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RESULTS OF THE DRINKING WATER ECOLOGICAL MONITORING ON THE TERRITORY OF THE AJARA AUTONOMOUS REPUBLIC

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Abstract. The research represented in the given work concerns studying the organoleptic, chemical and microbiological indicators in the drinking water on the territory of the Ajara Autonomous Republic. Particularly, among the organoleptic indicators the scent, taste and color of the drinking water have been determined; as for the chemical indicators – pH, ammonia and nitrite- and out of the heavy metals – lead, arsenic, cadmium and zinc have been determined.

Key words. Water, micro elements, organoleptic, chemical, heavy metals, monitoring.

1. Introduction

As it is known, the quality, characteristics and consistency of the drinking water are determined according to the international standards established by the World Health Organization (WHO). The chemical consistency and the permissible concentration of the bacterial pollution harmless for the human health are determined. In addition, the organoleptic parameters of the drinking water, giving it some pleasant features are also established.

Water contains set of characteristics effecting human health. They are divided into several groups: organoleptic, chemical and microbiological indicators.

The characteristics that the human can perceive with his sense organs are called organoleptic ones – water color, scent, taste, temperature, turbidity and transparency. These are the first features that tell us how trustworthy the water is and whether or not it has gone through certain changes. In case of such alterations the source of the water supply can become completely useless.

Chemical indexes, on their part, are divided into several groups. Group 1 contains the chemicals that are naturally found in the water, as the latter is not just pure H_2O. Rather it is a universal solvent which might contain iron, iodine, zinc and any chemical element of the Mendeleev System. While being shaped, certain water supply sources acquire various elements as they pass through the soil layers. This is a quite wide specter of the micro and macro elements that are natural part of the water. Group 2 is comprised of those elements that get into the water through the human activities, i.e. so called anthropogenic pollutants: wastewater from factories, heavy metals, pesticides, fertilizers, insecticides, detergents, washing powders, disinfectants, etc. Group 3 contains reagents artificially added to the water in order to enhance its quality. As water might contain various viruses, microbes and bacteria causing infectious diseases, it is widely known that chlorine, ozone and other substances, including polymers, can be used to make it safer. All of them are added with the doses that are safe for human health [2].

The amount of drinking water on the Earth is quite limited: as of now, on average, it is only possible to use 12.5–14 billion cubic meters of drinking water worldwide annually. As the population grows, the amount of drinking water per-person decreases. For instance, in 1989 on average 9000 m^3 water was used per inhabitant. For the year of 2000 this amount fell down to 7800 m^3. It is estimated that by 2025 this number will drop to 5100 m^3 per year.

With the help of water the human organism receives 25 % of mineral substances vital for its proper functioning. Macro-elements such as sodium, potassium, calcium and magnum are the ones that encompass 99 % of the human body and determine the general state of the organism. They are actively involved in the vital and plastic processes, building up tissues and especially bone tissues; they ensure normal osmotic pressure in biological fluids and cells, regulate enzyme activities, maintain organism's homeostasis and determine its immune system [1].

According to the research results, all the samples of the organoleptic indicators fall under the norm. Out of the chemical indicators, consistency of pH was 6.0–9.0 mg/l and ammonia and nitrite consistency – 0.1–0.5 mg/l, meaning that none of the indicators exceed the norm. While studying the heavy metals, it has been concluded that in one of the drinking water samples the amount of lead was 0.02 mg/l and the consistency of cadmium – 0.003 mg/l, exceeding the norm and being at the top edge of the maximum permissible concentration respectively. As for the other heavy metals – arsenic and zinc, they turned out to be in the boundaries of the permissible concentration.

Therefore, as a result of the ecological monitoring of the drinking water held in Ajara Autonomous Republic, it can be established that the drinking water is not polluted and is safe to be utilized by the population.

2. Aim, Objectives and Methodology of the Research.

The aim of the project was to determine the consistency of heavy metals, chemicals and organoleptic indicators in the water pipe drinking water on the Ajara Autonomous Republic territory.

Based on the aim the following objectives have been set:

- Taking coordinates of the objects via GPS navigator and creating the map.
- Determining the consistency of the organoleptic indicators (smell, taste, color), chemical indicators: pH, ammonia, nitrates and heavy metals such as lead, arsenic, cadmium and zinc in the samples of the drinking water.

