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HYDROCHEMICAL INVESTIGATION OF BIOLOGICALLY ACTIVE IONS IN THE SPRING WATERS OF SUJUNA VILLAGE, ABASHA MUNICIPALITY, SAMEGRELO–ZEMO SVANETI REGION, GEORGIA

Abstract: *The present study investigates the hydrochemical composition of spring waters located in Sujuna Village, Abasha Municipality, Samegrelo–Zemo Svaneti Region, Georgia. The research aimed to determine the*

concentrations of biologically active and environmentally significant physicochemical parameters, including pH, total hardness, magnesium (Mg^{2+}), calcium (Ca^{2+}), total iron, copper (Cu^{2+}), chloride (Cl^-), bromide (Br^-), bicarbonate (HCO_3^-), sulfate (SO_4^{2-}), total arsenic, permanganate oxidizability, dissolved oxygen (DO), biochemical oxygen demand (BOD_5), and free carbon dioxide (CO_2). Water samples collected from three natural springs were analyzed using standard hydrochemical and photometric methods at the Iason Moseshvili Hydrochemical Laboratory, Department of Chemistry, Faculty of Exact and Natural Sciences, Akaki Tsereteli State University. The obtained results revealed slight variations in the concentrations of the investigated parameters among the studied springs. Most measured values complied with the requirements of the Georgian Technical Regulation for Drinking Water, indicating satisfactory water quality for drinking and domestic use. A slight exceedance of the recommended concentration of total arsenic was observed in the investigated springs, suggesting the need for continuous environmental monitoring. The findings provide valuable baseline information on the hydrochemical characteristics of spring waters in the study area and contribute to the assessment and sustainable management of local groundwater resources.

***Key words**: spring water, hydrochemical analysis, biologically active ions, groundwater quality, drinking water, Sujuna Village, Abasha Municipality, Georgia.*

***Language**: English*

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Introduction

Water is one of the most essential natural resources and plays a fundamental role in sustaining human life, ecosystems, and economic development. It is indispensable for domestic consumption, agriculture, industry, energy production, transportation, and environmental protection. The availability of high-quality freshwater resources is therefore of great importance for public health and sustainable regional development.

Spring waters represent naturally discharged groundwater that has undergone natural filtration through geological formations. Owing to this process, spring water is generally characterized by relatively stable physicochemical properties and low levels of contamination. The hydrochemical composition of spring water is primarily controlled by the geological structure of the aquifer, the mineral composition of rocks, climatic conditions, and groundwater residence time. Consequently, the concentrations of dissolved ions may vary considerably among springs located even within the same geographical region.

Natural waters contain numerous dissolved mineral components, among which calcium (Ca^{2+}), magnesium (Mg^{2+}), bicarbonate (HCO_3^-), chloride (Cl^-), sulfate (SO_4^{2-}), iron, and trace elements are of particular importance. These constituents influence water hardness, mineralization, organoleptic properties, and its suitability for drinking and domestic purposes. Continuous monitoring of these parameters is therefore essential for protecting water resources and ensuring compliance with drinking water quality standards.

Abasha Municipality is situated in the southern part of the Samegrelo–Zemo Svaneti Region in western Georgia. The municipality is characterized by abundant groundwater resources, rivers, wetlands, and favorable hydrogeological conditions that promote the formation of numerous natural springs. Despite the widespread local use of spring water, comprehensive hydrochemical investigations of many springs in the municipality remain limited.

The present study aims to evaluate the hydrochemical characteristics of spring waters in Sujuna Village, Abasha Municipality, by determining the concentrations of major biologically active ions and selected physicochemical indicators. The obtained results provide valuable information on groundwater quality, assess compliance with the Georgian Technical Regulation for Drinking Water, and contribute to the sustainable management and protection of local water resources.

