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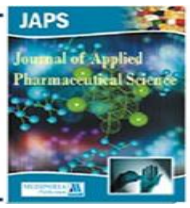

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Biological Effect of Heavy Metal in Drinking Water samples of Western Uttar Pradesh region in India

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ABSTRACT

Drinking water is a basic requirement for life and a determinant of standard of living. Poor water quality problem has also been observed in more number of habitations. Drinking water, in adequate quantity with safe quality is a basic requirement for life and a determinant of standard of living. Certain health problems are associated with people due to presence of excess of heavy metals and other impurities. The present study was conducted to analyze the various parameters of ground water in Uttar Pradesh India and to check its fitness for drinking. It will also clarify the health hazards imposed on the population of this state. The water samples are collected from Aligarh, Bulandshar, Merrut, MuzaffarNagar & Saharanpur zone of the Western U.P. region. 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 10500:2004). 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 aligarh(780-820mg/litre). The ground water of Saharanpur 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 Aligarh only. The sulphate content was highest in aligarh (223mg/l). The Cd, Cr, &Pb content of all the five regions of Uttar Pradesh showed higher the BIS permissible limits of 0.003, 0.05 and 0.01mg/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

Today heavy metals are abundant in our drinking water, air and soil; due to our increased use of these compounds. They are present in virtually every area of modern consumerism from construction materials to cosmetics medicines to processed foods fuel sources to agents of destruction appliances to personal care products (Bachmat, 1994).

It is very difficult for anyone to avoid exposure to any of the many harmful heavy metals that are so prevalent in our environment. While it does not appear that we are going to neutralize the threat of heavy metal toxicity in our communities nor decrease our utilization of the many commercial goods that they help produce we can take steps to understand this threat and put into action policies of prevention and treatment that may help to lessen the negative impact that these agents have on human health (Back *et al.,* 1965).Water, unless it is distilled, is not simply 'H_2O' (the chemical formula for pure water) but also contains many natural elements. Water gathers constituents from the rocks and ground through which it permeates. Some benefit to health, others are harmful. Water constituents are defined as a hazard when they have the potential to impair health (Sun *et al.*, 2006). 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 degree to which a system organ tissue or cell is affected by a heavy metal toxin depends on the toxin itself and the individual's degree of exposure to the toxin. These metals affects an individual in such a way that its respective accumulation within the body leads to a decline in the mental cognitive and physical health of the individual. The body has need for approximately 70 friendly trace elements which are called as heavy metals, but there are another 12 poisonous heavy metals, such as Lead, Copper, Aluminum, Arsenic, Cadmium, Nickel, Mercury etc., that act as poisonous interference to the enzyme systems and metabolism of the body (Schafer *et al*.,1985). No matter how many good health supplements or procedures one takes, heavy metal overload will be a detriment to the natural healing functions of the body. Some metals are naturally found in the body and are essential to human health. For example iron which prevents anemia, and Zinc is a cofactor in over 100 enzyme reactions. Magnesium and Copper are other familiar metals that, in minute amounts, are necessary for proper metabolism to occur. They normally occur at low concentrations and are known as trace metals (Petrus *et al*.,2005). Heavy or toxic metals are trace metals that are at least five times denser than water. As such, they are stable elements (they cannot be metabolized by the body) and bio-accumulative (passed up the food chain to humans). These include: mercury, nickel, lead, arsenic, cadmium, aluminum, platinum, and copper (metallic form versus ionic form). Heavy metals have no function in the body and can be highly toxic. Heavy metals are taken into the body via drinking of water, inhalation, ingestion, and skin absorption (Schafer *et al*., 1985). If heavy metals enter and accumulate in body tissue faster than the body's detoxification pathways can dispose of them, a gradual buildup of these toxins will occur. High-concentration exposure is not necessary to produce a state of toxicity in the body tissues and over time can reach toxic concentration levels. (Singh,2006).) Heavy metal overload in the walls of coronary arteries seems to decrease levels of nitric oxide, a compound known as "Endothelial Relaxing Factor". Heavy metal overload in the adrenal glands reduce the production of hormones, which cause early aging, stress, decreased sex drive and aggravation of menopausal symptoms. Heavy metal overload can lead to unresponsiveness of diabetics to their medications (Needleman *et al*., 1993). Heavy metal overload can lead to neurological diseases such as depression and loss of thinking power. It can also aggravate conditions such as osteoporosis and hypothyroidism. For obvious reasons, removing metals from the body safely has been a concern of physicians for many years. In general, heavy metals are systemic toxins with specific neurotoxic, nephrotoxic, fetotoxic and teratogenic effects. Heavy metals can directly influence behavior by impairing mental and neurological function, influencing neurotransmitter production and utilization, and altering numerous metabolic body processes. Systems in which toxic metal elements can induce impairment and dysfunction include the blood and cardiovascular, eliminative pathways (colon, liver, kidneys, skin), endocrine (hormonal), energy production pathways, enzymatic, gastrointestinal, immune, nervous (central and peripheral), reproductive, and urinary.

