Uranium Concentration in Ground Water of Bangladesh

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Abstract: Now-a-days uranium has been identified as a nephrotoxic metal, exerting its toxic effect by chemical action mostly in the proximal tubular in humans and animals. In the environment uranium is found naturally in very small amount in rocks, soil, air and water. In drinking water most of the uranium is dissolved which derives from the rocks and soil that the water is over. The level of uranium in drinking water is very low. According to the U.S. Environmental Protection Agency (EPA) for public water supplies the Maximum Contamination Level (MCL) is 30μg/L. In the present study, CR-39 plastic detector has been used to measure the uranium concentration in drinking water samples from various places of Bangladesh. The calibration curve was prepared from standard uranium solution containing 11.30, 28.58, 56.75 and 109.4 ppb dissolved uranium. 261 different water samples have been studied from 54 districts of Bangladesh. From the analysis it is found that uranium concentration in 19% of drinking water samples is above the safety level i.e. 30μg/L.

Key words: Uranium, drinking water, ppb, calibration curve, MCL.

Introduction

Now-a-days world is more concerned about the high level of radioactivity. Exposure to radiation even in low level is considered undesirable because, it may cause damage to public health and environment. Living organisms are directly and indirectly affected by the polluted air, water, and soil which are contaminated from both natural and nuclear explosion. So it is necessary to detect the radiation level in different samples in the environment. Uranium is naturally found in very small amounts in rocks, soil, water, plants, and animals including humans [1]. Uranium is weakly radioactive and contributes to low levels of natural background radiation in the environment. Uranium metal has very high density, 65% more dense than lead. Uranium in ores can be extracted and chemically converted into uranium dioxide or other chemical forms usable in industry. Uranium found naturally has 3 different isotopes, U-238, U-235, and U-234. Other isotopes can be synthesized. All uranium isotopes are radioactive and undergo radioactive decay by emission of an alpha particle accompanied by weak gamma radiation [2].

Uranium in soil and rocks is distributed throughout the environment by wind, rain and geologic processes [3]. Rocks weather and break down to form soil, and soil can be washed

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by water and blown by wind, moving uranium into streams and lakes, and ultimately settling out and reforming as rock. Uranium can also be removed and concentrated by people through mining and refining. These mining and refining processes produce wastes such as mill tailings which may be introduced back into the environment by wind and water if they are not properly controlled. Manufacturing of nuclear fuel, and other human activities also release uranium to the environment. Uranium from the environment enters the human body by ingestion with food and drink and by inhalation of respirable airborne uranium-containing dust particles or aerosols. The greatest health risk from large intakes of uranium is toxic damage to the kidneys, because, in addition to being weakly radioactive, uranium is a toxic metal [4].

Uranium exposure also increases the risk of getting cancer due to its radioactivity. Since uranium tends to concentrate in specific locations in the body, risk of cancer of the bone, liver cancer, and blood diseases (such as leukemia) are increased. Inhaled uranium increases the risk of lung cancer. Most people are not exposed to dangerous levels of uranium. However, people who live near uranium mining areas, or near government weapons facilities or certain industrial facilities may have increased exposure to uranium, especially if their water is from a private well.

Uranium in drinking water is covered under the Safe Drinking Water Act [5]. Health Canada recommended a maximum acceptable concentration of uranium in drinking water of 10µg/L. In 1991, USEPA proposed an MCL of 20 µg/L, which was determined to be as close as feasible to the Maximum Contaminant Level Goal (MCLG). Based on human kidney toxicity data collected since then and on its estimate of the costs and benefits of regulating uranium in drinking water, EPA has determined that the benefits of a uranium MCL of 20 µg/L do not justify the costs. Instead, EPA has determined that 30 µg/L is the appropriate MCL, since it maximizes the net benefits (benefits minus costs), while being protective of kidney toxicity and carcinogenicity with an adequate margin of safety.

