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QUANTITATIVE STUDY OF SOME BIOLOGICALLY ACTIVE IONS IN THE FRESH WATERS OF SUKHCHE VILLAGE (KHONI MUNICIPALITY, IMERETI REGION) AND THEIR SIGNIFICANCE FOR THE VITALITY OF LIVING ORGANISMS

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For the first time, the hydrochemical examination of the spring waters of Sukhche village of Khoni municipality was conducted. The content of magnesium and calcium ions, bicarbonate ions, chloride ions, sulfate ions, dry balance, permanganate oxidizability, dissolved oxygen, DOM_5 and carbon dioxide content has been determined. Relatively simple and fast chemical and physical-chemical methods with good reproducibility were selected for determination. Biogenic substances were determined by the photometric method. The content of the above-mentioned ions from the spring waters of Sukhche village of Khoni municipality is within the norm and its use for drinking and from the agricultural point of view is appropriate.

Keywords : Spring waters, ions, biogenic elements, titrant, indicator

Aim. We aimed to study the hydrochemical composition of the spring waters of Sukhche village of Khoni municipality. The importance of magnesium and calcium, as well as chlorine ions in managing the life processes of human, animal and plant organisms has been taken into account. The aim of our research was to study Mg^{2+}, Ca^{2+}, HCO_3^- Cl^-, SO_4^{2-}, CO_2, permanganate oxidizability, oxygen content, BBM_5, dry balance, and content of biogenic elements in the spring waters of Sukhche village of Khoni municipality.

Introduction. During rain, a large part of the water enters the ground. First it passes through the loose layer of the ground, then it goes deeper into the ground. It will pass through the sand, pebbles and stones. This is the way how the water is cleaned. Finally, it passes through that layer. which does not carry water. Clean water is collected in the ground. A person digs the ground in such a place. The well is a deep and narrow pit. There is water at the bottom of it. The heat of the sun does not penetrate deep into the earth. That's why the well water is cold. They take out water from the well with a vessel and drink it. Sometimes the bottom layer of the earth is sloping. Because of this, water cannot be accumulated. It flows into the ground. In the end, it can go up. This is how the source appears, which is also cold and clean. A person drinks spring water. While moving

through the soil crust, water acquires many substances, including salts, and a specific composition is formed. The amount of salts in water varies within wide limits, their total concentration e.i. the mineralization is relatively low in surface water and significantly high in groundwater [9].

Natural waters contain almost all the chemical elements in different concentrations – calcium, magnesium, sodium, potassium and iron cations are usually found in fresh water, and chloride, sulfate and bicarbonate ions are mainly found in anions. Natural waters have an approximately neutral reaction due to equal amounts of opposite charges. The total concentration of cations in water is equal to the total concentration of anions. One of the main tasks when investigating the composition of water was to determine the content of ions. The human body receives macro- and microelements from the environment with food, water or, rarely, air. The relationship between the physical-chemical characteristics of the elements and their biological activity allows predicting the expected result of the compounds of these elements entering the body [1].

Magnesium and calcium belong to the elements of life. The difference between the properties of magnesium and calcium cations is related to the different density of positive charge on their surface. The magnesium ion has a smaller radius, it hydrates better. Its free atomic orbitals interact with the unshared electron pairs of oxygen of water molecules by forming fairly stable aqua complexes. Hydrated magnesium cation is hydrolyzed unlike calcium cation. The ability of magnesium cation to form a complex is greater than that of calcium ion, but the latter forms strong complexes with amino acids and proteins. In the human body the content of magnesium is 0.04%, and that of calcium is 14%. Magnesium cation, similar to calcium cation, is mainly an intracellular ion and causes the constant osmotic pressure in it. Magnesium cation is the main activator of enzymatic reactions: it activates oxidative phosphorylation, DNA replication and bone tissue mineralization enzymes. In intracellular fluid magnesium cation forms complexes with ATP and ADP anions. Magnesium cation is the most important central ion in the chlorophyll cluster of metalloprophyrin. Photosynthesis takes place with its participation. Magnesium ions inhibit the release of some substances from the body (for example, acetylcholine) and promote others (for example, cholesterol), unlike calcium ions, which, on the contrary, inhibit the release of cholesterol, while stimulating the release of acetylcholine. The absorption of calcium from food products mainly depends on vitamin D. Unlike magnesium ions, calcium ions are concentrated in the intercellular fluid. It is the main component of bone tissue.

