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The Effect of Heat on Radio Iodine in Water in Sistan and Blouchestan Province of Iran

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Abstract: The study was conducted for the investigation of heat effect on radioactivity in the drinking water of chah-nimeh Station of Zaboul and Khatam hospital well for irrigating gardens of Zahedan in Iran. This drinking water supply has provided drinking water of Zahedan. The technique of Gamma Ray Counting was applied using I-125 detector. Activity concentration levels due to I^{125} was measured in 50 mL water samples collected at a volume of about 500 mL at the depth level of 0-25 cm with a step of 5 cm depth. It is resulted that activity concentration range of the concerned radio nuclides in case samples of Zaboul for 20, 30 and 40°C temperature of the drinking water were as follows: 6.08±0.08, 15±0.17 and 6.6±0.8 Bq L^{-1}, respectively and control samples 5.6±0.08 Bq L^{-1} for any temperature. Radioactivity concentration from Khatam hospital well water case samples were 12±2, 14±2 and 13±5 Bq L^{-1}, for 5, 10 and 15°C temperature, respectively. The slightly higher value of radio iodine in the drinking water of Zaboul city in case samples relative to control samples may be due to the use of temperature for case samples. Heating case samples causes raised radioactivity in Zahedan which support the result of drinking water. Knowledge of temperature variation effect on radio-iodine in water was particularly essential for estimating iodide group, especially I-129 transfer to fluvial systems and for successfully measuring radio-iodine in water studies Before the radiometric measurements, chemical analysis for concentration of Na, Ca and Mg was also carried out along with the measurement of electrical conductivity and pH of the water samples.

Key words: Drinking water, gamma counting, environmental radioactivity, ^{125}I

INTRODUCTION

For community purposes, water must be in sufficient supply and free from contamination, pollution and turbidity. Although there is a great interest in the study of man-made radiation and radioactivity in water but at first the exposed population to man-made radioactivity at different levels is an importance factor which depend on man-made radioactive in water for each region in the world (Mokrov, 2004).

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Man-made radiation and environmental radioactivity has led to the performance of extensive surveys in many countries of the world. Such investigations can be useful for both the assessment of public dose rates and the performance of epidemiological studies, as well as to keep reference data records, in order to ascertain possible changes in the environment radioactivity due to nuclear, industrial and other human activities. Man-made environmental radioactivity such as ^{125}I arises mainly from reactor activity or from the rainfall (Seki *et al*., 1988) and radioactive waste (Mokrov, 2003) and their decay products, which occur at trace levels in water.

Man-made radioactivity and the associated external exposure due to gamma radiation depend primarily on the geographical conditions. The specific levels of water radiation are related to the composition of water. There are many types of water depending upon the physical and chemical composition. The water is classified as saline, drinking water and alkali etc. In drinking water, the concentration of salts is decreased to the level at which the crop growth is affected. Drinking water has not a high content of natural salts and has not pH generally above 7.3 and not over 8.5. Nuclear fission in connection with atomic weapons testing provides another source of water contamination (Amachi *et al*., 2003).

Direct fall out from the atmosphere on the drinking water was primary source of contamination. The fission product ^{125}I is strongly absorbed and retained by water, as are radio nuclides, which will be found randomly in drinking water due to accident. The subject of radioactive contamination gained considerable public importance because of Chernobyl accident (Mettler *et al*., 2007). Man-made radio nuclides more or less contributors to radiation doses received by human beings. Because of increased public concern and awareness about radioactive pollution, this study has been carried out to determine the heat effect on amount of radioactivity from the drinking water of Chah Nimeh station in Zaboul city which is given its drinking water to Zahedan city by pipng and Khatam hospital well water in Zahedan irrigating garden.

