Iran. J. Radiat. Res., 2007; 5 (2): 97-100

Radioactivity monitoring in drinking water of Zahedan, Iran

S.A. Hosseini

Department of Medical Physics, School of Medicine, Zahedan University of Medical Sciences, Zahedan, Iran

Background: The present research has focused on the effect of radioactivity on drinking water from five sites in the region of Zahedan city. ***Materials and Methods:*** The measurement of water activity in wells, river and spring has been used as a screening method. The determination of gamma emitters was performed by use the application of gamma spectrometry. ***Results:*** The values of Radium concentration was between less than 2 mBq/l to 3±0.4 for water wells, 5±0.4 mBq/L for river, and less than 2 mBq/L for spring. ***Conclusion:*** All values of activity in the selected water samples were lower than the permissible limit for drinking water consumption. The water was safe for drinking, washing and agricultural use. **Iran. J. Radiat. Res., 2007; 5 (2): 97-100**

Keywords: *Drinking water, radioactivity, radium isotopes.*

INTRODUCTION

The largest contributor of ionizing radiation to the population is natural radioactivity. People may consume the water which is polluted with occurring naturally radioactive material [1]. It can affect on them, if it is more than limit [2]. On the other hand such radiations account for more percentage of the total radiation dose to the general population [3]. However, the risk to a population is increased by increasing the amount of radio isotope dose in drinking water and by increasing the number of persons using water [4]. For this reason, every effort should be made to reduce the ionizing radiation from drinking water and the number of persons used water, as well as to reduce the dose involved in a particular drinking water.

A sampling network has been established, in collaboration with health center of Zahedan, in order to monitor the radioactivity levels of drinking water from the Zahedan network and to ensure the radiological protection of population in terms of the annual dose from water consumption. This program is in accordance with the council Directive 98/83/EC, on the quality of drinking water [5]. It is generally agreed by experts in the scientific community that ionizing radiation to people from sources can be reduced substantially with no decrease in the value of water derived.

The aim of this program was to perform measurements of different radio nuclides in order to determine the total dose to the public as a radioactive pollution due to natural and artificial radio nuclides in drinking water.

MATERIALS AND METHODS

Water samples were collected from five wells, one river and two springs in winter season. The wells are situated in different parts of Zahedan city, south-east of Iran. There are only one well in each geographical region; north, south, west and east of Zahedan city. The river is called "dried river" because it only has water in winter season. The water of these wells is given to grass, tree and sometimes is consumed as drinking water. The people consume grass, directly or indirectly. The wells are composed of siltstones and sandstones. Limestone is also present within river. Most of wells are constituted of schist and marble. Their geology is complex. Limestone, peritonitis, schist and serpentines are present.

Five samples were collected during winter

Corresponding author:
Dr. Seyed Abbas Hosseini
Department of Medical Physics, School of Medicine, Zahedan University of Medical Sciences, P.O box 98166-508, Zahedan, Iran.
E-mail: *sepehrhssn@yahoo.com*

[Downloaded from mail.ijrr.com on 2025-10-17]

season from wells, river and spring. Each well sample is taken from the exit to the pumping station of the supply network. Water samples were transferred to Atomic Energy for determination of gamma-emitting nuclides. These samples were examined for radium isotopes and man- made radionuclides. One litre of water sample collected in polyethylene bottles was used for radionuclide determination,

The water samples are measured in a high resolution gamma spectroscopy system with an HPGe detector (Canberra) of 70% relative efficiency and computerized multi-channel analyser.

All the samples were measured in a polyethylene beaker with a volume of 260 ml. The efficiency has been determined by a standard multi nuclide source, having the same geometry and density with the measured samples. Measurement time was more than 8 hr. The minimum detection activity was determined with a confidence level of 95%. All tests were carried out by the department of radiation protection of the Iran Atomic Energy Organization.

The radium activity was measured by alpha spectrometry. The minimum detection activity of this method (95% confidence level) was 1 mBq/l for a counting time of 8 hr. The screening methods may be used to monitor the parameter indicator for determining total indicative dose (TID). The most commonly used screening method is the measurement of gross alpha activity and gross beta activity. If the gross alpha and gross beta are less than 0.1 and 1 Bq/L respectively, it can be assumed that the TID is less than the parameter indicator value 0.1 mSv/year and no further radiological investigation are needed. If the gross alpha activity exceeds 0.1 Bq/L, or the gross beta activity exceeds 1 Bq/L, analysis for specific radio nuclides is required [6].

The choice of radio nuclide was based on the available information about the potential sources of radioactivity in country. In Iran, the determination of radium isotopes has been chosen as an indication of natural radioactivity.

Specific measurements may be carried out for specific radio nuclides. If one of the measured activity concentration exceeds 20% of a reference concentration, analysis of additional radio nuclides shall be required. Reference concentration for each concentration radio nuclides can be calculated using the dose coefficients for adults, laid down in Annex III, Table A of Directive 96/29/Euratum [7], assuming an intake of 730 L per year.

Based on documents (Annex II & III) of the 98/83/EC Directive, concerning the radioactivity monitoring, the frequency and location of the sampling must be defined in order to ensure that the measured values are representative for an annual average activity concentration. When the representative sampling shows that the parametric indicator value of 0.1 mSv/year is exceeded, necessary actions should be implemented.

RESULTS AND DISCUSSION

The risk to individuals from consuming drinking water is very low. The activity of radium in the wells samples under investigation ranges from less than 2 mBq/l to 3.1±0.4 mBq/l; 5±0.4 mBq/l in river sample and less than 2 mBq/l in spring (table 1). Compared to radium activity concentration values in drinking water of other European countries, the values of this study are low.