The following research methodology will be used: determining the research object coordinates through the GPS navigator; studying the organoleptic indicators according to the GOST 3351-74; color – via photo calorimetric method; out of the chemicals, nitrates were determined through GOST 33045-14 with the help of photo calorimetric method using 520 nm wavelength and 30 mm (3cm) size cuvette, whereas, the nitrates were determined using 400 nm wavelength and 30 mm (3 cm) cuvette. Results achieved are compared to the graph and the concentration is determined. pH is determined via pH meter, heavy metals (lead, arsenic, cadmium and zinc) – using atomic-absorptive spectrometer (GOST 31870).

The following water pipelines in Khulo municipality were selected as the research objects: Dekanashvilebi, Jinjikhauri, Nadolabrevi and Vashlovani sources. Khulo municipality is the most mountainous in the Ajara Autonomous Republic. It is located on the slopes of the Arsiani and Meskheti ridges on 400-3007 m. above the sea level. Its highest peak is Mount Kanli (3007 m. above the sea level); climate – continental; average annual temperature – 10.1 °C; average annual rainfall – 1000–1200 mm.

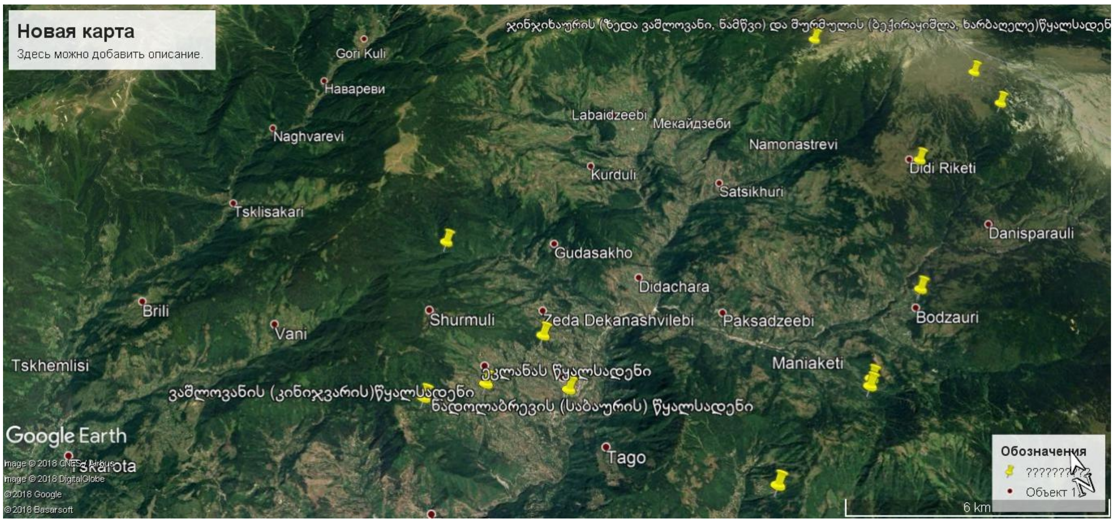

Fig. 1. GPS coordinates of the Khulo Municipality Water Pipelines

Dekanashvilebi water pipeline – GPS coordinates X-0275949 Y-4613475 – construction is open, strict regime area, conditionally determined. Regime requirements are not determined on the construction; highway length – 0.8 km.

Vashlovani water pipeline – GPS coordinates X-0274000 Y-4614257 – construction is open, strict regime area is not determined, therefore is easily accessible for the strangers. Regime requirements are not determined on the construction; highway length – 1 km.

Jinjikhauri water pipeline – GPS coordinates X-0287563 Y-4621521 – strict regime area of the construction is conditionally determined. Regime requirements are not determined on the construction, highway length – 2 km.

Nadolabrebi water pipeline – GPS coordinates X-0272417 Y-4614447 – construction is open, its strict regime area is not fenced; regime requirements are not determined on the construction, highway length – 2 km. Out of the organoleptic indicators, the following have been determined – smell, taste and color.

For determining the color, 100 ml research water sample was taken, filtered and moved to the 50 mm size cuvette. It is then placed in the photo colorimeter, where, together with sample water, we put (with 50 mm cuvette) distilled water of the same amount. The outcome is then compared to the graph and the color is determined in the water sample in degrees (Table 1) [3].

