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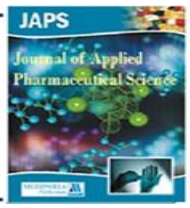

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Analytical study of water safety parameters in ground water samples of Uttarakhand in India

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ABSTRACT

The main problem of the locality is the drinking water. Certain health problems are associated with people living in hills that are because of the presence of excess of heavy metals and other impurities. The present study was conducted to analyze the various parameters of ground water in uttarakhand, India and to check its fitness for drinking. It will also clarify the health hazards imposed on the population of this state. The present study was conducted in five regions of Uttarakhand, India (Haridwar, Vikasnagar, Mussoorie, Dehradun & Dakpathar). Ten samples of ground water were collected from each of the five regions during the pre-mansoon (Jan-Feb) and post-mansoon (Sept-Oct)seasons.The pH was estimated by pH meter, acidity,alkalinity, sulphates,chorides,Total hardness(Ca & Mg) were determined by titration methods. The total suspended solid was calculated by the formula. The heavy metals like Mn, Al, Ba, Cd, Cr, Co, Cu, Fe and Pb were determined in the ground water samples by ICP mass spectroscopy. The concentrations of heavy metals, pH, alkalinity, sulphate, chloride, TDS & Total Hardness (TH) were compared with the standards by BIS for Drinking water (IS 10500:1991). The results shows that water pH of all the five regions showed no remarkable variation from the BIS recommended value of pH (6.5-8.5). The alkalinity was above the BIS desirable level of 200mg/l in all the samples, but was less than the maximum permissible limit. The Drinking water of all the regions contains higher amounts of TDS than the desirable limits. maximum TDS was detected in Haridwar & dehradun state. The ground water of mussoorie region shows total hardness to be above the BIS desirable level of 300mg/l. The chloride content was above the BIS desirable level of 250mg/l in dehradun only. The sulphate content was highest in haridwar (197.5mg/l) and dehradun (170mg/l) but it was below the desirable limit of 200mg/l. The Cd,Cr,&Pb content of all the five regions of Uttarakhand showed higher the BIS permissible limits of 0.01, 0.05 and 0.05 mg/l respectively. The content of Mn,Ba,Cu, Co&Fe are within the permissible limit of BIS standards for drinking water.

Keywords: Ground water, Hydro-chemical analysis, heavy metals, ICP mass spectroscopy.

INTRODUCTION

Only a small fraction (about 2.5%) of earth's water is fresh and suitable for human consumption. Approximately 13% of this fraction is ground water; an important source of drinking water for many people worldwide (Bachmat, 1994). The ground water has been used for drinking for a long time and its purity has made it a well known source of potable water all over the world. In Kumaun hills, ground water is available in the form of natural springs and they are used by more than 50% of total population of the region to meet their daily requirements (Singh *et al.*, 1985). In recent years, bore wells are also in use in many parts of the region as a source of potable water. Heavy metals are priority toxic pollutants that severely limit the beneficial use of water for domestic or industrial application **(**Petrus *et al.*, 2005). Nitrate has been identified as one of the major anionic pollutants of ground water. It is becoming a matter of serious concern in various

parts of our country owing to its number of health disorders namely, methemoglobinemia, gastric cancer, goitre, birth malformation and hypertension, etc **(**Petrus *et al.,* 2005). High concentration of nitrates (NO_3) in ground water has been related with excessive use of nitrogen fertilizers in agriculture and high amount of organic waste generated by human population **(**Petrus *et al*., 2005). The hydro-chemical analysis study is one of the most important aspects revealing quality of water that is suitable for drinking, agriculture and industrial purposes and it is possible to understand the change in quality due to rock-water interaction or any type of anthropogenic influence. (Kelley, 1940; Wilcox, 1962).