MATERIALS AND METHODS

The experiment was undertaken in Medical Physics Laboratory. The distance between Medical Laboratory and point of checking gamma ray (site) was about 4 km. Drinking water from Chah Nimeh of Zaboul city and Khatam Hospital well water of Zahedan sampling were done in the month of May-June 2007, by 2 L plastic glasses which total amount of samples was 20 L. Sampling from the both of them was performed using the Standard Sampling Methods. The samples were properly marked, cataloged and brought to medical Physics Laboratory at Zahedan city, Iran for processing before analysis.

The samples were put in 2 L cylindrical plastic containers (Chemical resistant) were filled and packed with drinking water samples. The empty containers were weighed and were filled with drinking water samples and weighed again. The net weight of the drinking water was noted. The containers were closed by screw caps and plastic tapes were wrapped over the caps. Same procedure was applied for the reference material. Before performing the chemical analysis, temperature of water was measured with a thermometer and pH was measured with a pH meter. The drinking water samples were first kept in the sun for several days.

^{125}I is similar to ^{129}I with its half life less than man-made radio nuclides ^{129}I. According to Seki *et al*. (1988), ^{125}I is found in drop of rain. So, this radio isotope has been chosen for the experiment in stead of ^{129}I.

The case samples of the drinking water and Khatam Hospital well water were then heated under 20, 30 and 40°C by electrical oven at the time 15 min, but the control samples of drinking water were not. ^{125}I had been poured into both of case and control samples of drinking water before heating it. Its total activity of ^{125}I was 445 Bq. The case and control samples of Khatam Hospital well water were heated at 5, 10, 15°C temperature. ^{125}I was put into the case samples, but ^{125}I was not poured into the control samples before heating.

The technique of gamma ray counting was applied for determination of radioactivity of the samples under investigation. The concentration of radioactivity in water supply of drinking water has been experimented by Gamma counting set. The characteristics of the gamma counting component were as follows: Serial No. GM1 8335 S 307, Counting system model: Automatic Gamma Manufacturer: KONTRON. Counting of every drinking water sample was collected for 20 sec. The lowest limits of detection (LLD) were determined for ^{125}I.

RESULTS AND DISCUSSION

High-resolution technique was employed for the measurement of gamma ray. Case and control water samples of Zaboul were compared (Table 1):

- Temperature increase radioactivity of drinking water samples
- The radioactivity of drinking water samples was increased in 30°C temperature than 20 and 40°C temperature. Because high temperature cause the activity of atoms and molecules will be raised.
- Activity of solid and liquid is less than gas or volatile materials such as ^{125}I under temperature 20, 30 and 40°C
- Activity of radio iodine in case drinking water is more than control drinking water samples under 20, 30 and 40°C temperature

Case and control water samples of Khatam hospital well of Zahedan were compared (Table 2):

- Heating case samples causes to increase activity iodine-125 of it
- There was not any change in activity iodine-125 of control samples
- There was more variation in radio iodine-125 between case and control samples

Heating case and control samples in two water showed that figures of low heating 5, 10 and 15°C was more than 20, 30 and 40°C temperature.

The results of investigation for temperature effect on drinking water samples from Chah Nimeh of Zaboul and Khata hospital well water of Zahedan in the Sistan and Blouchestan province of Iran showed that the effect of temperature on radio iodine in drinking water. The investigated radionuclide in this study was ^{125}I. The measured activity in case samples was different from control samples. The activity measured at one location was averaged out and the mean values are only tabulated. Three temperatures has been used on drinking water with radio iodine-125: 20, 30 and 40°C. All the case samples under 20, 30 and 40°C possess effect on gamma radioactivity. During affection of temperature, I^{125} produces 15±0.17 Bq L^{-1} in drinking water, with the emission of beta and gamma radiation. The average value of I^{125} concentration in the drinking water as a control was 5.6±0.03 Bq L^{-1}.