When the calcium ion concentration in the blood plasma decreases, mineral compounds are opened and the calcium cation content in the plasma increases due to hormonal action. Thyroid hormone activates salt secretion in bone tissue. Calcium ions are involved in nerve impulse transmission, muscle contraction, heart rhythm regulation, blood clotting process. Calcium ions inhibit the excitability of the central nervous system. And the reduction of its concentration causes seizures [6].

In the human body carbon content is 21.15%. It is included in all tissues and cells. in the form of an insignificant organic substance. From inorganic carbon compounds, carbon (IV) oxide, carbonic acid and its salts, hydrocyanic acid and its salts have medical biological importance.

Oxygen forms a double bond due to the presence of two unpaired electrons. Unlike sulfur atoms, it cannot increase the valency by removing electrons. Two unshared electron pairs allow the oxygen atom to form a donor-acceptor bond with each other. It uses both electron pairs to form a hydrogen bond. Without oxygen, it is impossible to carry out numerous, extremely important life processes. In particular, breathing, oxidation of the substrate, the main function of oxygen in the body is the oxidation of substances and the release of energy. Biological oxidation can be free when the released energy is converted into heat and chelated, and reactive when the released energy is used to drive endoergic reactions. It is important for the cell that oxygen is completely restored, otherwise its various active forms are obtained: superoxide anion-radical, hydroperoxide and hydroxide radicals, hydrogen peroxide and singlet oxygen. The body is protected from active forms of oxygen through the antioxidant system. It consists of the enzymes superoxide dismutase and catalase. Under the action of the former, the peroxide radical is transformed into oxygen and hydrogen peroxide, which, under the action of catalase, produces water and oxygen. Oxygen and its compounds are less active ligands. One liter of blood plasma dissolves five milliliters of oxygen. Hemoglobin has the function of carrying iron, which forms oxyhemoglobin with oxygen. With the help of this complex, one ml of blood can carry 250 ml of oxygen.

The large radius of the sulfur atom and relatively small electronegativity in the inner electronic screen and the presence of a vacant 3d orbital in the outer electron level lead to a decrease in the energy of the sulfur-containing bonds and an increase in the polarization of both the bonds and the unshared electron pairs in the outer level. The sulfur atom is a very soft center in compounds that preferentially interacts with soft easily polarizable reagents.According to the content in the body, sulfur (0.16%) belongs to macroelements. It is included in the composition of proteins, amino acids (cystine and cysteine), hormones (insulin) and vitamins (B_1). It contains hair creatine, bones, nervous tissue. Sulfur contained in amino acids is oxidized in living organisms, and the final products of oxidation are predominantly sulfates. Endogenous sulfuric acid produced in the body, participates in the detoxification of poisonous substances – phenol, cresol, indole – produced from amino acids by microbes in the intestines. In addition, sulfuric acid binds to medicinal preparations, their metabolites, compounds foreign to the body and is excreted from the body..

In the human body chlorine content is 0.15%. It is mainly present in the intercellular fluid. The body's daily need for chlorine is 4-6 g. Chlorine ions participate in the creation of a buffer system, in the regulation of osmotic pressure and water-salt exchange, they are part of some enzyme systems. They have an optimal radius for passing through the cell membrane [8].

