

On the Study of Dmanisi Mineral Water, Georgia

Natia Khazaradze ¹, Khatuna Omiadze²

¹ Akaki Tsereteli State University, Kutaisi, Georgia. khomiadze80@gmail.com

² Georgian Technical University, Tbilisi, Georgia. natia.khazaradze@gmail.com

Abstract: The object of study is the Dmanisi Mineral Water in the municipality of Dmanisi in Georgia. Although water has been used for centuries to treat kidney diseases, it was studied for the first time.

Keywords: Mineral Water, Kidney Diseses, PVDF 0.01 μ filter.

1. INTRODUCTION

Tourism business is one of the priority areas of Georgian economy development. Georgia has been known for its healing resources since time immemorial.

Considering the healing waters, muds, air and geographical location in the territory of Georgia. Georgia has the perspective of becoming a "hub" of healthcare services in the region. There are many mineral springs in Georgia that attract world interest. Such are Borjomi, Nabeglavi, Zvare, Bakuriani, Tskaltubo radon waters, Sulfuric waters and others.

However, there are also many sources that can be used for medicinal purposes They are related to the historical past, used for centuries, and only local municipalities or villages have information about them. Interest in gathering information about such sources and their medicinal use is not lost, the issue is relevant and is a subject of scientific research.

The object of research is the healing water "Dmanisi" near the village of Boslebi in the municipality of Dmanisi. According to the stock materials, the research source is related to the aquifer complex of middle Eocene, marine, volcanic-sedimentary sediments, which is lithologically represented by tuffs, andesite layers, tuff-sandstones and mudstones. Water moves through cracks and pores associated with host rocks such as tuffobrecs, tuffs, etc.

The source is of the magnesium-calcium hydrocarbonate chemical composition. It is enriched with organic compounds, which determine its healing factors (diuretic effect). For the reporting period, the source debit varied within 5-6 m³ per day. Water temperature 12-140C. The sanitary-bacteriological indicators of mineral water in the given period were unsatisfactory. This appears to be due to the high organic content in the water. Nevertheless, the water was successfully used by the local population for drinking and medicinal purposes. The number of users of the source is not so small. During the conversation, the villagers confirmed that the local population mainly consumes this water for drinking purposes, and the existence of scurvy-stone diseases has never been observed among the villagers.

Table I: Results of Chemical Analysis of Water:

No	Parameters	Unit	Results
1	pH		7,52
2	Amonium	mg/L	Not found
3	Mineralization	mg/L	0,575
4	Hardness	Mg. equivalent/L	5,9
5	Hydrocarbonates	mg/L	399

No	Parameters	Unit	Results
6	Calcium	mg/L	96,3
7	Magnium	mg/L	19,6
8	Sodium	mg/L	31
9	Potassium	mg/L	1,3
10	Sulphates	mg/L	21,1
11	Clorides	mg/L	6,9
12	Nitrates	mg/L	0,023
13	Nitrites	mg/L	Not found
14	Phosphates	mg/L	Not found
15	Fluorides	mg/L	0,04

2. STUDY OF WATER STABILITY

As we have already mentioned, only the local population consumes urine at the source, mostly its users supply water and take it home. In order to find out how much water maintains the stability of the composition, we conducted a study.

For this, water was taken in 2 glass bottles of 500 ml capacity, closed hermetically and delayed. Sample 1 - sample water taken from the source 18 hours after sampling, sample 2 - sample water sampled from the source 30 days after sampling. (Table II):

Table II: Study of water stability:

No	Parameters	Unit	Resultes		Methods
			Sample 1	Sample 2	
1	pH		7,52	7,61	ISO 10523:2010
2	Conductivity	Micsim/cm	543	542	
3	Mineralization	g/L	0,569	0,570	
4	Hardness	Mg. equivalent/L	5,9	6	
5	Hydrocarbonates	mg/L	399	397	
6	Calcium	mg/L	96,3	95,9	ISO 6058:2008
7	Magnium	mg/L	19,6	20	ISO 6058:2008
8	Sodium	mg/L	31	31,3	ISO 9964-3:2010
9	Potassium	mg/L	1,3	1,29	ISO 9964-3:2010
10	Sulphates	mg/L	21,1	22,0	ISO 10304-1:2007
11	Clorides	mg/L	6,9	6,83	ISO 10304-1:2007
12	Nitrates	mg/L	0,023	0,26	ISO 10304-1:2007
13	Nitrites	mg/L	Not found	Not found	ISO 10304-1:2007
14	Phosphates	mg/L	Not found	Not found	ISO 10304-1:2007
15	Fluorides	mg/L	0,04	0,41	ISO 10304-1:2007

As studies show, during the study period (1 month) the water is ion-salt composition maintains stability.

