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PHYSICO-CHEMICAL ANALYSIS OF THE DRINKING WATER FROM THE OLD PUBLIC FOUNTAIN-MONUMENT AT KADIN MOST (NEVESTINO), BUILT BY THE 13TH RILA INFANTRY REGIMENT IN 1932

(In honor of the 140th Anniversary of the Establishment of the 13th Rila Infantry Regiment)

Dr. Eng. Anton Sotirov, Assist. Prof.
Agricultural Academy – Sofia
Krasimir Sotirov
Sofia University of Mining and Geology
Viktor Sotirov
University of Architecture, Civil Engineering and Geodesy

Abstract. In the village of Nevestino (old Kadin Most) on Str. Mitko Palauzov No. 12 has a fountain built by the 13th Rila Infantry Regiment in 1932. In addition to providing water for itself, with this fountain the regiment has done a social deed for the local population, because before the water supply and sewerage network was built, the fountain supplied half of the village with fresh, high-quality and very cold water even in the summer. And now, every summer, in a water crisis, the tap provides the people of the village with fresh water. There is no information about the fountain in the institutions, as well as literature data about it. This article is its first documentation as an object and monument of culture. The water from both fountains meets the drinking water requirements for the studied indicators. It does not contain heavy metals, nitrates, nitrites, arsenic, preparations and other harmful components. It is not radioactive has a certain amount of electrolytes, which in this case are mineral salts, which explains the presence of chlorine, which is mainly part of the NaCl salt. Acidity is normal for natural water, with a slightly acidic character. The flow rate is 10 l/min. The new fountain built next to it has a flow rate of 20 l/min. to be identified, documented and included in the list of immovable cultural values and cultural monuments on the occasion of its 100th anniversary and in connection with the 140th anniversary of the establishment of the 13th Rila Infantry Regiment.

Keywords: cultural monuments; historical heritage; fountain; water quality

Introduction

In the village of Nevestino (old Kadin Most) on Str. Mitko Palauzov №12 is a fountain, which was built by the 13th Rila Infantry Regiment in 1932. Coordinates Location: 42°15'13.44"N, 22°5129.65E, Altitude: 444 m (Figs. 1,2,3).

The water is spring water with high taste qualities. In addition to providing water for itself, with this fountain the regiment has done a social deed for the local population, because before the construction of the water supply and sewerage network, the fountain supplied half of the village with fresh, high-quality and very cold water even in the summer. The water used by the fountain flows from the force of gravity along the slope of the terrain, and where it comes to the surface, it is directed to the fountain, after which it drains into a stone bed, and from there it returns to its natural channel, still clean to the Struma River, and on its way it is used as an underground reservoir of agricultural massifs and natural vegetation.

The check for information about a fountain built by the 13th Rila Infantry Regiment in the village of Nevestino (Kadin Most) did not yield results. None of the following institutions: Regional History Museum-Kyustendil, State Archives-Kyustendil, Municipality of Nevestino and Regional Administration-Kyustendil could provide any information or documents about it. No literary sources or reference data were found in local libraries and archives.

The 13th Rila Infantry Regiment is one of the most glorious military units in Bulgarian history, known as the "Iron Regiment" for its exceptional bravery and steadfastness in the battles for national unification.

The regiment was established on August 31, 1886 in the town of Kyustendil. The regiment participated in all major wars of Bulgaria from the end of the 19th and the beginning of the 20th century.

There are not many literature data on the quality of water at public fountains, especially those of cultural and historical significance, but the following recent studies in this field can be mentioned, for example:

Etova et al. (2026) published data about water hardness in different regions. It is pointed out that in Sofia the water is "soft" (< 2.49 °dH), while on the Black Sea coast it varies from "soft" to "very hard" (over 21 °dH).

Vitov&Sotirov (2025) worked on energy, mineral, water ans soil resources of Kyhustendil region, Bulgaria.

Toneva et al. (2025) published a detailed study by the Technical University of Varna on natural radioactivity (radium-226, lead-210) in public fountains. It concludes that although the levels are below WHO standards, constant monitoring is necessary due to lithological heterogeneity.