The main part of the southern part of the Khoni district is occupied by the Imereti plain. The district is divided by the tributaries of the rivers: Tskhenistskali and Gubistskali. The plain is made up of Quaternary pebbles, sands, loams and clays. To the north of the plain, the hilly foothills of Kolkheti, built with Paleocene-Eocene limestones, extend in a narrow strip. The district is located in the region of humid subtropical climate of the sea and is characterized by the altitudinal zonation of the air to match the terrain. In the middle mountainous zone, there is a cold winter and a long cool summer humid weather, similar to the weather in the highest places of the region on the Askhi plateau, with the difference that the summer there is short. In addition, precipitation is more abundant in the middle mountainous zone than in the foothills and lowlands. The main river is Tskhenistskali, it is joined by the heavily branched Satsiskvilo river, as well as Gordi water and Sukhche water. The second big river is Gubistskali. its tributaries within the district are: Upper (Zemo) Kukhi and Middle (Shua) Kukhi. There is a karst river on the Askhi massif. Alluvial soil of medium and large thickness is developed along the rivers on the plain [7].

Judging the experiment. The relevance of the issue lies in the fact that the content of the above-mentioned ions was determined for the first time in the given waters, for which highly sensitive methods were chosen [2-5]. Thus, Mg^{2+}, Ca^{2+}, HCO_3^- were determined for the first time in the spring waters of Sukhche village of Khoni municipality. Cl^-, SO_4^{2-} ions, CO_2, permanganate oxidizability, oxygen content, HBM_5, dry balance, biogenic elements – by chemical and photometric methods. The results of the analysis are given in Table 1.

Table 1

Hydrochemical investigation of some spring waters of Sukhche village of Khoni municipality, Mg/L

N	Regional names of spring waters	pH	SO_4^{2-}	Ca^{2+}	Mg^{2+}	HCO_3^-	Cl^-	dissolved oxygen	BOD_5	Permanganarimetric oxidizability	CO_2	Dry balance
1	Suchkhela	7.42	0.016	3.38	0.16	4.54	1.04	4.10	2.56	0.82	0.84	1.090
2	Khidi	7.54	0.029	1.46	0.41	2.18	0.58	3.52	2.24	0.16	0.62	1.021
3	Bzanara	7.68	0.012	3.56	0.05	3.98	0.68	3.02	1.98	0.48	0.66	0.963
4	Mogeladze	7.49	0.016	3.51	0.52	4.71	1.02	2.88	1.54	0.90	1.82	0.954
5	Jelias	7.32	0.021	4.92	1.92	7.12	1.06	3.07	2.30	0.88	2.02	1.141
6	Cold spring	7.34	0.013	5.44	1.62	6.94	1.08	3.10	2.25	1.14	2.18	1.075
7	Khurtsilava	7.24	0.025	4.94	1.54	6.98	0.72	3.39	2.30	0.64	1.74	1.780

Mg^{2+}, the ion in the largest amount is contained in the source of Jelias 1.92 mg/l. Its content is the smallest in the Bzanara spring at 0.05 mg/l SO_4^{2-}

The Ca^{2+} ion content is also variable. Its relatively large amount was observed in the cold spring at 5.44 mg/L, while Ca^{2+} content was low at 1.46 mg/L in the Khidi spring.

The HCO_3^- ion content is the largest in the Jelias spring at 7.12 mg/l, the content of hydrocarbonate ions is the smallest in the Khidi spring at 2.18 mg/l.

SO_4^{2-} ion high concentration is recorded in the source of the Khidi at 0.29 m g/l. Bzanara spring contains a small amount of sulfate ions at 0.012 mg/l.

The cold springwater contains a relatively large amount of Cl^- ions, 1.08 mg/l. And its mass content is small in Bzanara spring water at 0.58 mg/l.

The content of carbonic acid gas is the highest in the cold spring at 2.18 mg/l. Sukhchela spring contains a small amount of carbonic acid gas, 0.84 mg/l.

Permanganate oxidizability is relatively high in cold spring water 2.18 mg/l, its small amount is fixed in Bzanara spring water 0.48 mg/l.

The oxygen content is high in Sukhchela spring, 4.10 mg/l. A relatively low concentration of oxygen is recorded in the Mogeladze spring water at 2.88 mg/l.

The dry balance is the highest in Khurtsilava spring at 1,780 mg/l. Its content is the smallest in the Mogeladze spring at 0.963 mg/l.

DOM_3 is the highest in Sukhchela spring at 2.56 mg/l, the lowest in Mogeladze spring water – 1.54 mg/l, DOM_3.