3. DETERMINATION OF HEAVY METALS IN DMANISI MINERAL WATER

A plasma-emission spectrometer and a plasma-emission mass spectrometer were used to determine heavy metals. Agilent standard solutions were used to determine the concentration. The method used is ISO 11885:2007 (Table III)

The results of the conducted research show that the concentration of stibium exceeds the norm provided for by the resolution of the Government of Georgia on the approval of technical regulations for drinking water

To prove that this water does not show radioactivity, we conducted a test with a radiation detector mini rae. The device has the ability to identify alpha, beta and gamma radiation at a distance of 40 km. The test result for strontium-90 (Sr-90) is negative.

Table III: Study of Heavy Metals In Water

N	Parameters	Units	Results	MPC
1	Iron (total)	mg/l	0,156	0,3
2	Copper (Cu, total)	mg/l	1,8	2,0
3	Zinc	mg/l	0,23	3,0
4	Magnesium	mg/l	not found	0,4
5	Cadmium	mg/l	0,0004	0,003
6	Lead (Pb, total)	mg/l	not found	0,01
7	Selenium (Se , total)	mg/l	not found	0,01
8	Strontium	mg/l	0, 65	-
9	Nickel	mg/l	0,001	0,07
10	Molybdenum	mg/l	not found	0,07
11	Stibium	mg/l	0,035	0,02
12	Cyanides	mg/l	not found	0,07

4. DMANISI MINERAL WATER IONS MECHANISM OF ACTION ON THE HUMAN BODY

The Library of Medicine of the American National Institutes of Health, on the official page of PubMed, which is a text database of medical, biological and biotechnological publications, has published an article on February 3, 2020, the author of which is the urologist Sadaf Karim Suleiman with several co-authors, presenting a report by urologists on the topic: "What type of water intake is recommended for gallstone diseases".

The study was conducted on 1200 patients of different ethnicities, different sexes, ages and weights, who were suffering from kidney stone diseases. According to the analysis of urine collected during 24 hours, the disease was controlled in patients. As a result of the research, low-mineralized water, the total mineralization of which does not exceed 0.6, is selected as the best option for recommendatory and therapeutic purposes. Calcium, magnesium, sodium, bicarbonate and sulfates are named as necessary components in the following ratio:

- (Ca²⁺) - 100-110 ppm,
- Magnesium is 5 times less than calcium;
- Sodium is 3 times less than calcium;
- Hydrocarbonate is 3-4 times more than calcium;
- Sulfates are 4-5 times less than calcium.

Let's compare the composition of Dmanisi mineral water with the composition of recommended water.

The results show that the ratio of the main components included in the urine source meets the ratio of the components specified in the composition of the recommended water for urolithiasis. (table IV):

Table IV. Comparison of Dmanisi Mineral Water with recommended water:

Parameter	Unit	Recommended water	Dmanisi water
Mineralization	g/L	<0,6	0,569

Calcium	mg/L	100-110 ppm	96,3
Magnium	mg/L	5 times less than calcium	19,6
Spdoium	mg/L	3 times less than calcium	31
Hydrocarbonate	mg/L	3-4 times more than calcium	399
Sulphates	mg/L	3-4 times less than calcium	21,1