Valkanova et al. (2024). The article analyzes the widespread practice in Bulgaria to use uncontrolled spring fountains**.** The authors highlight the health risk of droughts or disasters, as these sources often do not have sanitary protection zones and are not subject to mandatory monitoring.

Hristov et al. (2023) provides data on 46 chemical components of mineral waters, including sulfates, carbonates, fluorides, and heavy metals, which is relevant to public mineral fountains.

Sotirov (2022) and Sotirov et al. (2014) presented a study about radiactivity and chemical composition of different water sources in Kyustendil region.

Vasileva (2020). A study published in *Geologica Balcanica* that evaluates the country's shallow groundwater through a Quality Index (WQI). The data are directly related to water quality in rural areas where fountains are fed by such aquifers.

Dzhonev (2017) examines the role of the city and the regiment, including the construction of military sites and monuments in the region.

Vachkov (2012), Dimitrov (2009), and Dodov (2006) mentioned the activity of the 13th Rila Infantry Regiment during the time of Balkan War.

Dimitrov et al. (2004) published information about heavy metals in water and soil around the areas, where similar fountains were built by the 13th Rila Infantry Regiment in the Osogovo Mountain.

Figure 1. Location of the studied area

Figure 2. Old fountain-monument (left) and new fountain (right)

Figure 3. Inscriptions and symbols

Materials and Methods

Physico-chemical studies of the water quality have been carried out, in accordance with Ordinance No. 9 of March 16, 2001 on the quality of water intended for drinking and domestic purposes.

We applied the method of measurement "*in situ*", in the field with direct "grab" samples, because the high degree of authenticity and accuracy of this study. We used digital (electronic) devices, because of their capabilities for fast, easy and precise measurement of the studied parameters at the field.

Total radioactivity (common radiation background) and radioactivity of water were measured with a Geiger counter "Radex" RD1503 (μSv/h) – Russia.

The conductivity meter "Lovibond – SensoDirect 150" – England was used to determine the acidity of water (pH), water temperature (t,°C), electrical conductivity (EC, μS/cm), total amount of dissolved solids (TDS, ppm), salt content (ppm) or resp. NaCl, redox potential Eh (mV), and specific gravity of water.

For study the chemical parameters of the water, we used a spectral photometer "Lovibond MD-600" – England. This instrument determines: free, total and combined chlorine Cl, acidity (pH), cyanouric acid CYA, total alkalinity $CaCO_3$, free, total and combined copper (Cu) and iron Fe (mg/l).

The content of nitrates NO_{3-} mg/l and nitrites NO_{2-} mg/l in water was determined by colorimetric method with test strips with ranges 0-10-25-50-100-250-500 mg/l.

The arsenic As content was measured by colorimetric method with test strips with ranges 0.005-0.0010-0.0025-0.05-0.1-0.25-0.5mg/l and malonic acid reagent.

To determine the zinc content of Zn, a method was applied with test strips in the ranges of 0-4-10-20-50 mg/l and sodium hydroxide reagent.

Manganese Mn was measured by colorimetric method with test strips in the ranges of 2-5-20-50-100 mg/l and sodium hydroxide reagent.

Bromine Br, Fluorine Fl, Mercury Hg, Chromium Cr are detected by test strips with direct colorimetry.

The content of lead Pb was established by semi-quantitative colorimetric analysis – Blei-Test, with a set of test strips with a range of 0-20-40-100-200-500 mg/l and reagent rhodic acid.

Sulfates SO_4^{2-} were measured by semiquantitative colorimetric analysis with test strips with a range of 0-200-400-800-1200-1600 mg/l.

Sulfites SO_3^{2-} were also measured by semiquantitative colorimetric analysis with test strips in the range 0-10-40-80-180-400 mg/l.

