STUDIA UNIVERSITATIS BABES-BOLYAI, CHEMIA, LIII, 4, 2008

THE IODINE CONTENT OF MINERAL WATERS

GEORGETA HAZI AND MIRCEA DIUDEA[a]

ABSTRACT. Iodine plays an important biochemical role in the synthesis of thyroid hormones, the iodine deficiency producing the increase of thyroid gland volume and the presence of goiter. The daily iodine intake need can be provided by drinking water and food. The aim of this study is to determine the iodine level in mineral waters and tap water. The iodine in mineral waters was quantitatively determined by Sandell-Kolthoff method. The concentration of iodine in the studied mineral waters shows a panel of values, being of particular interest for physicians and population as well.

Keywords: *iodine, mineral waters*

INTRODUCTION

The iodine, a non-metal of the VII-th group of Periodic Table, has been discovered by Courtois, in 1811, in the ashes of marine algae. It is spread in the earth crust as sodium and calcium iodate in the Chile's salpeter deposits, reprezenting 1-3 x 10^{-5} % of earth crust, as iodides in marine algae and in iodided mineral water sources [1].

Iodine has an essential biochemical role in the synthesis of two hormones produces by thyroid gland, triiodotironine and tetraiodotironine, which play an important role in the regulation of body cells' metabolism. The iodine deficiency determines the hypertrophy of thyroid gland called goiter. An increased volume of the thyroid gland, with the ostensible maintenance of the secretor function, with prevalence of more than 10%, within a community of a geographic region, defines the endemic goiter. Because of a large area spread, it can affect hundreds of millions people around the world, and because of the consequences and complications that can occur, it represent a matter of public health [2, 3].

Currently, in over than 118 countries, the iodine deficiency is considered a matter of public health. It is estimated that 1571 millions of people around the world (representing 28.9% of the world population) live in areas with

[a] *Faculty of Chemistry and Chemical Engineering, Babeş-Bolyai University, Arany Janos 11, RO-400084, Cluj-Napoca, Romania*

iodine deficiency, exposed to the risk of thyroid dystrophies, 656 millions have goiter and over 20 millions of them suffer from mental retardation [4, 5, 6]. The world and national experience show that prophylaxis can lead to the goiter eradication. These are based on actions meant to improve the iodine intake (the usage of iodinated salts in public consumption) and the social-economical conditions.

The daily iodine intake need by the adult human body, according to the standards of the World Health Organization, is rated to 100-200 μg/zi, and even more for the pregnant women [7]. It can be suplyed by daily drinking water and food. Water is an important source of minerals for the human nutrition. The composition of water reveals various substances: macro-elements (calcium, magnesium, sodium, potasium salts, clorides) and micro-elements (iodine, fluor, cobalt, zinc, selenium, lithium, copper). The intake of these minerals is ensured by food, which contains a much bigger concentration than water, about 90 per cent of the mineral comes from food and about 10 per cent of the daily intake of them is provided by the drinking water [8].

RESULTS AND DISCUSSION

In order to determine the amount of the iodine in waters, twenty types of mineral waters present in Romanian market were tested: A_1-A_{14} – sparkling mineral waters, A_{15}-A_{19} –non-gaseous mineral water and A_{20}-tap water (see Experimental section).

The results of the sample analyzed waters are presented in Table 1 and displayed in Figure 1:

Tabel 1 Average values of iodine concentration in studied waters.

Conc.	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}
Iodine (μg/L)	14,53 ± 1,91	4,16 ± 0,95	5,43 ± 1,28	23,56 ± 0,86	5,66 ± 0,76	23,86 ± 1,62	6,56 ± 1,45	13,02 ± 2,02	62,06 ± 3,12	26,23 ± 1,25
	A_{11}	A_{12}	A_{13}	A_{14}	A_{15}	A_{16}	A_{17}	A_{18}	A_{19}	A_{20}
Iodine (μg/L)	15,33 ± 1,25	156,3 ± 2,74	3,76 ± 0,25	4,93 ± 0,51	12,66 ± 2,41	23,06 ± 2,20	57,83 ± 4,01	13,22 ± 1,5	10,16 ± 0,95	15,7 ± 1,30