Adequate water resources for future generations are not only a regional issue but also a global concern. Our country's fresh water wealth is under threat due to variety of natural and human influences. Sixteen states in India- Andhra Pradesh, Bihar, Delhi, Gujarat, Haryana, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Orissa, Punjab, Rajasthan, Tamil Nadu and Uttar Pradesh have already been identified endemic to fluorosis (Mariappan *et al.,* 2000). Arsenic contamination of ground water in eight districts of West Bengal is well documented and more cases are also reported from eastern part of Bihar, Gorakhpur, Balia, Western part of Uttar Pradesh and Chattishgarh (Singh, 2006). The intensive farming belt of Western U.P., Haryana, Punjab, and parts of Rajasthan, Delhi and West Bengal have been reported to contain high NO_3 in groundwater (Malve et al, 1996). The guideline values for chemicals in water are based on available evidence, frequent presence of the contaminant in water and international concern about particular substances. In many cases the values are much lower than those described in documented toxic effects, but in other cases the evidence is unclear and guidelines may not be available on substances not normally present in water, or where the evidence of health effects is inadequate (WHO Guidelines, 1993 ; 1996). Water hardness is caused primarily by the presence of cations such as calcium and magnesium and anions such as carbonate, bicarbonate, chloride and sulfate in water. Water hardness has no known adverse effects; however, some evidence indicates its role in heart disease (Schroeder, 1960). Hard water is unsuitable for domestic use. Facies are recognizable parts of different characters belonging to any genetically related system. Hydrochemical facies are distinct zones that possess action and anion concentration categories. To define composition class, Back co-workers suggested subdivisions of the tri-linear diagram (Back *et al.,* 1965). The interpretation of distinct facies from 0 to 10% and 90 to 100% domains on the diamond shaped cation to anion graph is more helpful than using equal 25% increments. It clearly explains the variations or domination of cation and anion concentrations during premonsoon and post-monsoon. Ca-Mg-type of water predominated during pre-monsoon. The percentage of samples falling under Ca-Mg-type was 90 during pre-monsoon season. Similar type of water is predominated during post-monsoon also with 100 % water samples. For anion concentration, HCO_3^- type of water predominated during pre-monsoon with 87.5% samples and during post-monsoon with 91% samples. There is no significant change the hydro-chemical faces noticed during the study period (pre- and post-monsoon), which indicates that most of the major ions are natural in origin. The reason is groundwater passing through igneous rocks dissolves only small quantities of mineral matters because of the relative insolubility of the rock composition.The definition of "Heavy metals" is comparative one. It is defined as a chemical element with a specific gravity that is at least 5 times the specific gravity of water. The specific gravity of water is 1 at 4°C (39°F). Simply stated, specific gravity is a measure of density of a given amount of a solid substance when it is compared to an equal amount of water. Some well-known toxic metallic elements with a specific gravity that is 5 or more times that of water are arsenic, 5.7; cadmium, 8.65; iron, 7.9; lead, 11.34; and mercury, 13.546.

As trace elements, some heavy metals (e.g. copper, selenium, zinc) are essential to maintain the metabolism of the human body. However, at higher concentrations they can lead to poisoning. Heavy metal poisoning could result, for instance, from drinking-water contamination (e.g. lead pipes), high ambient air concentrations near emission sources. Heavy metals are dangerous because they tend to bioaccumulation. Bioaccumulation means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. Compounds accumulate in living things any time they are taken up and stored faster than they are broken down (metabolized) or excreted. Heavy metals can enter a water supply by industrial and consumer waste, or even from acidic rain breaking down soils and releasing heavy metals into streams, lakes, rivers, and groundwater. The most pollutants heavy metals are Lead, Cadmium, Copper, Chromium, Selenium and Mercury.

MATERIAL & METHODS

Sampling & preservation

The water samples were drawn during monsoon (July-Sept) and non-monsoon (Nov-Jan). The ground water samples were collected from Haridwar, Vikasnagar, Mussoorie, Dehradun and Dakpathar regions of Uttarakhand, India by proper method from 10 places of each area. Water Samples from different location were collected in the plastic cane of 2.5 litre, about ½ litre water samples was taken from one hand pump in one location and these were mixed to get one sample from one location. In this way sample collected were analyzed in 2-3 days so no special preservation required .However samples in the canes were kept in the refrigerator.