Smell and taste are determined through organoleptic (visual) method. While determining the first, we take sample water and place it in the 100 ml flask, put the top on it and warm it up to 50–60 ^{0}C. We shake the flask afterwards, open it and determine the smell in scores (Table 1). As for determining the taste, 100 ml of the water sample is put in the flask and warmed up to 20 ^{0}C. Then it's placed into the mouth for 3–5 seconds and determine the taste in scores (Table 1).

Table 1

Research Results of the Organoleptic Indicators in the Drinking Water Samples

No.	Research object Water Pipeline	Research Indicators			Normative		
		smell score	taste score	color degree	smell score	taste score	color degree
1	Dekanashvilebi	0	0	15	2	2	20
2	Jinjikhauri		0	5	2	2	20
3	Vashlovani	0	0	10	2	2	20
4	Nadolabrevi	0	0	10	2	2	20

From the table 1 it is vivid that the organoleptic indicators in the drinking water were compliant to the norms and in none of the cases has any of the components been proven to be deviated from it.

Out of the chemical indicators the following have been identified in the drinking water: pH, ammonia, nitrites and nitrates. While determining the ammonia, 50 ml of water sample was taken, 1 ml seignette salt was added; the liquid was then shaken and 1 ml Nessler reagent was added. Then it was shaken again and let rest for 10 minutes. The substance was placed into the 30 mm size cuvette and then put into the photo colorimeter. For control, the same amount of 30 mm control solution was taken. For testing the ammonia 400 nm wave length was used. The received data was then compared to the graph and ammonia concentration in the water was determined (the water was colored in yellow).

While determining nitrites, 50 ml sample water was taken and 2 ml Griess reagent was taken. It was rested for 40 minutes and the solution was then placed into the 30 mm cuvette, put into photo colorimeter and the same amount of control solution was taken. For nitrite testing, 520 nm wave length was taken and the received outcomes were compared to the graph which was followed by determining nitrite concentration [3] (Table 2).

For determining nitrates, the amount of sample water was 10 ml which was placed in the porcelain bowl, 1 ml 0.5 % salicylic was added; sodium solution was dried until receiving the dry remaining, then 1 ml concentrated sulfur acid was added and rested for 10 minutes. Afterwards, 5-6 ml distilled water added and the solution was placed into the 50 ml flask; 7 ml of 40 % sodium hydroxide (NaOH) was added and then was filled up with the distilled water. Then the solution was placed into the 30 ml cuvette and put into the photo colorimeter; the wave length was 400 nm; the same amount of distilled water was taken for the control. Received results were then compared to the graph and nitrate concentration was determined (Table 2).

Determining pH was happening on the pH-meter; the equipment was switched on, the electrodes were washed away with the distilled water and it was put into the working mode. Sample water was poured into the chemical glass and placed in the equipment. The results were shown on the pH-meter screen and compared to the standard which equals 7.0 (Table 2).

As it is shown in the Table 2, according to the research of the chemicals in the drinking water, pH concentration is the highest (6.64 mg/l) in drinking water from the Dekanashvili water pipeline, and the lowest (5.75 mg/l) – in the Nadolabrevi water pipeline. However, it is noteworthy, that pH indicators from 6.0 to 9.0 are considered as normal. As for the ammonia and nitrite concentration, every sample contained equal 0.1 mg/l. The concentration of nitrates was the highest (0.5 mg/l) in the Dekanashvili water pipeline and at its lowest (0.2 mg/l) in Nadolabrevi water pipeline. The nitrate concentration in every sample was within the limits of the maximum permissible concentration.

Out of the heavy metals, through the atomic absorption spectrometer (GOST 31870), the following ones have been determined: lead, arsenic, cadmium and zinc. Major sources of the atomic absorption spectrometer are the specter instrument and electric system. Namely, the equipment enables electro thermal atomization in the graphite cuvette [4].

Firstly, standard concentration solution sample was sent to the atomic absorption spectrometer. There were 4 concentration standards prepared: 10, 20, 30 and 40 microgram liter standard solutions (Fig. 2).