The content of biogenic elements NO_2^-, NO_3^-, NH_3, PO_4^{3-} is lower than the detection limit. No biogenic elements are found in the investigated spring water of Sukhche village of Khoni municipality.

Experimental part. Methodology for determination of chemical elements in water

The analyzes were carried out in the Analytical Chemistry Laboratory of Kutaisi Akaki Tsereteli State University. The methods tested in hydrochemical practice were used for the analysis [2].

The acidity rate was measured by the potentiometric method (potentiometer pH 673-M). The mercurimetric method was used to determine chlorides (titrant 0.01 $Hg(NO_3)_2$, indicator (diphenyl carbazole). Hydrocarbons were determined by the acidimetric method (titrant 0.1-0.01 N HCl, indicator methyl orange).

The content of calcium and magnesium, as well as the total hardness of the water under investigation, was determined by the complexonometric method (titrant 0.01 N Complexon III). To determine the magnesium ion content, we used eriochrome as an indicator, we created the recommended area with an ammonia buffer, and to determine the calcium ion, Merexide was used as an indicator. We created an alkaline area with 2N sodium alkali.

Sulfate ions were determined by the classical gravimetric method, they represent a precipitated form $BaSO_4$. Carbonic acid gas was determined by the alkalimetric method. Titrant 0.1-0.01N NaOH. Indicator Phenophthalein.Oxidability was determined by the permanganatometric method (oxidizing agent 0.01 N $KMnO_4$, in acidic area), titrant 0.01 N $H_2C_2O_4$) [10].

The oxygen content was determined by the iodometric method (titrant 0.01 N $Na_2S_2O_3$). In an alkaline environment $Mn(OH)_2$ is oxidized by oxygen dissolved in water and passes into a tetravalent manganese compound, which is formed by acidifying the solution KI in excess I_2. DOM_5 were determined by the mentioned method. The dry weight was determined by the classical gravimetric method.

Biogenic substances were determined by the photometric method [11]: NO_2^- shell reagent, NO_3^- sodium salicylate, NH_4^+ – Nessler's reagent, PO_4^{3-} – ammonium phosphorolybdate.

NO_2^- – its photometric determination using Gries's reagent in the acid zone is based on the reaction of formation of a reddish-brick-colored azo dye as a result of the interaction of sulfanilic acid, nitrite ion and alpha-naphthylamine.

NO_3^- – it was determined by the photocolorimetric method using sodium salicylate. The method is based on the interaction between nitrate ions and sodium salicylate ions, in the presence of sulfuric acid, during which the resulting yellow coloration is directly proportional to the nitrate ion concentration.

The determination of NH_4^+ is based on the interaction between the ammonium ion and Nessler's reagent (mercury tetra iodide) in the alkaline zone, during which the resulting yellow coloration is directly proportional to the concentration of the ammonium ion.

PO_4^{3-} was determined by the photocolorimetric method, which is based on the interaction of orthophosphoric acid and ammonium molybdate in the acid zone, during which the blue color formed is directly proportional to the concentration of phosphate

Conclusion. In the studied spring waters of Sukhche village of Khoni municipality, the content of Mg^{2+} Ca^{2+}, HCO_3^- Cl^-, SO_4^{2-}, CO_2, permanganate oxidizability, oxygen, BOD_5 and dry balance is within the norm and its use for drinking and from the economic point of view is appropriate.