TESTING METHODS OF DIFFERENT PARAMETER

The pH of the ground water was estimated by pH meter. The alkalinity of water is generally due to present of carbonate and hydroxide ion. Alkalinity provides an idea of the nature of salts present in the water. The total alkalinity of ground water was calculated by titration method. The total solid (TS) present in 100ml of sample water was calculated by evaporating the water sample at 103^0 to 105^0 C to dryness in drying oven, cooling it in desiccators and then weighed. The TS in mg/1 = (A-B) x 100 /

sample volume in liter. Where A = weight of (dried residue + dish) & B = weight of dish. The total suspended solid (TSS) was calculated by the following formula: Total suspended solid (mg) / ltr = (A-B) x 1000 / sample vol. in litre. Where, A=weight of filter + dried residue, B=weight of filter paper. The total dissolved solids (TDS) term is used to describe the inorganic salts and small amount of organic matter present in solution. It was calculated by subtracting TSS from TS. Total hardness was calculated by adding calcium and magnesium hardness derived by EDTA titration method. The chloride was estimated by silver nitrate titration method and sulphates were estimated by titration method.

After collection of water samples, these were preserved to avoid further contamination. These samples were first filtered with whatmann's filter paper to remove un-dissolved material; after filtration different elements were determined in these samples by Inductive coupled plasma microscopy method. ICP mass spectroscopy has grown to be one of the most important techniques for elemental analysis because of its low detection limits for most elements. Its high degree of selectivity, in this application an ICP torch serves as an atomizer and ionizer. The sample introduction is accompanied by ultrasonic nebulizer. In this instrument positive metal ions produced in a conventional ICP torch, are sampled through a differently pumped interface linked to a quadruple mass spectrometer. The spectra produced in this way, which are remarkably simple compared with conventional ICP optical spectra, consist of a simple series of isotope peaks for each element. These spectra are used for qualitative and quantitative estimation of their amount in sample.

RESULTS & DISCUSSION

The physico-chemical characteristics of drinking water of the study area are presented in Table 1.

Table 1: The Physicochemical characteristics of water samples in Uttarakhand, India.

Parameter	BIS Standards (mg/l)	Haridwar	Vikasnagar	Mussoorie	Dehradun	Dakpathar
pH	6.5-9.2	7.25	7.0	7.4	7.2	7.1
ALKALINITY	Desirable : 200 mg/l , Permissible : 600 mg/l	275	328	336	288.25	322
TOTAL HARDNESS (TH)	Desirable :300 mg/l , Permissible : 600 mg/l	252	282	329	290.5	272
T H(As Ca^{++})		206.5	212	249	290.5	208
T H(As Mg^{++})		45.5	70	80	40.5	64
TDS	Desirable : 500 mg/l , Permissible : 2000 mg/l	682.5	567.5	551	610	548
SUSPENDED SOLID(SS)	-	16.5	22	18	22	20
CHLORIDE	Desirable : 250 mg/l , Permissible : 1000 mg/l	153.5	196.0	121.0	289.0	185.0
SULPHATE	Desirable : 200 mg/l, Permissible : 400 mg/l	197.5	153	139	170	132

The results show that water quality of Haridwar, Vikasnagar, Mussoorie, Dehradun, Dakpathar shows no remarkable variation from the BIS recommended value of pH . The alkalinity was above the BIS desirable level of 200mg/l in all the samples, but was less than the maximum permissible limit. The Drinking water of all the regions contains higher amounts of TDS than the desirable limits. The maximum TDS was detected in Haridwar (682.5 mg/L) and dehradun (610 mg/L) state. The ground water of mussoorie region shows total hardness to be above the BIS desirable level of 300mg/l.The chloride content was above the BIS desirable level of 250mg/l in dehradun only. The sulphate content was highest in haridwar (197.5mg/l) and dehradun (170mg/l) but it was below the desirable limit of 200mg/l.