Results and Discussion

1. Water analyses. From Tables 1 and 2 it can be seen that the water from the two fountains is the same. The values of the measured physico-chemical parameters are almost identical. The new fountain, built in the 80s of the 20th century, has almost twice the flow rate, indicating that most of the water from the underground stream has been captured. Accordingly, the temperature is slightly higher, due to the different way of building and using newer materials. Acidity, redox potential, electrical conductivity and mineral salt content are almost the same. One indicator of clean water is the equality between the values of mineral salts and dissolved solids (Rusydi, 2018). Hardness and total alkalinity are also of the same value. In the water of both fountains there are indications of small amounts of bromine, which is often part of the mineral salts coming from the water when passing through the soil horizons. According to the measured physical and chemical parameters, the water is of good quality for drinking and domestic water, for domestic animals and livestock. After drainage of the water from the two fountains, it continues its path uncontaminated through the azonal alluvial soils (FAO-ISRIC-IUSS, 2006) on the 1st and 2nd floodplain terraces of the Struma River, feeding the subordinate horizons of the agricultural areas located along its flow.

Table 1. Results of the physical and chemical studies of the water from fountain built by the 13th Rila Infantry Regiment

№	Water Measurement Parameter	Result
1	Flow rate, l/min.	10.0 l/min.
2	Water temperature t,°C	12.4 °C
3	Acidity pH	6.51
4	Electrical conductivity EC, μS/cm	828 μS/cm
5	Total dissolved solids TDS, ppm	422 ppm
6	Mineral salts, ppm	422 ppm
7	Specific gravity S.G.	1.000
8	Redox potential Eh, mV	115 mV
9	Hardness, mg/l	425 mg/l
10	Total alkalinity, mg/l	120 mg/l
11	Calcium carbonate CaCO3, mg/l	120 mg/l
12	Free chlorine Cl, mg/l	0.3 mg/l
13	Total chlorine Cl, mg/l	3.0 mg/l
14	Bromine Br, mg/l	0.5 mg/l
15	Fluor Fl, mg/l	0.0 mg/l
16	Iron Fe, mg/l	0.0 mg/l
17	Copper, mg/l	0.0 mg/l
18	Mercury Hg, mg/l	0.0 mg/l
19	Lead Pb, mg/l	0.0 mg/l
20	Manganese Mn, mg/l	0.0 mg/l
21	Zink Zn, mg/l	0.0 mg/l
22	Sulfite SO_3^{2-}, mg/l	0.0 mg/l
23	Sulfate SO_4^{2-} , mg/l	0.0 mg/l
24	Chromium Cr, mg/l	0.0 mg/l
25	NitriteNO_3^-, mg/l	0.0 mg/l
26	Nitrate NO_2^-, mg/l	0.0 mg/l
27	Cyanuric acid CYA, mg/l (disinfectants, herbicides, etc.)	0.0 mg/l
28	Arsen As, mg/l	0.0 mg/l
29	Common radiation background, μSv/h	0.16 μSv/h
30	Water radiation, μSv/h	0.17 μSv/h
31	Organoleptics – color, smell, taste	colorless, tasteless and odorless

Table 2. Results of the physical and chemical studies of the water from the new fountain, built next to the old one in the 80s of the 20th century

№	Water Measurement Parameter	Result
1	Flow rate, l/min.	20.0 l/min.
2	Water temperature t,°C	14.5 °C
3	Acidity pH	6.58
4	Electrical conductivity EC, μS/cm	793 μS/cm
5	Total dissolved solids TDS, ppm	397 ppm
6	Mineral salts, ppm	397 ppm
7	Specific gravity S.G.	1.000
8	Redox potential Eh, mV	146 mV
9	Hardness, mg/l	425 mg/l
10	Total alkalinity, mg/l	120 mg/l
11	Calcium carbonate CaCO3, mg/l	120 mg/l
12	Free chlorine Cl, mg/l	1.0 mg/l
13	Total chlorine Cl, mg/l	3.0 mg/l
14	Bromine Br, mg/l	0.5 mg/l
15	Fluor Fl, mg/l	0.0 mg/l
16	Iron Fe, mg/l	0.0 mg/l
17	Copper, mg/l	0.0 mg/l
18	Mercury Hg, mg/l	0.0 mg/l
19	Lead Pb, mg/l	0.0 mg/l
20	Manganese Mn, mg/l	0.0 mg/l
21	Zink Zn, mg/l	0.0 mg/l
22	Sulfite SO_3^{2-}, mg/l	0.0 mg/l
23	Sulfate SO_4^{2-} , mg/l	0.0 mg/l
24	Chromium Cr, mg/l	0.0 mg/l
25	Nitrite NO_3^-, mg/l	0.0 mg/l
26	Nitrate NO_2^-, mg/l	0.0 mg/l
27	Cyanuric acid CYA, mg/l (disinfectants, herbicides, etc.)	0.0 mg/l
28	Arsen As, mg/l	0.0 mg/l
29	Common radiation background, μSv/h	0.16 μSv/h
30	Water radiation, μSv/h	0.11 μSv/h
31	Organoleptics – color, smell, taste	colorless, tasteless and odorless