Pic.1 - Abasha Municipality

Abashi Municipality: The study was conducted in Sujuna Village, located in Abasha Municipality, Samegrelo–Zemo Svaneti Region, western Georgia. Abasha Municipality occupies the southern part of the Samegrelo–Zemo Svaneti Region and borders Martvili Municipality to the north, Khoni and Samtredia Municipalities to the east, Lanchkhuti Municipality to the south, and Senaki Municipality to the west.

The municipality is situated within a lowland area at an elevation of approximately 20–50 m above sea level. The relief is predominantly flat and composed of Quaternary alluvial deposits, including gravel, sand, and clay. The hydrographic network is well developed and includes the Rioni, Abasha, Tskhenistskali, Tekhuri, Noghela, Kovza, and Zana rivers, together with numerous drainage canals and wetlands. These geological and hydrological conditions favor groundwater recharge and the formation of natural springs.

Three representative springs located in Sujuna Village were selected for investigation. Water samples were collected from the Sujuna Spring, the Sabashvilebi Spring, and the Makalatia Spring. These springs are widely used by the local population as sources of drinking water and for domestic purposes. Their hydrochemical characterization is therefore important for assessing water quality, ensuring safe use, and establishing baseline data for future environmental monitoring.

Experimental Part. Methodology for determination of chemical Elements in Water. Water samples were collected from three natural springs located in Sujuna Village, Abasha Municipality, following standard sampling procedures for hydrochemical investigations. Laboratory analyses were performed at the Iason Moseshvili Hydrochemical Laboratory, Department of Chemistry, Faculty of Exact and Natural Sciences, Akaki Tsereteli State University**.**

The physicochemical characteristics of the water samples were determined using standard analytical methods widely employed in hydrochemical studies. The pH values were measured potentiometrically. Total hardness, calcium (Ca^{2+}), and magnesium (Mg^{2+}) concentrations were determined by complexometric titration using EDTA. Bicarbonate (HCO_3^-) concentrations were measured by acidimetric titration, while chloride (Cl^-) ions were determined using the mercurimetric method.

Total iron and copper concentrations were analyzed spectrophotometrically using a UN-5100B UV/VIS spectrophotometer following appropriate sample preparation procedures. Sulfate (SO_4^{2-}) concentrations were determined gravimetrically, whereas bromide (Br^-) and total arsenic were analyzed using iodometric methods. Free carbon dioxide (CO_2) was determined by alkalimetric titration, and permanganate oxidizability was evaluated by the permanganatometric method. Dissolved oxygen (DO) and biochemical oxygen demand (BOD_5) were determined according to the Winkler iodometric procedure.

All analytical determinations were performed in accordance with established hydrochemical laboratory protocols, and the obtained results were evaluated with reference to the Georgian Technical Regulation for Drinking Water.

Results and Discussion. The analytical results obtained for the three investigated springs of Sujuna Village are presented in Table 1. The hydrochemical composition of the spring waters demonstrates only slight variations among the sampling sites, indicating generally similar hydrogeological conditions within the study area.

Table 1. Hydrochemical Characteristics of Spring Waters in Sujuna Village, Abasha Municipality, Samegrelo–Zemo Svaneti Region, Georgia

N	Local Names of the Spring Waters	pH	mg-eq/L	Mg/L													
			Water Hardness	Mg^{2+}	Ca^{2+}	Total Fe	Cu^{2+}	Cl^-	Br^-	HCO_3^-	Free CO_2	dissolved oxygen	BOD_5	SO_4^{2-}	Permanganate Oxidizability	Total As	ხვრეთი დარიშხანი
1	Sujuna Spring	7,3	4,16	21,00	48,80	0,052	0,003	8,38	0,020	4,48	0,38	1,50	24,96	0.0855	0,32	0,011	0,015
2	Sabashvili Spring	7,5	4,24	20,79	51,20	ND	0,001	11,36	0,021	4,92	0,30	1.37	20,42	0.0616	1,14	0,012	0,013
3	Makalatia Spring	7,2	3,96	19,03	48,00	0,066	ND	9,94	0,023	4,72	0,44	1,70	24,13	0.0063	0,24	0,010	

The measured pH values ranged from **7.2 to 7.5**, indicating neutral to slightly alkaline water, which is considered favorable for drinking purposes. Water hardness varied between **3.96 and 4.24 mg-eq/L**, with the highest value recorded in the **Sabashvilebi Spring** and the lowest in the **Makalatia Spring**. These results classify the investigated waters as moderately hard, reflecting the dissolution of calcium- and magnesium-bearing minerals.

