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Uranium in Ground water of Eastern Uttar Pradesh, India: A preliminary study

Meher Prabodha Kumar[1], Sharma Prerna[1], Khare Akash[2] and Mishra Kaushala Prasad[1]
[1]Division of Life Sciences, Research Centre, Nehru Gram Bharati University, Allahabad- 211002, INDIA
[2]Department of Chemistry, Research Centre, Nehru Gram Bharati University, Allahabad-211002, INDIA

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Abstract

Natural uranium is found in various sources of water and its assessment in drinking water is important from viewpoint of public health. Recent reports of higher concentrations of uranium in ground water of north-west (Punjab) regions of India have prompted similar study in ground water of other regions of India. Present report is a preliminary study on evaluation of uranium in ground water in a few districts of eastern Uttar Pradesh. Water samples were randomly collected from hand pumps and wells at many random locations of Varanasi, Allahabad, Kaushambi and Fatehpur districts. Concentrations of uranium in the samples were measured using the LED fluorimetric technique. Results showed variations in concentrations obtained from place to place and values ranged from 11±0.76 to 63.33±2.28 µg/l of uranium in the ground water of the designated locations. The measured values were found close to permissible limits of World Health Organisation (WHO) and United States Environmental Protection Agency (USEPA). In presented preliminary data slightly higher concentration of uranium in samples from some of the wells requires attention if confirmed. Further detailed studies are in progress to collect and examine larger number of samples for drawing definite conclusions regarding uranium in ground water of the eastern region of Uttar Pradesh in India.

Keywords: Uranium, ground water, drinking water, LED fluorimeter, Uttar Pradesh, India.

Introduction

Uranium is one of the naturally occurring radioactive and trace heavy metal found in environment. It is mostly present in earth crust, soil, plants, rocks and granites[1,2]. Exposure to natural uranium can cause both radiological as well as chemical toxicity[3]. However, the chemical toxicity of natural uranium is much more pronounced than its radiological toxicity[4,5]. The uranium concentration mainly depends on the geological features of the area and varies from place to place[6]. Generally, humans get exposed to natural uranium from food, water and air. Ground water is one of the major source for drinking and irrigation purposes, intake of uranium from the drinking water is of greater concern than from other possible sources. The uranium found in ground water is mainly of geogenic in origin[7]. Exposure of higher than permissible limit of uranium to humans may cause pathological consequences to human body. The chemical effects of uranium include harm to kidney[5,8], bone tissue[9] etc. To prevent from the deleterious adverse health effects of uranium in drinking water, it is recommended to monitor the uranium concentration in different drinking water resources and take remedial action for mitigation. Many studies were carried out for measurement of uranium concentration in different water resources at different locations[7,10- 13]. However, no such study has been carried out in eastern Uttar Pradesh region in India. Among others, Varanasi, Bhadohi, Allahabad, Kaushambi and Fatehpur are the important districts of eastern Uttar Pradesh due to their population, tourist interests and socioeconomic viewpoint. Varanasi is a known district for its cultural heritage, religious relevance and an increasing tourist destination. It has a geographic area of 1535 Km^2, having about 3,682,194 population with a population density of 2,399 persons/Km^2[,14]. From Hindu mythological view point Allahabad is a holy city, religious center and an important tourist attraction. This city is formed at the confluence of Ganges and Yamuna rivers[15,16].

According to 2011 census it has population of 59, 59, 798 people. Bhadohi has grown into an industrial hub producing and exporting carpets to world. Likewise, Kaushambi and Fatehpur districts have a total population of 15, 96, 909 and 26, 32, 684 respectively. A large number of people in the eastern Uttar Pradesh depend on the ground water for drinking, irrigation and other house hold needs. It has also to be noted that the inhabitants of this region are using hand pumps, wells and bore well extensively for drinking water. Present study was aimed to measure uranium concentration in the ground water of Varanasi, Allahabad, Kaushambi and Fatehpur districts. This study reports the first preliminary data on uranium concentration in drinking water from well and hand pumps from the districts of eastern Uttar Pradesh region. It has been found that measured values varied from place to place but average values were close to permissible limits set by World Health Organization (WHO). However, samples from a few locations showed higher than standard values which need further studies for confirmation.