2. Dimensions and measurements of the fountain-monument structure.

The dimensions of the fountain are as follows:

Length 150 cm

Width 50 cm

The arch begins after a 20 cm threshold, followed by a smaller step 13 cm high and 4 cm wide.

The height from the lowest to the highest point is 95 cm, but the upper section is missing—as evidenced by the inscription—meaning the actual height is greater, likely 120 cm.

Trough dimensions: 165 x 65 cm.

Features 3 spouts (out of a total of 4), with a length of 15 cm and a depth of 50 cm; equipped with water inlet and outlet connections.

Material: stone and cement; features built-in reflectors on the front-left and at the rear.

3. Inscriptions and symbols.

The inscriptions are black and partially obliterated:

Probable inscription at the top of the vault

ОБИЧАЙТЕ БЪЛГАРИЯ

Символ: изправен лъв

13 й

пехотенъ Рилски полкъ

1932 год.

СТРОИТЕЛИ

Редн. Юрд. Христовъ

Редн. Драг. Козичевъ

LOVE BULGARIA

Symbol: Rampant lion

13th

Rila Infantry Regiment

1932

BUILDERS

Private Yurd. Hristov

Private Drag. Kozichev

4. Conceptual design for the restoration of the drinking fountain-monument

Includes restoring the fourth spout, repairing the structure and rendering, and refreshing the exterior finish (white). Restoration of the fountain to include the original inscriptions and symbols in black on its facade. Cleaning and repair of the basin. Arrangement of a seating area – installation of a wooden bench (Fig. 4).

Figure 4. Dimensions and a project proposal for restoration of the monument

Conclusion

The water from both fountains – old one and the new one (Fig. 1) meets the drinking water requirements for the studied indicators. It does not contain heavy metals, nitrates, nitrites, arsenic, and other harmful components. It is not radioactive has a certain amount of electrolytes, which in this case are mineral salts, which explains the presence of chlorine, which is mainly part of the NaCl salt. Acidity is normal for natural water, with a slightly acidic character. The flow rate is 10 l/min. The new fountain built next to it has a flow rate of 20 l/min. The fountains are constantly flowing with a total flow rate of 30 l/min., which reduces the possibility of microbial contamination. It has a lower temperature of approximately 2 degrees than the water of the new fountain. It has low acidity and mineralization. There are some indications of bromine that need to be examined more precisely in a licensed laboratory. Methodology of the study (Institute of Agriculture-Kyustendil) (Table 1, Table 2).

The memorial fountain is currently in poor condition and requires restoration and preservation, and the institutions need to help to be identified, documented and included in the list of immovable cultural values and cultural monuments on the occasion of its 100th anniversary and in connection with the 140th anniversary of the establishment of the 13th Rila Infantry Regiment.

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✉ **Coressponding author: Dr. Eng. Anton Sotirov, Assist. Prof.**
ORCID iD: 0009-0006-4078-3750
Institute of Agriculture-Kyustendil
Department of “Agrotechnology, Plant Protection and Economics”,
Agricultural Academy
Sofa, Bulgaria
E-mail: a_sotir@iz-kyustendil.org

✉ **Krasimir Sotirov**
Sofia University of Mining and Geology

✉ **Viktor Sotirov**
University of Architecture, Civil Engineering and Geodesy