Table 1: Radioactivity concentration of Zaboul city drinking water in different temperature

Temperature (°C)	Radioactivity concentration (control) (Bq L^{-1})	Radioactivity concentration (case) (Bq L^{-1})
20	5.6±0.08	6.0±0.08
30	5.6±0.08	15.0±0.17
40	5.6±0.08	6.6±0.08

Table 2: Radioactivity concentration of Zahedan city water in different temperature

Temperature (°C)	Radioactivity concentration (control) (Bq L^{-1})	Radioactivity concentration (case) (Bq L^{-1})
5	2.90±0.10	12±2
10	3.08±0.18	14±2
15	3.00±0.20	13±5

The average value and range of measured concentration of ^{125}I for drinking water was different in various temperatures. For ^{125}I the average value and range of measured specific activity for drinking water in temperature 20°C; was 6±0.08 Bq L^{-1}. The ratio of ^{125}I in 20°C and ^{127}I as the control drinking water is generally greater than one and that is also true for the present case. The average activity value of ^{125}I in temperature 30°C was about two times higher than that of ^{127}I in control drinking water sample. The activity concentration of ^{125}I in drinking water in 30°C is order of magnitude higher than that of ^{125}I in 20°C and ^{125}I for the drinking water. This is also in accordance with the well-known fact that ^{125}I under 30°C in the drinking water is of the order of percentage whereas ^{125}I in 20°C and ^{125}I in 40°C are in activity level. The average values of activity concentration of ^{125}I in all the samples found in drinking water of Zaboul city was not the same as each other. The activity concentration of ^{125}I in most samples of drinking water was below the lowest limit of detection (LLD). The reasons of less existence of ^{125}I in the drinking water of Zaboul to Zahedan in control samples are that the radio iodine might have reduced the amount of ^{125}I from it. The less values of fall out may be due to drinking water material. Temperature may be other reason for the reduced values in the radio iodine of interest (Ames and McGarrah, 1980). The variations in the activity levels have been observed to be lying within the activity values measured all over the world. According to Mokrov *et al*. (2000), the average value of activity concentration for radio nuclides in different conditions are known for water. The measured value of activity concentration of ^{125}I for the drinking water under investigation in 30°C was within the world average range. The ranges of activity concentrations for radio nuclides water given in the Mokrov (2003) are reported. The measured values of the activity concentration for the samples of Zaboul were lying within averages, when different temperature and adding radioiodine are not considered. As far as the mutual comparison of the case samples of drinking water and control samples of the drinking water under investigation is concerned, there is drastic change in the activity concentrations in both types of drinking water. However, a slight increasing trend was observed in the measured activity of radio iodine 125 between 20 and 40°C. It is well known that a given temperature effect radio iodine. Since, temperature effect is an essential raw material used for the manufacturing of different type's radio iodine deposit, therefore, when this temperature is processed into radio iodine drink water sample, most of the radio iodine and some of the material accompanies the drinking water (Ashworth and Shaw, 2006). It has also been estimated earlier that 30°C temperature applied to the samples in recommended amounts could raise radioactivity level in drinking water. The use of given temperature in large extent have affected radio nuclides concentration, especially ^{125}I containing 30°C are the one of the cause of presence of high activity of radio iodine in drinking water (Spomer *et al*., 2008; Dickstein *et al*., 2008). For case samples under low temperature 5, 10 and 15°C (Table 1, 2) was more than 20, 30 and 40°C temperature. The causes of this situation were related to components of both waters. Heating could produce conditions in which affect on case and control sample in activity but there was a big difference in activity between case and control sample. The method of experiments was alike, only different ions or molecules could be considered. According to Mokrov (2003), construction of ^{125}I in samples would be changed and there would be a new matter. However, heating could provide situation for ions or molecules in the water to vary the component of water (Mokrov *et al*., 2000; Bors and Martens, 1992).

In this study, the use of different temperature helps the polluted drinking water with radio iodine is converted to benefit drinking water. The drinking water should pass through many experiments with the extensive use of radio iodine. The slightly increasing trend at the beginning may be an indication of the large change of activity in the future due to the applications of temperature.

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