Magnesium concentrations ranged from **19.03 to 21.00 mg/L**, while calcium concentrations varied from **48.00 to 51.20 mg/L**. Calcium was the dominant alkaline earth metal in all investigated springs, indicating that groundwater chemistry is primarily controlled by natural interactions between water and carbonate-bearing geological formations.

The concentrations of total iron and copper were very low in all investigated samples. Total iron was below the analytical detection limit in the Sabashvilebi Spring and reached a maximum value of **0.066 mg/L** in the Makalatia Spring. Copper was not detected in the Makalatia Spring, while only trace concentrations were measured in the remaining springs. These findings indicate the absence of significant contamination from iron- and copper-bearing sources.

Among the major anions, chloride concentrations ranged from **8.38 to 11.36 mg/L**, whereas bicarbonate concentrations varied between **4.48 and 4.92 mg/L**. The relatively stable concentrations of these ions suggest that the investigated groundwater is controlled mainly by natural geochemical processes rather than anthropogenic pollution.

Bromide concentrations exhibited noticeable variation among the investigated springs, with the highest value observed in the Makalatia Spring. Sulfate concentrations remained low in all samples, ranging from **0.0063 to 0.0855 mg/L**, indicating insignificant sulfate enrichment of the groundwater.

The concentration of free carbon dioxide ranged from **0.30 to 0.44 mg/L**, while dissolved oxygen

varied between **1.37 and 1.70 mg/L**. The highest biochemical oxygen demand (BOD_5) was recorded in the Sujuna Spring (**24.96 mg/L**), whereas the lowest value was measured in the Sabashvilebi Spring (**20.42 mg/L**). The observed differences most likely reflect natural hydrogeochemical conditions rather than anthropogenic impacts.

Permanganate oxidizability values remained low, indicating a limited amount of oxidizable organic matter in the investigated waters. Total arsenic concentrations ranged from **0.010 to 0.012 mg/L**. Although these values are close to the maximum permissible concentration established by the Georgian Technical Regulation for Drinking Water, they indicate that periodic monitoring should be continued to ensure long-term water quality and consumer safety.

Overall, the hydrochemical characteristics demonstrate that the investigated spring waters possess stable physicochemical properties and are generally suitable for drinking and domestic use. The obtained results provide an important scientific basis for future groundwater quality monitoring and environmental management in Abasha Municipality.

Conclusion

This study presents a comprehensive hydrochemical assessment of three natural springs located in Sujuna Village, Abasha Municipality, Samegrelo–Zemo Svaneti Region, Georgia. The investigated physicochemical parameters exhibited only minor variations among the studied springs, indicating relatively uniform hydrogeological conditions within the study area.

The analyzed concentrations of pH, total hardness, magnesium, calcium, total iron, copper, chloride, bicarbonate, sulfate, dissolved oxygen, biochemical oxygen demand, free carbon dioxide, and permanganate oxidizability generally complied with the requirements of the Georgian Technical Regulation for Drinking Water. The measured concentrations of total arsenic were close to, and in some samples slightly exceeded, the recommended guideline value, indicating the importance of periodic hydrochemical monitoring.

Overall, the investigated spring waters are characterized by satisfactory hydrochemical quality and can be considered suitable for drinking and domestic purposes. The obtained results provide valuable baseline information for groundwater quality assessment in Abasha Municipality and contribute to the sustainable management, rational utilization, and long-term environmental protection of local groundwater resources. Continued monitoring is recommended to identify possible temporal changes in water quality and to ensure the safety of water resources for the local population.

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