Bangladesh is located in the midst of one of the world's largest river systems. Although this vast amount of water provides a living for almost 1/3 of the country's population, the water quality is poor and the abundance of this water does little to meet the drinking needs of the people. Drinking water in Bangladesh is not largely a river based water purification system but instead, the most crucial source of drinking water, ground water, remains in Bangladesh. Bangladesh is very much dependent on ground water both for drinking and irrigation purposes. An estimated 97% of drinking water of the rural population in Bangladesh is now supplied by groundwater. About 80% of the population is covered by manually operated shallow tube wells and 6% by manually operated deep tube-wells. It has been estimated that about 8.0 million hand pump tube-wells have been installed under private initiatives and government has sunk about 1.2 million tube-wells. Uranium is always present in surface water and groundwater. There is an extremely wide range of concentration from below 0.01 µg/l to in excess of 1500 µg/l water. According to British Geological Survey (BGS)[6] report, some of the samples of ground water in Bangladesh have a concentration over MCL of 30 µg/l. Aim of the work is to find out the concentration of uranium in ground water in various places of Bangladesh.

Materials and Methods

In order to measure the concentration of Uranium in ground water in different places of Bangladesh a total of 261 water samples from 54 different places were collected. The locations of the collected water samples have been shown in the map (Fig. 1). Each of the collected samples was stored into fresh plastic container individually. Solid State Nuclear Track Detector (SSNTD) technique has been used for water sample analysis. The plastic detector known as CR-39 was developed in 1933 and is now in widespread use. It is an excellent detector of charged particles, which could be revealed by etching the plastic. The chemical name: Polyallyl diglycol carbonate (PADC), also known as Tastrak, CR-39 and CR39. Chemical formula and structure of monomer is: $C_{12}H_{18}O_7$. The method of Gamboa *et al*. [7] has been used for direct determination of uranium content in liquid sample. The relationship between uranium concentration (ppb) and alpha track density was obtained by using standard uranium solution having concentration of 11.30, 28.58, 56.75 and 109.4 ppb. The calibration curve (Fig. 2) was used to determine the uranium concentration in drinking water samples. 50μl of water sample was placed over the detector surface and exposed to the plastic detectors for two weeks and etched in 6N NaOH solution at a constant temperature of 70°C for four hours. After etching, the detectors were ready for examination under an optical microscope. The central portion of the detector was scanned using a binocular research microscope at a magnification of 400 (40x objective and 10x eyepiece). By proper adjustments the alpha track etch pits in the detector were identified and counted. For background correction blank test detectors were scanned under microscope and cancelled these tracks from the original data.

Results and Discussion

In Bangladesh most of the people live in villages and tub-well is being used for drinking water. As uranium is a toxic element for human health found in ground water in a tiny amount it is necessary to test every tub well. In the present study 261 different water samples have been analysis. It is found that the range of uranium content to be 0.50 ppb to 51 ppb. It is also found that uranium concentration in 27% of drinking water sample in the range of 0.5-10 μg/L, 38% of drinking water sample in the range from 11-20 μg/L, 16% of drinking water sample in the range of 21-30 μg/L and 19% of drinking water sample above the safety level i.e. 30 μg/L (Fig. 3). The lowest uranium concentration obtained 0.5 ppb which belongs to the area of Mymensingh and the highest uranium concentration obtained 51 ppb from Gazipur District. This level of uranium is above the safety level.

According to World Health Organization appropriate range for uranium content in our drinking is 1 to 2 ppb, but even 20 ppb may be tolerable. Even so if a water sample contains above 2 ppb of uranium it is suggested to be treated before drinking. British Geological Survey reported high uranium concentration in drinking water of Bangladesh. They found highest Uranium content 47 μg/L in Chapai Nawabganj. Table 1 shows the uranium content of 5 water samples from different places of Bangladesh.

