



NATURAL RADIONUCLIDES IN DRINKING WATER

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Abstract. This article summarizes data from an examination of drinking water performed in the Varna region concerning content of natural uranium.

Keywords: drinking water; control; natural radionuclides; Varna region; natural uranium

Background

At the beginning of April 2017, the media announced startling information on increased natural uranium content in drinking water. As a result of all this fear that has occurred in the country, the competent authorities responsible for control of drinking water began a massive testing of water sources all over Bulgaria.

The first information provided to the media was about the water pipeline in the town of Haskovo^{1,2)} and later about water of the surrounding villages near Haskovo. The panic continued with testing of water in the towns of Parvomay, Velingrad and Plovdiv. There were comments about values more than three times higher than the maximum admissible value in the European and Bulgarian legislation. The limit value of natural uranium content set out in Ordinance No. 9 is 0.03 mg /l (milligrams per liter).³⁾ It was also commented that the increased values for the town of Haskovo had been known to authorities since the previous year 2016. Bans on

the use of drinking water for drinking and household purposes have been issued in some places. The media started to seek competent opinion by specialists to clarify the danger of using water with increased content of natural uranium.

The microbiologist Yordan Stefanov explains clearly in his media talks how and what amount of consumed water containing natural uranium, could harm human health:

[I]ntoxications, in general, are divided into two types: acute and chronic. For acute intoxication with natural uranium, it is necessary to swallow between 204 – 242 mg/kg in order to have an adverse health effect. You can estimate how much water you need for a 65 kg person (204×65). In order to reach this amount, it is necessary to drink plenty of liters of water – note that the reported concentration is 0.390 mg / l. The second type of intoxication is chronic. In this case, the individual is poisoned with smaller doses of the agent, but with prolonged intake (a series of days). It was found that in order to monitor chronic intoxication from uranium it is necessary to consume 2 mg /kg daily. This means that a 65 kg individual should take 130 mg each day and the amount in one liter is 0.39 mg. So the individual has to take over 250 liters of water to get chronic intoxication.^{4,5)}

Intoxication could occur not only as a result of drinking water containing natural uranium. Water enters the human body during eating, washing and bathing, and also having contact with wet objects. But to get this done, one has to contact water with an extraordinary high content of natural uranium.

There is another very important issue, namely the natural environment in which the individual is born and lives. This is the so-called „natural gamma background“. For Bulgaria, according to the Nuclear Regulatory Agency, Sofia, the radiation background ranges from 0.06 $\mu\text{Sv/h}$ to 0.40 $\mu\text{Sv/h}$ for different places in the country (Kamenova-Totzeva, 2014).

It turns out, however, that there are places around the world where the radiation background is many times higher. For example, the city of Ramsar⁷⁾ in Iran. The water used in this settlement passes through uranium deposits, which is why the background radiation is over 80 times higher than the average value for the world. However, people live a normal life there. Disease and mortality are within the average for the whole world. This is possible because for generations these people have been born and lived in these places. Their organism has adapted to the local living conditions.

Of course, intoxication from water with increased natural uranium content and radiation from the natural gamma background are different things and should not be confused. But both processes lead to radioactive exposition of the human body, which is not to be neglected.

In this context we conducted an examination and analysis of the results of the radiological indicator „natural uranium“ in drinking water. The samples were collected from central water sources in the settlements on the territory of the Varna region for a period from the beginning of 2016 until June of 2017. These data were formally provided to us by the Regional Health Inspectorate (RHI) – Varna, with the permission of the Director, given in Letter No.18/ 31.07.2017 for granting access to public information. The information provided is without prejudice to the rights and good repute of others, does not endanger national security, public order, public health and citizens' morals. The information provided does not constitute a trade secret and does not contain personal data, nor does it contain classified information.

The data are extracted from the radio-chemical analysis of the samples, examined by the Radiation Control Department of the RHI – Varna.

Study and results

Sampling was performed for a period of 18 months – from the beginning of 2016 to the end of June 2017. All water sources from which drinking water was sampled and tested are from the Varna region. The number of samples tested throughout 2016 is significantly less (only 12 samples) than those tested in 2017, although the latter were taken during half of a year (44 samples). Of the 12 samples tested in 2016, only one sample - the one from the village of Chernevo - was not repeated (Table 1).

Table 1. Data from the examination of the drinking water taken from the water sources from the Varna region

| Water supply area | 2016 | 2017 |
|------------------------------|-----------------------|-----------------------|
| | Natural uranium, mg/l | Natural uranium, mg/l |
| Village of Tsonevo | | <0,0006 |
| Village of Batova | <0,0006 | <0,0006 |
| Village of Zlatina-Vetrino | <0,0006 | <0,0006 |
| Town of Valchi Dol | <0,0006 | <0,0006 |
| District Priboy | | 0,0006±0,00015 |
| Town of Aksakovo | <0,0006 | <0,0006 |
| Village of Dolishte | | <0,0006 |
| Village of Kapitan Radevo | | <0,0006 |
| Village of Izvorsko | <0,0006 | <0,0006 |
| Village of Lyuben Karavelovo | | <0,0006 |