Material and Methods

Present investigation was carried out in the selected districts of eastern Uttar Pradesh region. Figure-1 gives the geographical location of present study design in eastern region of Uttar Pradesh. Water samples were randomly collected from well and/or hand pumps from different locations of the eastern Uttar Pradesh

Figure-1 Representation of the study area. Extended view of Uttar Pradesh with sampling locations of Eastern Uttar Pradesh A-Varanasi (Red), B- Allahabad (Yellow), C- Kaushambi (Green), D-Fatehpur (Black).

Water samples were collected in triplicate in polypropylene bottles that were pre-washed previously soaked in 15% (v/v) HNO_3 for 24 hr and after that it was rinsed with double distilled water. Before collecting water samples, bottles were again rinsed with the water of sampling location. Special care was taken to avoid contamination during collection and handling of samples. Collected samples were carried to laboratory then filtered through 0.45 micron nylon milipore filter paper and measurements were carried out immediately on the same day using the standard protocol of the instrument LED Fluorimeter, UA-01 (Quantalase, Indore) described elsewhere[10]. Briefly, LED fluorimeter works by measurement of fluorescence in uranium complexes present in the aqueous sample. Green fluorescence light is emitted when UV light falls on the uranium complex; this fluorescence is measured using a Photo Multiplier Tube (PMT). Since the measured fluorescence is proportional to the excitation intensity of the source and uranium concentration in the sample. Thus, measurement of fluorescence gives the value of uranium concentration present in the sample. Statistical analysis were performed using SPSS statistics software.

Results and Discussion

The study area was chosen to represent a large segment of land space which is also thickly populated (A to D). The area, importance and populations of chosen study districts are described in the material and method section above. As can be seen the western region of the State of Uttar Pradesh borders with the State of Punjab of India. It is to be noted that in water samples from wells of Punjab State at various locations abnormal values of orders of magnitude of uranium have recently been reported which is a cause of concern to investigators and public authorities[11]. The source of origin and public health impacts of high values of uranium concentration in drinking water of Punjab remains to be determined.

Table-1 contains the results from measurement of uranium concentrations in samples of drinking water collected from various widely separated locations. It can be seen from the figure that uranium concentration from the ground water samples varied from 11±0.76 µg/l to 63.33±2.28 µg/l in the region of eastern Uttar Pradesh. There was no trend in going from east to west within the eastern region.

Figure-2 gives the concentration of uranium at various locations within the district which ranged from 11.3±3.02 to 63.33±2.28 µg/l of uranium with an average of 28.90±4.34 µg/l in the ground water of Varanasi district. The average uranium concentration of 28.90 µg/l in Varanasi district is lower than minimum acceptable limit of 30 µg/l recommended by WHO and United States Environmental Protection Agency (USEPA) [17,18].

