ა(ა)იპ ორგანიზაცია
„ქიმია და ადამიანის ჯანმრთელობა"
chem.hum.health@gmail.com

CHEMISTRY & HUMAN HEALTH
ქიმია და ადამიანის ჯანმრთელობა

Iodine-Containing Mineral Spring Drinking Waters in the Context of Human Health Protection and Disease Prevention

R. KVATASHIDZE, L. AKHALBEDASHVILI, M. BROKISHVILI, G. TODRADZE, N. JANASHVILI, N. GAGNIASHVILI, M. UKLEBA

Al. Tvalchrelidze Caucasian Institute of Mineral Resources, Tbilisi State University

ABSTRACT

This paper is devoted to the study of iodine-containing mineral spring drinking waters identified in the Kaspi district of Georgia and to the assessment of their practical significance for public health. In six springs, across all four seasons of the year, the iodide-ion content was determined by a kinetic method, while the overall chemical composition was established using methods compliant with ISO standards. It was found that the iodine concentration in the springs ranges from 16–54 ug/L and follows a pronounced seasonal dynamic, being minimal in spring–summer and maximal in winter. The waters are practically neutral (pH 7.48–7.69) and fall within the normal range of mineralization. The findings are discussed in comparison with existing methods of iodine-deficiency-disorder prevention (iodized salt, iodide preparations), demonstrating the advantage of iodine-enriched drinking water as a safe and physiologically effective alternative. The study highlights the potential of the mineral waters of the Kaspi district as a natural resource for supplying the population with iodine.

INTRODUCTION

Underground fresh waters remain among the most significant mineral resources, owing to their renewability over time, high quality indicators, and reliable protection. The subsoil of Georgia is rich, across its entire territory, in mineral waters possessing a wide spectrum of physico-chemical properties, of which 95% are potable waters [1]. The confirmed exploitable reserves amount to 67,000 m3/day. In the 1980s, the country had 46 operating mineral-water deposits, 17 bottling enterprises, 18 balneological resorts, and 27 water-treatment facilities [2].

The therapeutic activity of mineral waters and their mechanism of action on the human body are determined by several characteristics: ionic-salt and gas composition, temperature, and the presence of specific microelements: iodine, bromine, boron, manganese, and lithium.

The iodine content of Georgia's mineral waters reaches tens and hundreds of mg/L, whereas in surface waters this figure ranges only from 1.4–24 ug/L. High concentrations (10–59 mg/L) are also characteristic of Georgia's oil-associated waters. From a geochemical standpoint, iodine is an element of complex behavior: despite its Clarke value (400 mg/t), it is highly dispersed in the environment. Through active participation in redox, sorption, and biochemical processes, iodine readily changes its form of occurrence (iodide, iodate, molecular, organic forms), which significantly complicates the establishment of regularities in its dynamics over time and space [3]. Nevertheless, it has been established that waters in contact with sedimentary and oil-bearing rocks are distinguished by elevated iodine content the main sites of occurrence being volcanic gases, the weathering crust of ore deposits, and other halogen deposits [1]. In free, mineral form, iodine is rarely found in nature; isolated occurrences have been recorded in the thermal springs of Vesuvius and on Vulcano Island [4].

According to international health organizations, approximately 12% of the world's population suffers from iodine deficiency, and roughly 1.5 billion people live in regions where the air, water, and soil are iodine-deficient. Even in Western Europe, despite its high level of economic development, 800 million people are at risk of iodine-deficiency disorders, and 190 million suffer from endemic goiter. Georgia is among the world's leading countries in terms of endemic goiter prevalence (60–70% of the population), and data from the past 10–15 years indicate a fairly high prevalence of thyroid pathologies. It is precisely the urgency of this problem that necessitated the detailed study of the iodine-containing mineral springs discovered in the Kaspi district.

The contemporary relevance of the issue is further confirmed by recent international research. A national assessment of iodine nutrition status and iodized-salt use conducted in Georgia confirmed that the country still requires ongoing monitoring and intervention for iodine-deficiency prevention [8]. A recent global-level analysis (Global Burden of Disease, 2021) likewise showed that the burden of iodine deficiency among women of reproductive age continues to rise in a number of regions, lending particular importance to the study of natural, local sources of iodine intake [9]. In addition, the latest studies on the iodine content of drinking and mineral waters (for example, in Norway) have confirmed that iodine concentrations vary considerably among different mineral-water brands, and in certain cases can cover a substantial part of daily requirements — confirming that the individual geochemical study of mineral waters, as demonstrated here for the Kaspi district, remains a scientifically and practically heterogeneous yet consistently relevant task [10].

MATERIALS AND METHODS

In six springs selected in the Kaspi district, across all four seasons of the year, the quantitative determination of the iodide ion was carried out using a kinetic method based on the iodide-ion-catalyzed oxidation of thiocyanate ion by a mixture of nitrate and nitrite ions, with photometric detection [5]. The complete chemical analysis of the waters (pH, major cations and anions, total mineralization) was carried out using methods compliant with ISO standards.

RESULTS AND DISCUSSION

The data obtained showed that the iodide-ion content in the studied springs ranged from 16–48 ug/L, with an average value of 32 ug/L (Table 1). The table reveals a pronounced seasonal trend: the minimum concentration is recorded in spring–summer, while the maximum occurs in winter, when the value reaches as high as 54 ug/L in some springs.