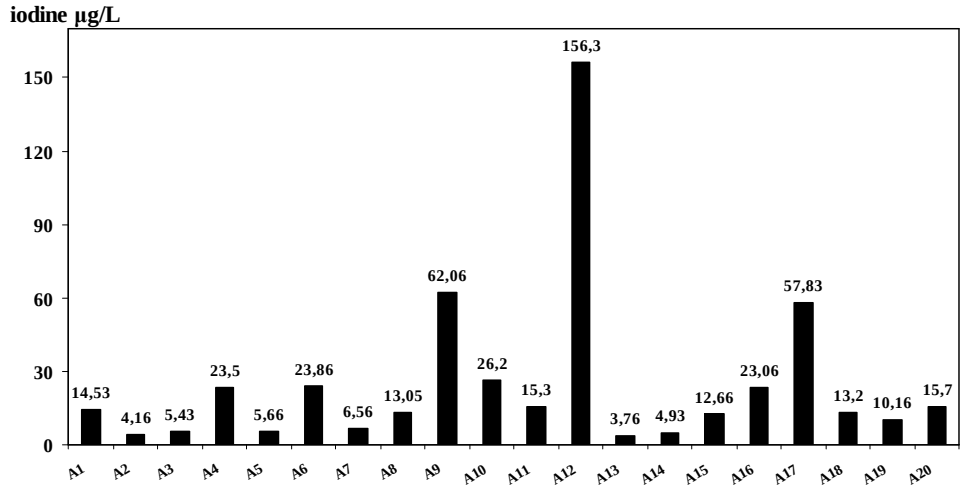

Figure 1: The iodine concentration in the studied waters

The daily iodine intake from water can vary very much, depending on water. The critical value of iodine concentration in water that can induce goiter is 2 – 3 µg/L iodine. Recent studies remark that, in the areas with goiter prevalence, the iodine concentration in water is at most 0.3 µg/L, while in other areas it is higher than 25 µg/L [9, 10].

The performed study shows that the iodine level in waters can vary much. The data show a high iodine level in the sparkling mineral water A_{12} (156.3 µg/); if it would like to provide the daily iodine intake by this water, it would be enough to consume 1L/day of it. A pretty good concentration show the mineral waters A_9 (62.06 µg/L) and A_{17} (57.83 µg/L). The samples A_4, A_6, A_{10} and A_{16} have an average iodine level of 23 µg/L, while some other waters have a lower concentration (4.1 – 6.5 µg/L). Tap water shows a concentration of 15.7 µg/L iodine. All the analyzed waters show a satisfactory level of iodine, higher than the level causing the goiter.

In the endemic areas, the level of iodine in soil, water and food (vegetables, plants) is low and is strictly correlated with the endemic goiter. Out of the low iodine level, the soil and water can contain significant quantities of organic, inorganic, bacterial substances and pollutants which represent a potential goitrous factor. For example, the consumption of water with high nitrates concentration (over 50 mg/L) causes thyroid hypertrophy, but without affecting the urinary iodine levels [11, 12].

Studies performed on the Black Sea shore areas and in central Dobrogea on the phreatic water characteristics, show waters having normal levels of iodine, but highly mineralized, especially by calcium salts, and containing organic residues [13].

Romanian mineral waters show a large hydro-chemical variety, caused by the complex geological structure of our country. The majority of the waters studied by us originates in Eastern Carpathian Mountains, and shows a panel of values of iodine concentration, predominating lower iodine concentrations (below 10 µg/L). We observed that the waters coming from volcanoes mountains show a higher iodine concentration (sparkling mineral water A_{12} and non-gaseous mineral water A_{17}).

Other studies made in our country concerning the levels of iodine in phreatic waters, show different values, depending on the geographical region. In some areas the level of iodine decreased by 70% in a period of 15 years, probably because of non-ecological agriculture and the increase of polluting substances [14].

Other studies show various levels of iodine in waters. In Israel the concentration of iodine measured by using the same dosing method (Kolthoff) was 22.8 µg/L in tap water and 7 µg/L in mineral water [15].

Waters analyzed in China show concentrations of 0.6 – 84.8 µg/L, with lower levels in the mountains areas. The iodine level in tap water was 4.3 ± 2.43 µg/L, water from source 23.59 ± 27.74 µg/L and in water from other natural sources 12,72 ± 10,72 µg/L. The concentration of iodine soil was found 0.11 – 2.93 mg/kg, without statistical differences between soils from different districts. The data show that soil and water iodine levels are not high, which implies the consumption of iodized salt [16].

Studies performed in Denmark, regarding the level of iodine in drinking water of 55 different cities, show values between less than 1 up to 139 µg/L, with higher levels in the samples taken from islands or in the coast areas. It has been determined a significant statistical correlation between the iodine in drinking water and the levels of urinary iodine [17, 18, 19].

In Greenland, the iodine level in drinking water is lower than 3.3 µg/L for all the samples examined [20].

The data presented show that the iodine levels in drinking water and other sources (springs, mineral waters, juices) may significantly differ by geographical region, soil composition, influencing the daily iodine intake.