| | | |
|-----------------------------------|---------|---------|
| Village of Voditsa | | <0,0006 |
| Village of Zasmyano | | <0,0006 |
| District „Sveta Marina“ | | <0,0006 |
| Water pipe Charamiyski | <0,0006 | <0,0006 |
| Village of Dobrogled | | <0,0006 |
| Village of General Kantardzhievo | | <0,0006 |
| Village of Klimentovo | | <0,0006 |
| Village of Gen. Kiselovo | | <0,0006 |
| Village of Belogradets | <0,0006 | <0,0006 |
| Village of Venchan | | <0,0006 |
| Village of Dobrina | | <0,0006 |
| Village of Cherkovna | <0,0006 | <0,0006 |
| Village of Chernook | | <0,0006 |
| Village of Kiten | | <0,0006 |
| Village of Manastir | | <0,0006 |
| Village of Kamen Dyal | | <0,0006 |
| Village of Avren | <0,0006 | <0,0006 |
| Village of Benkovski | | <0,0006 |
| Village of Zdravets | | <0,0006 |
| Village of Kitka | <0,0006 | <0,0006 |
| Water source “Kamchiya-Bliznatsi“ | | <0,0006 |
| Village of Sadovo | | <0,0006 |
| Village of Dyulino | | <0,0006 |
| Village of Solnik | | <0,0006 |
| Village of Golitsa | | <0,0006 |
| Village of Goren Chiflik | | <0,0006 |
| Village of Venelin | | <0,0006 |
| Village of Momchilovo | <0,0006 | <0,0006 |
| Village of Yagnilo | | <0,0006 |
| Village of Nikolaevka | | <0,0006 |

| | | |
|----------------------|---------|---------|
| Village of Izgrev | | <0,0006 |
| Village of Levski | | <0,0006 |
| Village of Prosechen | | <0,0006 |
| Village of Chernevo | <0,0006 | |
| Village of Razdelna | | <0,0006 |

The method used for testing natural uranium in drinking water is according to the Bulgarian Standard BDS12578-75. This is a luminescent method. It is based on the ability of six valent uranium in a melt with sodium fluoride to fluoresce under irradiation of ultraviolet light. The intensity of the luminescence is proportional to the concentration of natural uranium in the sample. By its amount, the intensity of the light is proportional to the natural uranium content in the range of $1 \cdot 10^{-8}$ up to $7,5 \cdot 10^{-6}$ g in one pearl. The uncertainty of this analysis is 25% (Kamenova-Kotzeva, 2014). The test is carried out at a temperature of $20 \pm 0,2$ ° C. The maximum allowable value of the natural uranium indicator in drinking water, according to Ordinance No. 9 (On the quality of water intended for drinking and household purposes. No. 30 of 2001 - Table B, amend., SG 102/14, in force from 28.11.2015) is 0.03 mg/l (milligrams per liter).³⁾

The value of 0,0006 mg/l is the limit value of the used test method. All results, except one, are below the limit of sensitivity of the test method. Only the result obtained for the water source in the Priboy area has reached the limit sensitivity. The error of the value of the natural uranium in the sample is $\pm 0,00015$ mg /l. Adding the error even to the maximal measured value we obtain a value which is orders of magnitude less than the minimal allowable value for content of natural uranium in the drinking water according to Ordinance No. 9.

Conclusion

The analysis of data for the drinking water, taken from central water sources in the settlements on the territory of the Varna region for the period from the beginning of 2016 to the end of June 2017 undoubtedly leads to the following conclusions: (i) all results obtained for the whole 2016 and for the first half of 2017 are well below the minimum value published in the current regulatory documentation; (ii) the results obtained are below the limit of the sensitivity of the testing method.

As a conclusion of this examination it is confirmed that the central water sources from the settlements in the Varna region, where the sampling for natural uranium was made, meet the requirements of Ordinance No. 9 of 2001, last amended - SG, no. 102 of 2014, in force as of 28.11.2015. Drinking water in the above mentioned water sources has a „natural uranium“ content well below the allowable limits.

Therefore, drinking water in the Varna region (from the examined water sources) contains no radioactive contamination concerning the indicator „natural uranium“ and from this point of view it is safe to drink by the population in the region.

NOTES

1. <https://news.bg/regions/otnovo-uran-vav-vodata-na-haskovo.html>
2. <https://news.bg/regions/leko-zavisheno-nivo-na-uran-v-tri-haskovski-sela.html>
3. <http://www.wabd.bg/docs/Zakoni/NAR9.pdf>
4. <https://offnews.bg/nauka/vsichko-koeto-triabva-da-znaem-za-urana-vav-vodata-653425.html>
5. https://nauka.offnews.bg/news/Novini_1/Jordan-Stefanov-Uranat-e-nad-normata-no-miasto-za-isteriia-niama_79059.html
6. http://www.bnra.bg/bg/emergency/radgamma_background
7. https://www.ramsar.org/sites/default/files/documents/library/strategic_framework_rsis_en.pdf

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