Table 2 shows the heavy metals concentrations of ground water samples in all the five regions of Uttarakhand, India. These were analysed by ICP technique. The Cd,Cr, and Pb content of all the five regions of Uttarakhand showed higher the BIS permissible limits.The content of Mn, Ba,Cu,Co,Fe are within the permissible limit of BIS standards for drinking water.

Table 2. The Heavy metals concentrations in water samples of Uttarakhand, India.

Heavy Metals	BIS Desirable Level (mg/l)	BIS Permissible level (mg/L)	Haridwar	Vikasnagar	Mussoorie	Dehradun	Dakpathar
Mn	0.1	0.3	0.052	0.058	0.054	0.053	0.054
Al	-	0.2	0.056	0.058	0.056	0.056	0.056
Ba	-	-	0.075	0.078	0.079	0.079	0.078
Cd	0.003	0.01	0.131	0.132	0.130	0.133	0.130
Cr	0.05	0.05	0.094	0.096	0.094	0.096	0.098
Co	-	-	0.060	0.062	0.064	0.064	0.060
Cu	0.05	1.5	0.022	0.022	0.021	0.021	0.018
Fe	1.0	1.0	0.066	0.068	0.062	0.067	0.064
Pb	0.05	0.05	0.084	0.090	0.088	0.088	0.090

Heavy or toxic metals are trace metals that are stable elements (they cannot be metabolized by the body) and bio-accumulative. These include mercury, nickel, lead, arsenic, cadmium, aluminum, platinum and copper. Heavy metals have on function in the body and can be highly toxic. They are taken in to the body by drinking, inhalation, ingestion and skin absorption. A gradual build up of these toxins will occur, if heavy metals enter and accumulate in body tissue faster than the body's detoxification pathways can dispose them off. High concentration exposure is not necessary to produce a state of toxicity in the body tissues and over time it can reach toxic concentration levels. Lead in humans on long term exposure can lead to acute or chronic damage to the nervous system on humans. It causes plumbism - tiredness, lassitude, abdominal discomfort, irritability, anemia; bio-accumulation; impaired neurological and motor development, and damage to kidneys. Cadmium in humans on long-term exposure is highly toxic; causes 'itai-itai' disease-painful rheumatic condition; cardio vascular system affected; gastro intestinal upsets and hyper tension. High exposure can lead to obstructive lung disease and has been linked to lung cancer, and damage to human's respiratory systems. Arsenic could lead to weight loss, skin and nervous system toxicity. Copper is an essential substance to human life, but in high doses it can cause anemia, liver and kidney damage, and stomach and intestinal irritation. Effect of the Mercury is to cause damage to the brain and the central nervous system. Chromium is used in metal alloys and pigments for paints, cement, paper,

rubber, and other materials. Low-level exposure can irritate the skin and cause ulceration. It is carcinogenic and causes respiratory problems. Long-term exposure can cause kidney and liver damage, and damage too circulatory and nerve tissue. Chromium often accumulates in aquatic life, adding to the danger of eating fish that may have been exposed to high levels of chromium.

The Drinking water of all the regions contains higher amounts of TDS than the desirable limits. no sample crossed the maximum permissible limit for TDS, alkalinity, hardness, calcium, magnesium, chloride, sulfate, nitrate, and fluoride. The concentration of chloride, sulfate, nitrate, and fluoride are well within the desirable limit (Jain *et al*., 2009). The heavy metals analysis of the ground water sample in our study showed that the cadmium (Cd), chromium (Cr), and lead (Pb) content of all the five regions of Uttarakhand is higher than the BIS permissible limits of 0.01, 0.05 and 0.05 mg/l respectively. Therefore, the people living in these areas are prone to develop various ill effects of these heavy metals on long term exposure.