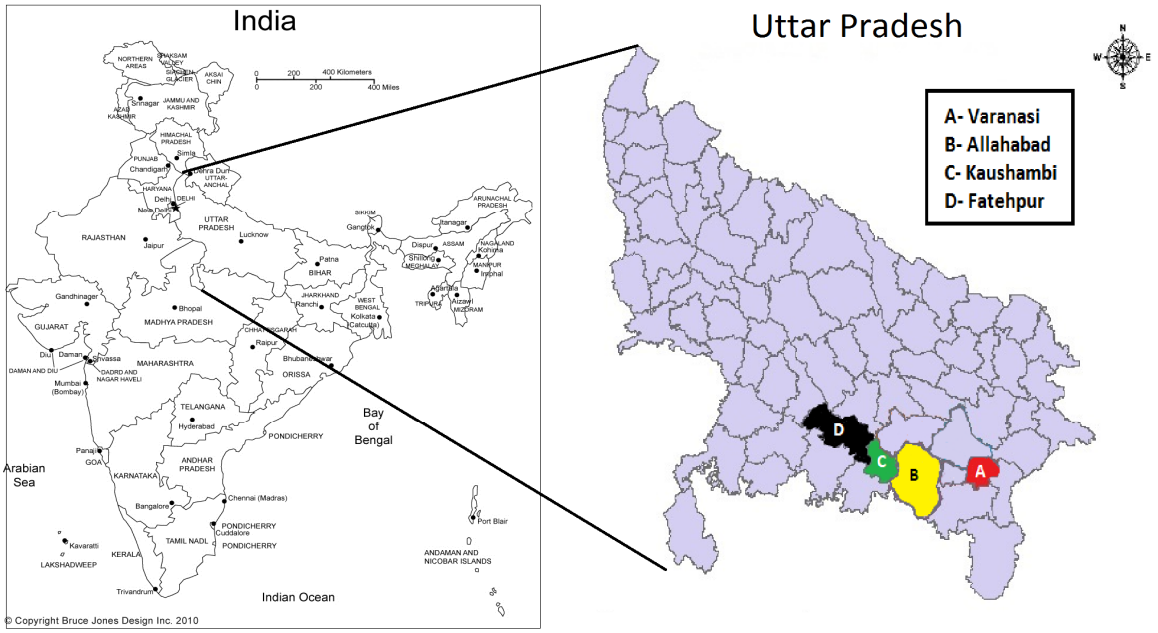

Figure-1
Samples were collected in post monsoon period of the year 2013

Table-1
Sampling locations of Varanasi, Kaushambi, Allahabad and Fatehpur districts of eastern Uttar Pradesh with sources of water and measured concentration of uranium µg/l± SD

District	Locations	Source of water	U conc. (µg/l± SD)
Varanasi	Mirza Maurad	Hand pump	52.3 ± 12.50
	Mohansaray (Entry point of Varanasi)	Well water	44.84 ± 14.76
	Nayi Basti, Pandaypur, Varanasi	Well water	29.37±1.09
	Sarnaath	Hand pump	11.3±3.02
	Hanuman Ganj	Hand pump	25.42 ± 2.08
	Cholapur	Hand pump	16.01±1.75
	Paragdeeh	Hand pump	26.61±4.49
	Sindhora	Hand pump	20.25±5.18
	Phulpur	Hand pump	21.52±4.03
	Babatpur	Hand pump	12.99±1.27
	Baragaon	Hand pump	63.33±2.28
	Gulab Nagar	Hand pump	27.26±1.19
	Lohradeeh	Hand pump	24.56±2.88
Kaushambi	Puramufti	Hand pump	11.21±0.75
	Chail	Hand pump	11.00±0.76
	Baigawaan	Hand pump	12.08±0.76
	Mahajanpur	Hand pump	12.24±0.54
Allahabad	Bamrauli	Hand pump	11.5±1.02
Fatehpur	Khaga	Hand pump	11.95±0.46
	Bindaki	Hand pump	35.84±1.22