REFERENCES

1. *Bregvadze U., Natidze M., Mumulashvili Z.* Water chemistry and microbiology. "Education" Publishing House, 1997, 3-20.
   Chikovani M., Kupatashvili N., Kurasbediani M. European Sciences review Scientific journal, 2019 (May-June), 5-6, 123-127.
3. *Chikovani M., Gabelashvili M., Zarkva M., Megrelishvili N.* Hydrochemical and Sanitary Microbiological Research of the Elena Hill Spring Waters in the Nakhunao Community of Martvili Municipality. RS Global Monographs, 2020, 1, Series 6(58), 27-31.
4. *Chikovani M., KupatashviliN., Jolokhava M.* International Scientife Journal Theoretical Applied Science, 2023, 127, series 11, 238-241.
5. *Chikovani M., Kakhidze N., Balavadze L., GiorgadzeN., Pataridze M.* World Science, 2023, 1, series 81, 1-4.
6. *Gabrichidze O., Rziani B.* Media chemistry. Publishing house "Intellect", 2003, 114-148.
7. Georgian Soviet Encyclopedia, 1987, XI, 349-350.
8. *Kipiani E., Chikovani M., Gvinianidze N.* Chemical Journal of Georgia, 2009, 9, 4, 385-392.
9. *Supatashvili G.* Environmental chemistry. Tbilisi University Publishing House, 2009, p. 188.
10. *Supatashvili G.* Quantitative analysis. Tbilisi, 2010, 81 p.
11. *Supatashvili G.* Quantitative analysis practice, 2016, 56-101.

იმერეთის რეგიონის ხონის მუნიციპალიტეტის სოფელ სუხჩეს მტკნარ წყლებში ბიოლოგიურად აქტიური ზოგიერთი იონის რაოდენობრივი შესწავლა და მათი მნიშვნელობა ცოცხალი ორგანიზმების ცხოველმყოფელობისთვის

მანუჩარ ჩიქოვანი, ნანა ჯულაყიძე, მაგდანა ჯაქია, იზოლდა ლომსიანიძე, იზოლდა დიდებარიძე, ანნა მოგელაძე

ქუთაისის აკაკი წერეთლის სახელობის სახელმწიფო უნივერსიტეტი, საქართველო

რეზიუმე

პირველად იქნა ჩატარებული ხონის მუნიციპალიტეტის სოფელ სუხჩეს წყაროს წყლების ჰიდროქიმიური გამოკვლევა. განსაზღვრულია მაგნიუმის, კალციუმის, ჰიდროკარბონატ-, ქლორიდ- და სულფატ-იონები, მშრალი ნაშთი, პერმანგანატმეტრული ჟანგვადობა, განსხვავებული ჟანგბადი, $ШБ_5$ და ნახშირბადის დიოქსიდის შემცველობა. განსაზღვრისთვის შერჩეულ იქნა კარგი განმეორებადობის მქონე შედარებით მარტივი და სწრაფი ქიმიური და ფიზიკურ-ქიმიური მეთოდები. ბიოგენური ნივთიერებების შემცველობა შესწავლილია ფოტომეტრული მეთოდით. ხონის მუნიციპალიტეტის სოფელ სუხჩეს წყაროს წყლებში ზემოთ აღნიშნული იონების შემცველობა არის ნორმის ფარგლებში და მისი გამოყენება სასმელად და სამეურნეო თვალსაზრისით მიზანშეწონილია.

КОЛИЧЕСТВЕННОЕ ИЗУЧЕНИЕ НЕКОТОРЫХ БИОЛОГИЧЕСКИ АКТИВНЫХ ИОНОВ В ПРЕСНЫХ ВОДАХ СЕЛА СУХЧЕ ХОНСКОГО МУНИЦИПАЛИТЕТА ИМЕРЕТИНСКОГО РЕГИОНА И ИХ ЗНАЧЕНИЕ ДЛЯ ЖИЗНЕДЕЯТЕЛЬНОСТИ ЖИВЫХ ОРГАНИЗМОВ

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РЕЗЮМЕ

Впервые проведено гидрохимическое исследование родниковых вод села Сухче Хонского муниципалитета. Определены магний, кальций, гидрокарбонат, хлорид и сульфатионы, сухой баланс, перманганатная окисляемость, содержание растворенного кислорода, $БПК_5$ и диоксида углекислого газа. Для определения были выбраны сравнительно простые и быстрые химические и физико-химические методы с хорошей воспроизводимостью. Содержание биогенных веществ изучено фотометрическим методом. Содержание вышеуказанных ионов в родниковой воде села Сухче Хонского муниципалитета находится в пределах нормы и ее использование для питья и в сельском хозяйстве целесообразно.