EXPERIMENTAL SECTION

Measuring the iodine concentrations in waters was done by using the Sandell-Kolthoff method. Iodide was measured by its catalytic action on the reduction of the ceric ion (Ce^{4+}) to the cerous ion (Ce^{3+}) coupled to the oxidation of As^{3+} to As^{5+}, in oxido-reducing reaction between Ceric ammonium sulphate and Arsenious acid. This reaction, called the Sandell-Kolthoff reaction, is written as follows:

$$2\ Ce^{4+} + 2\ I^- \rightarrow 2\ Ce^{3+} + I_2$$
$$I_2 + As^{3+} \rightarrow As^{5+} + 2I^-$$

The reaction is slow, but could be accelerated by the iodide ion. The ceric ion (Ce^{4+}) has a yellow color, while the cerous (Ce^{3+}) is colorless. Thus, the course of reaction can be followed by the disappearance of yellow color as the ceric ion is reduced. The speed of this color disappearance is directly proportional to the amount of iodide catalyzing it and is measured by a spectrophotometer, after an exact time, at 405 nm [21,22].

CONCLUSIONS

The various brands of mineral waters studied by us show variable values of iodine concentration. However, the mineral water consumption cannot provide the whole need of the daily intake of this oligo-mineral, essential for the human body, but can contribute to the daily iodine supply.

REFERENCES

1. C. D. Nenițescu, “Chimie generală”, Ed. Didactică şi Pedagogică, Bucureşti, **1972**, 862.
2. F. Delange, *Thyroid*, **1994**, *4***,** 107.
3. L. Gozariu, “Endocrinologie”, Litografia U.M.F, Cluj-Napoca, **1987**, 115.
4. F. Delange, H. Burgi, Z. P. Chen J. T. Dunn, *Thyroid*, **2002**, *12***,** 915.
5. P. Vitti, F. Delange, A. Pinchera, M. Zimmermann, J. T. Dunn, *The Lancet*, **2003**, *361*, 1126.
6. *** WHO, UNICEF, ICCIDD, Bull. WHO, Geneva, **2001**, *1*, 1.
7. *** WHO, UNICEF, ICCIDD, Bull. WHO, Geneva**, 1994**, *8*, 1.
8. M. Vlad In: “Magneziul în biologia şi patologia umană”, N. Miu, G. Dragotoiu, Ed Casa Cărții de Ştiință, Cluj, **2000**, 52.
9. G. Buia, M Rădulescu, “Geologie Medicală”, Ed. Universitas, Bucureşti, **1999**, 67.
10. M Vernescu, “Apele minerale. Captare, transport prin conducte, condiționare, înmagazinare, distribuție”, Ed. Tehnică, Bucureşti, **1988**, 16.
11. A. G. Ubom, *Sci. Tot. Envir*., **1991**, *107*, 1.
12. J. M. S. van Maanen, A. van Dijk, K. Mulder, M. H. Baets, P. Menheere, D. van der Heide, P. Merents, J. Kleinjans, *Toxicol. Lett.*, **1994**, *72*, 365.
13. E. Circo, *Acta Endocrinol.*, **2005**, *1*, 73.
14. C. Dumitrache, M. Popa, Al IX-lea Congres al Societății Române de Endocrinologie, Cluj-Napoca, 13-15 sept. **2001**, vol. rez, 141.
15. C. Benbassat, G. Tsvetov, B. Schindel, M. Hod, Y. Blonder, B. A. Sela, *Isr. Med. Assoc. J*, **2004**, *6,* 97.

16. Y. L. Lu, N. J. Wang, L. Zhu, G. X. Wang, H. Wu, L. Kuang, W. M. Zhu, *J. Zhejiang Univ. Sci. B*, **2005**, *6*, 1200.
17. S. Andersen, K. M. Pedersen, F. Iversen, S. Terpling, P. Gustenhoff, S. B. Petersen, P. Laurberg**,** *Br. J. Nutr*, **2007**, *8*, 1.
18. L. B. Rasmussen, E. H. Larsen, L. Ovesen, *Eur. J. Clin. Nutr*, **2000**, *54,* 57.
19. S. Andersen, S. B. Petersen, P. Laurberg, *Eur. J. Endocrinol*, **2002**, *147*, 663.
20. S. Andersen,B. Hvingel, P. Laurberg, *Int. J. Circumpolar Health*, **2002**, *61*, 332
21. Sandell EB, Kolthoff IM. *Mikrochimica Acta*, 1**937***, 1*, 9.
22. J. T. Dunn, H. E. Crutchfield, R. Gutekunst, *WHO, UNICEF, ICCIDD*, Netherlands, **1993**, 7.