5. DETERMINATION OF PHENOLIC ACIDS (HPLC)

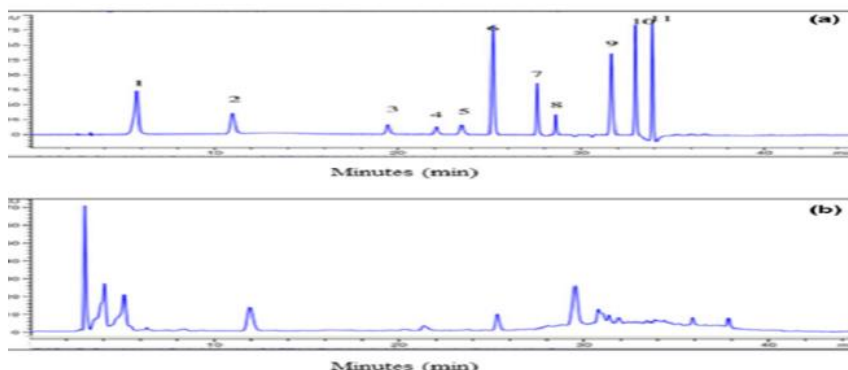


Fig. 1.- Standard solutions, **Fig. 2. -** Research sample

As a result of liquid chromatography-mass spectrometric analysis, the presence of phenolic acids was observed in the water, namely the content of gallic acid, pyrocatechin, as well as formic acid and citric acid.

Their total quantitative value < 0.120 mg/l.

The official medicine of many Western European countries successfully uses preparations of the plant Polygonum Aviculare in case of urinary stone diseases. Scientific studies have confirmed the special treatment ability of Polygonum Aviculare, which, together with other diuretics, removes kidney stones, turns them into sand and removes them imperceptibly from the body. This healing ability of Polygonum Aviculare is associated with the presence of organic acids contained in it called phenolic carboxylic acids: caffeic, chlorogenic, gallic and protocatechic acids.

It may be assumed that the micro-amounts of carboxylic acids and low mineralization in Dmanisi water are a good combination to be used for the prevention and treatment of stone diseases.

As a result of gas chromatography-mass spectrometric analysis, the presence of aromatic hydrocarbons in Dmanisi Water was not confirmed.

6. MICROBIOLOGICAL ANALYSIS

Table: V

indicator	unit	results	Normative
Mesophilic aerobes and facultative anaerobes	Colony-forming units in 1 ml 37 ° C	16	20
	22 ° C	55	100
Total coliform bacteria	Number of bacteria in 300 ml	105	not allowed
E. coli	Number of bacteria in 300 ml	not found	not allowed
Pathogenic microorganisms, among them Salmonella	in 100 ml	not found	not allowed
coliphages	Number of bacteria in 300 ml	25	not allowed
Streptococcus faecalis	in 250 ml	not found	not allowed

Due to the presence of bacteria in the healing water of Dmanisi, it needs to be disinfected before consumption.

Since the "Dmanisi Water" itself represents low mineralized water, we chose the ultrafiltration system, namely the PVDF 0.01 micron module. The membrane is made of high quality antifouling polyvinylidene fluoride material. After

cleaning, microorganisms, bacteria, heavy metals are removed from the water and minerals and trace elements are preserved. However, compared to nanofiltration and reverse osmosis, it is characterized by low efficiency in removing organic substances and ions of low concentration. The filter has a long-lasting effect and maintains stability

Table VI . PVDF filter action study on water

№	Indicator	Unit	Analysis results	
			before	After
1	pH		7.8	7,52
2	Ammonium	mg/l	0,03	not found
3	Hydrocarbonate	mg/l	339,5	336,1
4	Calcium	mg/l	93,9	92,1
5	Magnesium	mg/l	25,1	23,1
6	Sodium	mg/l	22,1	21,8
7	Potassium	mg/l	1,06	0,98
8	Stibium	mg/l	0,035	not found
9	Coliphages	Number of bacteria in 300 ml	25	not found
10	Total Coliform Bcteria	Number of bacteria in 300 ml	105	not found

As the analysis shows, when using the ultrafiltration system, namely the PVDF 0.01 micron module, the mineral composition of the Dmanisi Water is maintained, the water is microbiologically purified, and the heavy metal - stibium is also retained.

The device, in which the PVDF 0.01 micron filter is installed, is a capsule made of stainless steel. It has two valves for water inlet and outlet. A hollow fiber membrane filters water from the outside to the inside. The filter improves the taste of water, delicately cleans water from pollutants and at the same time preserves useful minerals and trace elements.

Cleans water from pathogenic microorganisms, removes viruses, heavy metals, pesticides and herbicides.

It should be taken into account that the methods indicated in the articles are used with high concentrations of pressure on the membrane. In the case when we use the membrane to purify the water of the Dmanis spring, the duration of operation may even increase.