Table 1. Seasonal dynamics of iodide-ion content in the studied springs, μg/L

Spring No.	Spring	Summer	Autumn	Winter
1	27	21	32	48
2	25	21	42	48
3	30	24	37	54
4	20	17	16	48
5	15	–	32	43
6	16	–	32	39

Analysis of the chemical composition of the waters (Table 2) showed that the studied springs are practically neutral (pH 7.48–7.69) and fall within the normal range of mineralization total mineralization ranges from 468–866 mg/L, and the combined sodium and potassium content is 50–166 mg/L. These indicators confirm that the waters are safe for drinking and suitable for long-term consumption.

Table 2. Physico-chemical composition and iodine content of the studied spring waters

N	pH	Na+K mg/L	Ca2+ mg/L	Mg2+ mg/L	HCO3 – mg/L	Cl – mg/L	SO4 2 – mg/L	Total mineralization mg/L	I – ug/L
1	7.67	147.2	74.89	14.21	464.0	35.5	130.3	866.1	32.0
2	7.58	135.9	61.62	14.21	476.0	21.3	85.2	794.2	42.0
3	7.68	165.6	46.45	14.79	479.0	22.4	110.2	838.4	37.0
4	7.48	59.11	66.36	11.94	348.0	11.01	42.6	539.0	16.0
5	7.69	59.57	57.83	10.24	360.0	2.84	17.0	507.5	32.0
6	7.61	50.6	59.12	9.10	320.0	6.21	23.4	468.4	32.0
Norm	6–9	200.0	140.0	85.0	–	250.0	200.0	1000–1500	–

The iodine content recorded in the waters is regarded as a positive indicator, as it corresponds to the human body's daily and seasonal requirements. The average daily requirement for iodine is estimated at 3 ug/kg of body weight, although this figure is conditional and depends on the physiological state of the organism in particular, the requirement increases considerably during periods of growth and development; on the season of the year from September to January, the iodine concentration in the blood decreases, rises again from February, and reaches its maximum in May–June, although these fluctuations are of small amplitude; and on ambient temperature the requirement for iodine increases in cold conditions. The primary function of iodine is the continuous supply of the thyroid gland for uninterrupted hormone synthesis. The body normally maintains a constant blood iodine concentration (10-5–10-6), yet both deficiency and excess lead to the development of corresponding hormonal pathologies [6].

Among the widely used preventive measures, the consumption of iodized salt carries certain limitations the assimilation of iodine in solid form leads to excessive accumulation of salt crystals in the body, while under storage conditions and thermal processing the salt loses a significant portion of its iodine content and, accordingly, its beneficial properties. Intake in the form of iodide is comparatively safe, since it is rapidly oxidized in the body and reacts with proteins, carbohydrates, and lipids to form complex organic compounds; however, prolonged medicinal treatment can lead to excessive accumulation of iodine in the body and to the development of iodism [7].

Against this background, the consumption of iodine-enriched drinking water offers a number of advantages: iodine does not evaporate during thermal processing, is not lost during storage, itself acts as a natural preservative of the water, has no age-related contraindications, and can be consumed in amounts of up to 3 liters per day. Consequently, replenishing iodine deficiency through naturally iodine-enriched water represents a significantly more effective and physiologically safe approach.

CONCLUSION

The iodine-containing underground drinking waters identified in the Kaspi district have, from both a scientific and a practical standpoint, heightened interest in the geochemical study of other mineral springs in the region and of the mineral raw materials and soils located in their vicinity. The results obtained confirm that the studied waters, owing to their natural iodine content, neutral pH, and mineralization within normal limits, constitute a promising and safe resource for the natural provision of iodine to the population an alternative to medicinal and food-based methods of prevention. A comprehensive geological-chemical-economic assessment of Georgia's mineral raw materials, and of its water deposits in particular, is of great importance for shaping the country's mineral-resource policy and for attracting investment.

REFERENCES

1. *Tsersvadze N. Mineral Waters of Georgia. Publishing House “Nekeri”, 2017, pp. 6–7, 30.*
2. *Gobejishvili R., Javakhishvili A. Geographic Atlas of Georgia. p. 119.*
3. *Supatashvili G. Hydrochemistry of Georgia. Publ. TSU, Tbilisi, 2003, pp. 14–18.*
4. *Marakashvili E. Popular Scientific Literature in Chemistry. “Chemistry and Medicine”, Book No. 2.*
5. *Khukhia B. Photometric Methods of Analysis. Publ. TSU, Tbilisi, 1954, vol. 54, pp. 59–63.*
6. *National Center for Disease Control and Public Health (NCDC) of Georgia. Available at: www.ncdc.ge / endocrinologe.ge*
7. *Eristavi R., Sudov B., Melitauri G. Search and Prognosis of Deep-Seated Ore Deposits of the Primary Haloes of Iodine. Publ. Tbilisi, Georgian Academy of Sciences, A. Janelidze Geological Institute, 2000, pp. 407–414.*
8. *Gerasimov G., van der Haar F. Report on the National Assessment of Iodine Nutrition Status and Iodized Salt Use in the Republic of Georgia. Tbilisi, Georgia: NCDC, UNICEF, Iodine Global Network (IGN), 2017.*
9. *Wang T., Tong J., Liu Y., Liu Y., Xu H., Liu Y. Global, regional, and national burden of iodine deficiency for women of reproductive age, 1990–2021: a systematic analysis based on the Global Burden of Disease Study 2021. Frontiers in Nutrition, 2025, 12:1577169. DOI: 10.3389/fnut.2025.1577169.*
10. *Carlsen M.H., Kielland E., Markhus M.W., Dahl L. Iodine concentration in tap water, mineral water, and coffee. Food & Nutrition Research, 2023, 67:9517. DOI: 10.29219/fnr.v67.9517.*
11. *Iodine Global Network (IGN). Global Scorecard of Iodine Nutrition, 2021.*