Table 1: *Data for the uranium concentration of only 5 water samples out of 261.*

No. of obs.	Source of Sample	Color of the sample	Total volume of the sample ml	Odor of the sample	Track density per mm^2 per day	Uranium Concentration from Calibration Curve(μg/L)
1	Wazipur Thana, Barisal	Colorless	100	Odorless	7.18±0.90	8
2	Patiya, Chittagong	Colorless	100	Odorless	19.23±1.3	21
3	Boirob Thana, Kishorgong	Reddish	100	Odorless	5.10±0.81	1
4	Monirampur, Jessore	Colorless	100	Bad order	11.30±1.1	13
5	Moulabibazar	Colorless	100	Odorless	38.74±2.9	44

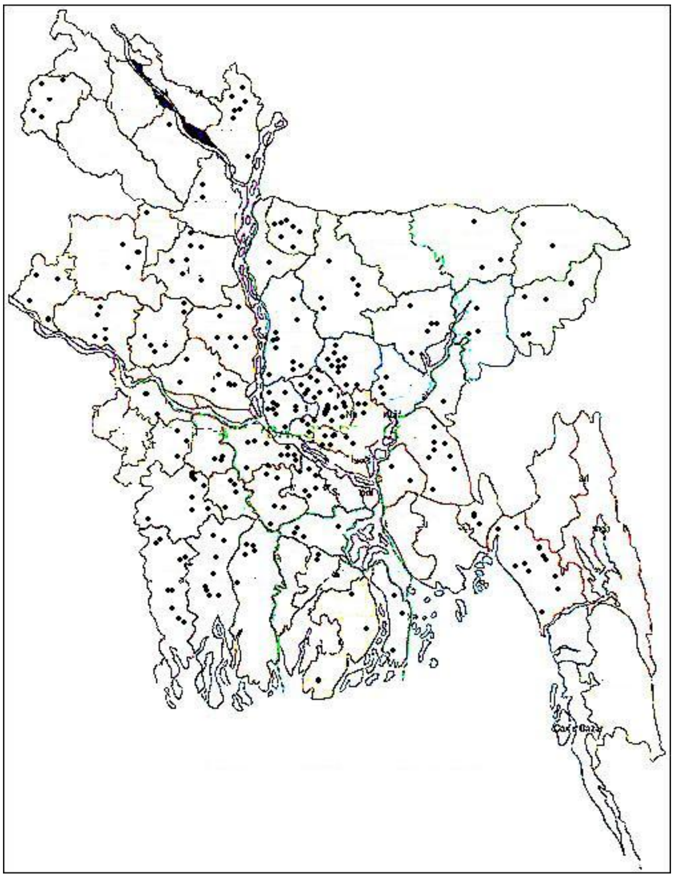

Fig. 1: *Map of Bangladesh showing locations of drinking water sampling sites*

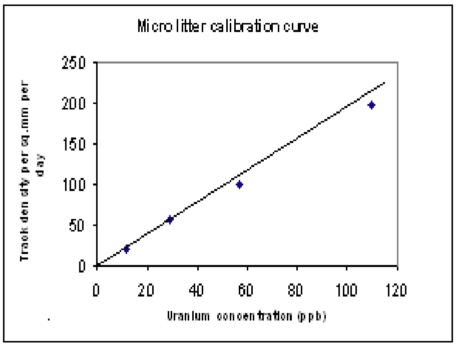

Fig. 2: *Calibration curve between track density and uranium concentration*

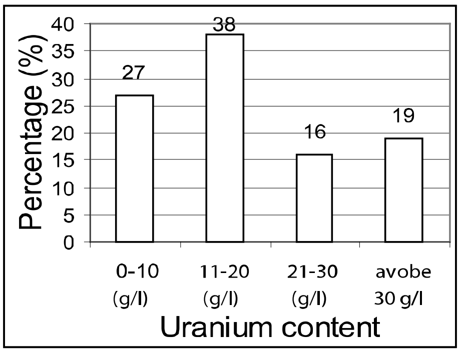

Fig. 3: *Uranium content*

Conclusion

In order to determine the uranium content of natural drinking water solid state nuclear track detector technique whsnsd was used. Calibration curve has been established from standard uranium solutions. Alpha track density is proportional to uranium concentration, so, uranium content of drinking water has been obtained straight from the calibration curve. The result was satisfactory which compare well with the data of British Geological survey report. We obtained the range of uranium content in our water samples to be 0.50-51 ppb and uranium concentration in 19% of drinking water sample above the safety level i.e. 30 μg/L. So father studies on more water samples from different places of Bangladesh are necessary.

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