Table 1. Radium concentration in water sample (mBq/l).

Sample point	Sample site	Source	Consumed water	Radium concentration (mBq/l)
Zahedan	Karim abad	Well	Wash-agriculture	< 2
	Orqideh square	Well	Wash-cooking	< 2
	Cambusia land	Spring	Drinking	< 2
	Buzurg mehr	River	Drinking	5±0.4
	Goorband	Well	Drinking	3.1±0.4

[Downloaded from mail.ijrr.com on 2025-10-17]

The reported radium values (mBq/l) of drinking water of some European countries are: France 4.4-930; Germany 0.4-600; Italy 0.5-130; Romania 0.4-37; Switzerland 0-1000; Spain 3.7-4.4; Finland 0.5-150000, etc [8]. The results of the present study are also low, in comparison with other values measured else where in the world [9-11].

Radium activities can be affected by seasonal variations. Seasonal variation of the radium levels was investigated by analysis of the radium isotopes in the waters under investigation. The concentration of isotopes in waters is depending on the season. The concentration increases in summer due to the high evaporation rates and the increase of solubility of salts due to the higher temperature of the water [12]. Consequently, there is expected to be an increase in the radium concentration in those waters sampled in summer. The low radium concentrations are due to the geological characteristics of points.

The ^{226}Ra concentrations measured in surface water are generally below the detection limit. Significant differences have been found depending on the geological characteristics of the area of reference, although the very distinct concentration levels of ^{226}Ra found in samples of similar litho logy imply the influence of more complex factors in the solution of ^{226}Ra in water. Due to the relationship between other radioactive material and ^{226}Ra, no significant correlation between ^{226}Ra and other radioactive material concentrations has been observed unless measurements carried out in a high background radiation region are considered separately.

Radium-226 at levels above the risk level of the measurement method are not detected in any of the examined well water sources: Assuming the maximum concentration value, it is estimated that an annual dose received by the population drinking that water is 0.04 mSv, which is below the value of 0.1 mSv recommended by the World Health Organization.

No artificial radioactivity has been detected by means of gamma spectroscopy. The examined radio nuclides $Cs^{137}$and I^{131} are below the minimum detection activities.The difference in Ra-226 may be due to the lower calcium uptake in which leads to higher resorption of radium [2].

The recommendations outlined below are directed toward the people and the operator of drinking water equipment. To accomplish this reduction, it is essential that responsible men always monitor the drinking water and people not be used such water as drinking water. When drinking water is required, it is essential that people be protected from excessive radiation exposure during the usage. These recommendations are intended to provide guidelines for the elimination or reducing doses to people. Also, included are recommended upper limits on people doses for certain drinking waters.

In conclusion, the levels of gamma emitters in the drinking water of the suppliers for the region of Zahedan city in Iran were below the low detection activity. The radium concentration is well below the 20% of the reference level for radiological protection. The total dose for one year of intake is estimated to be well below the value of 0.1 mSv/year.

REFERENCES

1. Kluszczyński D, Tybor-Czerwińska M, Kacprzyk J, Kamiński Z (2006) Concentrations of natural 226Ra and 222Rn radioisotopes in the water from deep well intakes in the vicinity of Łódź. *Med Pr;* ***57:*** *451-4.*
2. Muth H and Glöbel B (1983) Age dependent concentration of 226Ra in human bone and some transfer factors from diet to human tissues. *Health Phys;* ***44:*** *113-21.*
3. Robison WL, Noshkin VE (1999) Radionuclide characterization and associated dose from long-lived radionuclides in close-in fallout delivered to the marine environment at Bikini and Enewetak Atolls. *Sci Total Environ. Sep* ***30;*** *237-238:311-27.*
4. Soto J, Fernańdez PL, Gómez J, Róđenas C (1995) Study of the occurrence of 222Rn and 226Ra in drinking water in Spain. *Health Phys;* ***69:*** *961-5.*
5. Coucil Directive 98/83/EC of 3 November (1998). On the quality of water intended for human consumption. *L 330/32 EN Official Journal of the European Communities 5.12.98*
6. World health organization (WHO) (1993) Guidelines for drinking water quality, Recommendation, vol. 1, *Geneva.*

[Downloaded from mail.ijrr.com on 2025-10-17]

7. Council Directive 96/29/Euratom of 13 May (1996), Laying down basic safety standards for the protection of the health of workers and general public against changes arising from ionizing radiation, *OJ L 159, 29.6.1996. Annex III, Table A.*
8. UNSCEAR, united nation scientific committee on the effects of atomic radiation, (2000), sources and effects of ionizing radiation. Annex B: Exposures from national radiation sources. *United Nations, New York, pp. 125*
9. Ortega X, Valles I, *Serrano I (1996) Environ Int,* ***22:*** *397-354.*
10. Clulow FV, Davé NK, Lim TP, Avadhanula R (1998) Radionuclides (lead-210, polonium-210, thorium-230, and -232) and thorium and uranium in water, sediments, and fish from lakes near the city of Elliot Lake, Ontario, Canada. *Environ Pollut,* ***99:*** *199-213.*
11. Hakam OK, Chukri A, Reyss JI, Lferde M (2001) Determination and comparison of uranium and radium isotopes activities and activity ratios in samples from some natural water sources in Morocco. *J Environ Radioactivity,* ***57:*** *175-189.*
12. Herranz, M. Abelairas A. and Legarda, F. (1992) *Radiation isotopes,* ***51:*** *203-208.*

[Downloaded from mail.ijrr.com on 2025-10-17]