Table 2

Research Results of the Chemical Indicators in the Drinking Water

No.	Research object Water Pipeline	Research Indicators				Maximum permissible amount (PMA)
		pH	ammonia mg/l	nitrite mg/l	nitrates mg/l	
1	Dekanashvilebi	6,64	0,1	0,1	0.5	pH <7,0>
2	Jinjikhauri	6.55	0,1	0,1	0.3	ammonia 2.0 mg/l
3	Vashlovani	6,29	0,1	0,1	0.2	nitrite 0,3 mg/l
4	Nadolabrevi	5,75	0,1	0,1	0.2	nitrates 4.5 mg/l

Fig. 2. Standard Concentration Solution

Then the drinking water sample was prepared: nitric acid was added to the 250 mg/l water, until the pH concentration wasn't reduced to the 1.6–2.0. During this process the water was being released from the sulfates and chlorides and heavy metals were activated in it. The solution was rested for 2 hours after which the water was ready to be placed into the atomic absorption spectrometer. 1 ml/l water was put into the Eppendorf tube. Then the solution with the known concentration was tested in order to check the readiness of the equipment [3].

The lamp necessary for determining the research element was placed into the atomic absorption spectrometer and with the help of the created method the concentration of the element in the sample was determined. The special lamp, which has the specific wave length is used for determining every element (lead lamp wave length is 283 nm, that of arsenic – 183.7 nm, cadmium – 228.8 nm and zinc – 306.66 nm). For 4–5 minutes absorption takes place in the atomic absorption spectrometer, after which, according to the GOST 31870 given in the graph, the received data was counted in the table [3].

Table 3

Research Results of the Heavy Metal Consistency in the Drinking Water

Heavy Metals	Research Object Name				PMA Mg/l
	Dekanashvilebi Mg/l	Jinjikhauri Mg/l	Vashlovani Mg/l	Nadolabrevi Mg/l	
Lead Mg/l	0.008	0.02	0.02	0.01	0,01
Arsenic Mg/l	0.005	0.005	0.005	0.005	0,01
Cadmium Mg/l	0.002	0.003	0.002	0.001	0,003
Zinc Mg/l	0.6	1.2	1.0	0.9	3,0

As the Table 3 shows, while testing the concentration of the heavy metals in the drinking water, it has been established that in Jinjikhauri (Zeda Vashlovani, Namtsvi) and Vashlovani (Kinijvari) pipeline sample water, the amount of lead was 0.02 mg/l which is more than the maximum permissible concentration (0.01 mg/l). Apart from this, in Jinjikhauri (Zeda Vashlovani, Namtsvi) drinking water the concentration of cadmium turned out to be 0.003 mg/l making it on the verge of the maximum permissible concentration. The lower verge of the permissible concentration of cadmium is 0.001 mg/l, as well as in case of the lead.

Laboratory researches were held in the "Laboratory Research Center of the Ministry of Agriculture of the Ajara Autonomous Republic, which is accredited according to the ISO-17025:2010 standards.

Conclusion

After studying the ecological condition of the water pipelines in Jinjikhauri, Nadolabrevi, Dekanashvilebi and Vashlovani, it can be concluded that I zone of the strict regime of the pipeline is not protected (fencing of the pipeline at the 30 m. distance), except for the Dekanashvilebi water pipeline; As a result of studying the organoleptic indicators it has been established that all of its indicators (color, smell, taste) were within the norm; The following has been determined after researching the chemical indicators: the concentration of pH was relavitvely higher (6.64 mg/l) in Dekanashvilebi water pipeline and the lowest (5.75 mg/l) in the Nadolabrevi drinking water. However, as noted before, the pH concentration of 6.0–9.0 is considered as a norm. What concerns the concentration of the ammonia and nitrites, it was equal in all of the samples – 0.1 mg/l. The concentration of the nitrates was comparatively higher (0.5 mg/l) in Dekanashvilebi drinking water and the lowest (0.2 mg/l) in the Nadolabrevi one. In every sample, however, the nitrate concentration was within the maximum permissible concentration level;

While studying the heavy metals is has been established, that the lead concentration in the Jinjikhauri and Vashlovani drinking water was 0.02 mg/l which exceeds the maximum permissible concentration. On top of that, the cadmium level in the same drinking water turned out to be 0.003 mg/l putting it on the verge of the maximum permissible concentration. The rest of the heavy metals were proven to remain within the permissible concentration.

Therefore, based on the ecological research of the drinking water on the territory of the Ajara Autonomous Republic it can be concluded that the drinking water is not polluted and is safe for the population to utilize.

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