These results are of concern as lead has been recognized for centuries as a cumulative general metabolic poison (Adepoju-Bello et al, 2005). It is neurotoxin and is responsible for the most common type of human metal toxicosis (Berman, 1980). Also, studies have linked lead exposures even at low levels with an increase in blood pressure (Zietz, 2007) as well as with reduced intelligence quotient in children (Zietz, 2007) and with attention disorders (Needleman, 1993).

CONCLUSIONS

Heavy metal toxins contribute to a variety of adverse health effects. There exist over 20 different heavy metal toxins that can impact human health and each toxin will produce different behavioral physiological and cognitive changes in an exposed individual. The present study gives an overview to show the how much quantity of element is present in mainly from Haridwar, Vikas-Nagar, Mussoorie, Dehradun and Dakpathar regions of Uttarakhand, India. As per BIS norms for Drinking water (IS 10500:1991) for heavy metals viz. Copper 0.05ppm, Mn 0.10ppm, Cd 0.01ppm, Pb 0.05ppm, Cr 0.05ppm Al 0.03, & Mg 30ppm are recommended. The present study gives an overlook on various elements in various parts of the two regions. It has been observed that due to industrial pollution, the metals like Cd, Pb & Cr are found on the higher side in Uttarakhand. On the basis of present study we observed that due to the excess quantity of Cd, Pb, and Cr in uttarkhand, India, the human beings of that region are suffering with various diseases like gastrointestinal and thyroid diseases.

REFERENCES

Adepoju-Bello, A.A. and O.M. Alabi. Heavy metals: A review. The Nig. J. Pharm.2005; 37: 41-45.

Bachmat Y. Ground water contamination and control, Marcel Dekker, Inc, New york. (1994).

Back W, Hanshaw BB. (1965). Advances in hydroscience. In: Chemical Geohydrology. (page no. 49)Academic Press, New York.

Berman, E. Toxic Metals and Their Analysis. Philadelphia, PA: Hayden and Sons.(1980).

Jain CK, Bandhopadhyay A, Bhadra A. Assessment of ground water quality for drinking purpose, District Nainital, Uttarakhand, India. Environmental Monitoring and Assessment. June 2009.

Kelley WP. Permissible composition and concentration of irrigation waters. Proc ASCE. 1940; 66: 607.

Malve SP and Dhage SS. Nitrate: An environmental pollutant. Everyman's Science. 1996; XXXI (5): 158-163.

Marcovecchio, J.E, S.E. Botte and R.H. Freije. Heavy Metals, Major Metals, Trace Elements. In: Handbook of Water Analysis. L.M. Nollet, (Ed.). 2nd Edn. London: CRC Press. (2007) 275-311.

Mariappan P, Yegnaraman V, Vasudevan T. Occurrence and removal possibilities of fluoride in ground waters of India. Poll Res. 2000, 19(2):165-177.

Needleman, H.L. The current status of childhood low-level lead toxicity. Neurotoxicology.1993;14: 161-166.

Petrus R and Warchol JK. Heavy metal removal by clinoptilolite: An equilibrium study in multicomponent system.Water Research.2005; 39:819-830.

Schroeder HA. Relations between hardness of water and death rates from certain chronic and degenerative diseases in the United States. J Chron disease. 1960, 12:586-591.

Singh AK and Rawat DS. Depletion of oak forest a threatening to springs: An exploratory survey. The National Geographical J Env Quality. 1985; 31(11): 44-48.

Wilcox LV. The quality water for irrigation use. US Dept Agric Bull. 1962: 40

WHO Guidelines for drinking water quality, 2nd edition. Volume 1: recommendations. Geneva: WHO, 1993; Volume 2: Health criteria and other supporting information. Geneva: WHO,1996.

Zietz, B.P, J. Lap and R. Suchenwirth. Assessment and management of tap water lead contamination in Lower Saxon, Germany. Int. J. Environ. Health Res. 2007; 17(6): 407-418.