. 111-124. 2020. DOI: 10.24855/biosfera.v12i3.549.

[16] Selyanina S.B., Trufanova M.V., Yarygina O.N. [et al.], "Features of biotransformation of organic substances in the conditions of swamp ecosystems of the North (on the example of the Ilassky swamp massif)", Proceedings of the I.D. Papanin Institute of Biology of Inland Waters of the Russian Academy of Sciences, vol. 79, no. 82. 2017, p. 200. 2017. DOI: 10.24411/0320-3557-2017-10040.

[17] Shigaeva T.D., Polyakov Yu. N.M., Kudryavtseva V.A., "Redox potential as an indicator of the state of environmental objects", biosphere, vol. 12, no. 3, pp. 111-124, 2020. DOI 10.24855/BIOSFERA.V12I3.549.

[18] Antipin I. S., Kazymova M. A., Kuznetsov M. A. [et al.], "Organic chemistry. History and mutual relations of universities of Russia", Russian Journal of Organic Chemistry, vol. 53, no. 9, pp. 1275-1437, 2017. – DOI 10.1134/S1070428017090019.

[19] Yalaletdinova, A, Kantor, E., Galimova, Yu., "Drinking-water Quality Risk Assessment Based on Parameters with Organoleptic (Taste and Odor) Effects Observed in Water from Surface Water Intake and Infiltration Water Intake Facilities", IOP Conference Series: Earth and Environmental Science, vol. 670, p. 012046, 2021. DOI: 10.1088/1755-1315/670/1/012046.

[20] Deines J., Kovalevsky V., Kochneva I., Moshnikov I., Rozhkova V., "Physical and chemical properties of shungite rocks from different stratigraphic levels of the zaonega formation", Proceedings of the Karelian Research Centre of the Russian Academy of Sciences, pp.84-89, 2020. 10.17076/geo1187.

[21] Kuptsova P.S., Komarova L.N., Vypova E.R., "Study of the radioprotective properties of fumaric acid and 3-hydroxypyridine fumarate under the action of ionizing radiation on human cells», Radiation Hygiene, vol. 16, no.1, pp. 32-39, 2023. DOI:10.21514/1998-426X-2023-16-1-32-39.