To what extent it will be possible to use proven practice and use sodium hydroxide or 3% citric acid solution for cleaning the track and reservoir is the subject of study.

In the laboratory, we compared the indicators of water purified by ultraviolet light and water purified by ultrafiltration.

Table 7. Comparison of UF and UV filtration performance on water

№	indicator	unit	UV	UF
1	coliphages	Number of bacteria in 300 ml	not found	not found
2	Total coliform bacteria	Number of bacteria in 300 ml	not found	not found
3	Stibium	mg/l	0,035	not found

We repeated the analysis after 1 month to study the stability of the microbiological parameters of the water after cleaning:

Table 8. to study the stability of the microbiological parameters"

№	indicator	unit	UV cleaning	UF cleaning
---	-----------	------	-------------	-------------

1	coliphages	Number of bacteria in 300 ml	11 From 25	not found
2	Total coliform bacteria	Number of bacteria in 300 ml	35 From 105	not found

If we compare the results of the analysis, we can see that UV treatment did not remove heavy metals from the water, and coliform bacteria still developed in the water, although not in the same amount as in the original water. The advantage of ultraviolet sterilization is that it destroys not only the vegetative but also the spore forms of bacteria and does not change the organoleptic properties of water, but the main disadvantage of the method is that the after-effect lasts for a short time. In addition, compared to the UF method, it requires electricity, therefore the installation of the UF filtration system for field conditions is simpler and more compatible.

Making conclusions from a medical point of view is beyond the topic of the paper and our competence, however, the micro-amounts of those carboxylic acids found in the water, which are recommended in pharmacy for urinary stone diseases, the low mineralization of the water and the ratio of minerals in the water, which is considered by urologists to be the best option for nephritis, pyelonephritis and kidney stones. The presence of inclusions allows us to assume that the source we studied is a good combination to be used for preventive and therapeutic purposes in kidney diseases.

7. REFERENCES:

- [1] Jusoh, J., Hashemi, S., Jusoh, J., Kiumarsi, S., & Mohammadi, S.. Influence Factors of Spa and Wellness Tourism on Revisit Intention: the Mediating Role of International Tourist Motivation and Tourist Satisfaction. International Journal of Research – Granthaalayah , 1-2. (2015)
- [2] G. Kufaradze, History of medical tourism. The material is presented at the Samkunalto tourism lecture, St. Georgian University of Andria Privtsavuli, Tbilisi2015.
- [3] Niko Ketskhoveli: "They will grow even more" (1978).
- [4] Сравнительная характеристика химического состава минеральных вод Дманиси и Уджарма / Л. Бокучава, Н. Алексидзе, Н. Бокучава, Г. Джинчарадзе // Известия Академии Наук Грузинской ССР. Серия химическая, т. 3. - 1977. - N2. - стр.110-114.
- [5] Legislative Bulletin page updated on June 21, 2021.
- [6] Letter No. 22/4739 dated July 4, 2022 of the Mineral Resources Agency of Georgia
- [7] Supatashvili G. Quantitative analysis practice. Tbilisi 2018
- [8] Супаташвили Г.Д. Гидрохимия Грузии. ТБ. ТГУ. 2003
- [9] Молчанова Я. П. И др. Гидрохимические показатели состояния окружающей среды. М., 2010.
- [10] Контроль качества продукции физико-химическими методами. Ашапкина В.В., М., Дели принт 2005.
- [11] physicians weekly - Which Type of Water Is Recommended for Patients with Stone Disease 2022 /05/ 02
- [12] Медицинский совет для врачей КУРОРТНОЕ ЛЕЧЕНИЕ БОЛЕЗНЕЙ ПОЧЕК И МОЧЕВЫВОДЯЩИХ ПУТЕЙ 30.08.2008
- [13] pubmed.ncbi.nlm.nih.gov/17333204/
- [14] pubmed.ncbi.nlm.nih.gov/32016596/
- [15] www.mdpi.com/2077-0375/12/3/280

DOI: <https://doi.org/10.15379/ijmst.v10i2.3224>

This is an open access article licensed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>), which permits unrestricted, non-commercial use, distribution and reproduction in any medium, provided the work is properly cited.