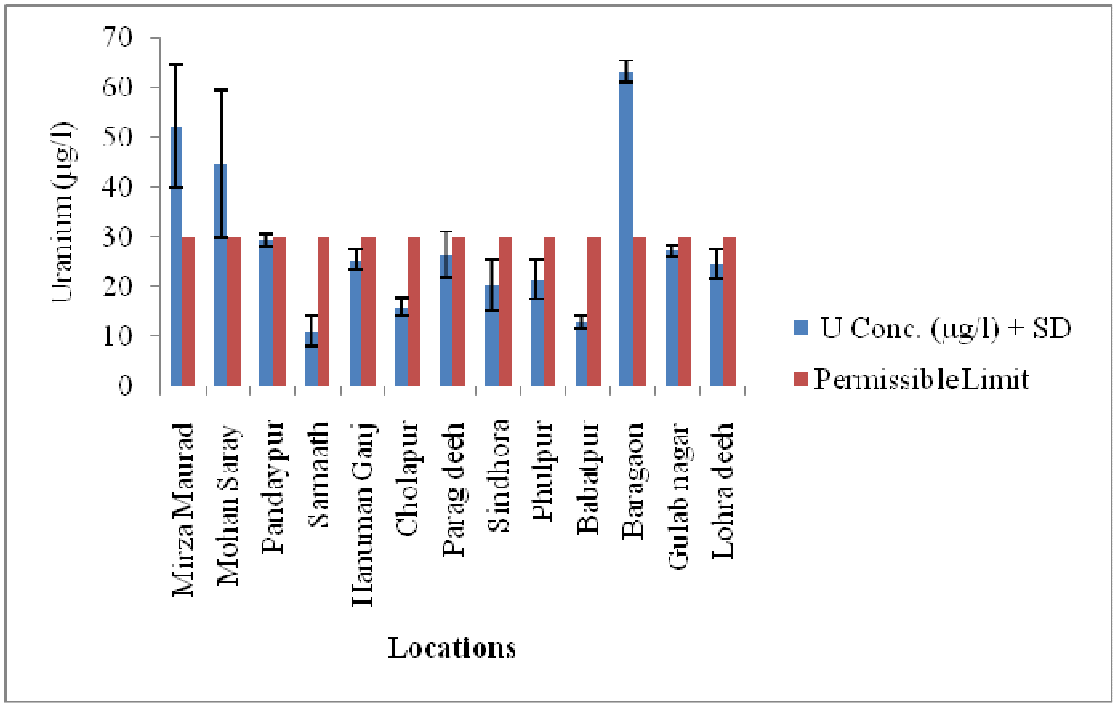

Figure-2
Uranium concentrations (µg/l±SD) at designated locations of Varanasi district and the WHO permissible limits

Present study showed that about 77% of samples from ground water examined by fluorimetry method yielded uranium concentration less than permissible limit of 30 µg/l. The uranium concentration in samples from Mirza Murad, Mohansaray and Baragaon were found to be 52.3±12.50 µg/l, 44.84±14.76 µg/l and 63.33±2.28 µg/l respectively, which are significantly higher than the standard limit set by WHO and USEPA. These measurements were carried out from three samples collected randomly from the wells. It is unclear as to how these abnormal values may have arisen and it needs to be repeated and confirmed by further studies.

In addition, uranium concentration in the well water sample from Nayibasti was found to be 29.37±1.09 µg/l which is also nearly close to the minimum acceptable limit. It is known that the uranium concentration mainly arises on the geology and type of associated rocks in the specific area. In addition, normally granitic rocks on weathering add the level of uranium to groundwater[12,19]. To our best of knowledge, however, no health concerns of any kind have been reported among people living in the vicinity of studied locations. It may be important to note that the water samples from Mirza Murad and Baragaon are from hand pump whereas the samples from Mohansaray and Nayibasti were from wells. The observed average value of uranium concentration (28.90 µg/l) in ground water of Varanasi is less than the uranium concentration of ground water reported in literature from other places in India[7,11-13].

An interesting result of our study is the measured far lower values of uranium concentration in water samples of certain locations within the eastern region. For example, at location of Bamrauli, western Allahabad measured value of 11.5±1.02 µg/l is markedly far lowers the minimum acceptable limit. It can further be seen from Table 1 that uranium concentration in water samples of Kaushambi district have a range of 11.00±0.76 to 12.24±0.54 µg/l with average value of 11.63 µg/l of uranium in ground water. These values are found well below the minimum acceptable limit recommended by WHO and USEPA. However, the uranium concentrations in Bindaki, Fatehpur district were found to be 35.84±1.22 µg/l which is slightly above the minimum acceptable limit. The reason for higher uranium concentration is unexplained but local ground geology may be the contributing factor for the rise in uranium concentration. A possibility exists that percolation of water from contaminated soil in agricultural fields may, in part be, contributing factor for the observed higher uranium concentration at this location.

It is fortunate that there is no reported health problem ascribable to drinking water especially level of uranium in the population of this region. It would be, however, warranted to monitor and map the concentration of uranium in drinking water in the state of Uttar Pradesh especially in eastern region for creating base line data for reference as well as environmental factors that may be a significant contributor in future.

Conclusion

Present study has measured uranium concentrations in samples of ground water of Varanasi, Allahabad, Kaushambi and Fatehpur districts of eastern Uttar Pradesh region. Measured values of uranium showed wide variation in samples from Varanasi to Fatehpur. Most of the values observed from the study were found below the permissible limits of WHO and USEPA. However, in this preliminary study, some places of Varanasi and Fatehpur districts, higher concentrations of uranium were observed that needs confirmation by further deeper studies. It is suggested that constant monitoring and detailed investigations are warranted to get baseline values of uranium concentration in the ground water of this region. A more systematic study covering wider area in drinking water is highly warranted.

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