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 Aligarh, Bulandshar, Meerut, Muzaffernagar, Saharanpur regions of Uttar Pradesh, 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) / litre = (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. The results show that water quality of Aligarh, Bulandshar, Merrut, Muzaffernagar, Sharanpur 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 ground water of Aligarh region contain higher amount of TDS than the desirable limits. All regions contain less total hardness to the BIS desirable level of 300mg/l. Aligarh contain less total hardness (132mg/l) in comparison to all regions ground water samples. The chloride content was above the BIS desirable level of 250mg/l in Aligarh (375mg/l) & Bulandshar (305mg/l). Merrut, Muzaffernagar & Sharanpur ground water samples contains less chloride in comparison to the BIS desirable level of 250mg/l. The sulphate content was highest in Aligarh (223mg/l). Sharanpur contains less sulphate (154mg/l) in all regions ground water samples, but it was below the desirable limit of 200 mg /l.

Table 2, shows the heavy metals concentrations of ground water samples in all the five regions of western Uttar Pradesh, India. These were analyzed by ICP technique. The Cd, Cr, and Pb content of all the five regions of western Uttar Pradesh 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. 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.

Table. 1: The Physicochemical characteristic of drinking water samples in western Uttar Pradesh, India.

Parameters	BIS Standard (mg/l)	Aligarh	Bulandshar	Merrut	Muzzaffernagar	Sharanpur
pH	Desirable 6.5-8.5	7.7	7.6	7.4	7.3	7.5
Alkalinity	Desirable 200 Permissible 600	328	312.5	283	258	270
Total Hardness	Desirable 300 Permissible 600	132	173	154	151	168
TH (as Ca++)	Desirable 75 Permissible 200	115	151	113	123	138
TH (as Mg++)	Desirable 30 Permissible 100	17	22	41	28	30
TDS	Desirable 500 Permissible 2000	800	453	488	472.5	470
TSS	-	20	12	13	14.5	17
TS	-	820	465	501	487	487
Chloride	Desirable 250 Permissible 1000	375	305	180	155	147
Sulphate	Desirable 200 Permissible 400	223	197	192	172	154

Table. 2: The Heavy metals concentrations in drinking water samples of Western Uttar Pradesh Regions, India.

Metals	BIS Desirable Level (mg/l)	BIS Permisirable Level (mg/l)	Aligarh	Bulandshar	Merrut	Muzzaffer nagar	Sharanpur
Mn	0.1	0.3	0.061	0.066	0.064	0.061	0.062
Al	-	0.2	0.096	0.096	0.098	0.096	0.086
Ba	-	-	0.146	0.148	0.146	0.143	0.112
Cd	0.003	0.01	0.126	0.124	0.123	0.129	0.135
Cr	0.05	0.05	0.101	0.102	0.100	0.101	0.110
Co	-	-	0.065	0.072	0.068	0.075	0.071
Cu	0.05	1.5	0.024	0.026	0.028	0.025	0.028
Fe	1.0	1.0	0.271	0.278	0.276	0.267	0.265
Pb	0.05	0.05	0.080	0.078	0.077	0.084	0.090

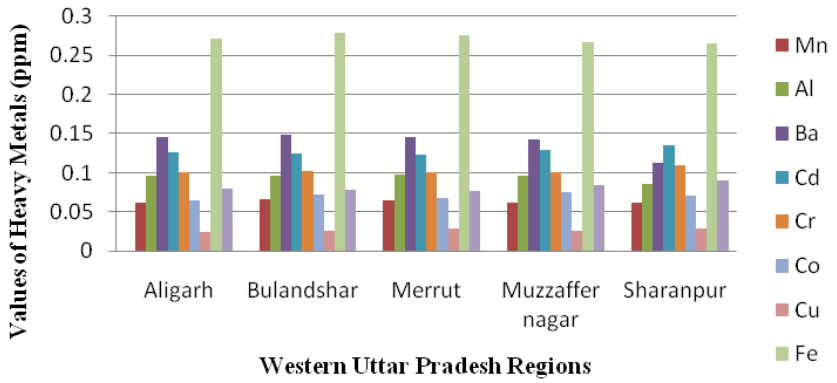

Fig. 1 The Heavy Metal Concentration in Drinking Water Samples of Western Uttar Pradesh Region, India.

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 Uttar Pradesh 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 Aligarh, Bulandshar, Merrut, Muzaffer nagar & Sharanpur zone of the Western Uttar Pradesh India. As per BIS norms for Drinking water (IS10500:2004) for heavy metals viz. Copper 0.05ppm, Mn 0.1ppm,Cd 0.003ppm, Pb 0.01ppm, Cr 0.05ppm Al 0.03,Ba0.7ppm & Mg 30ppm are recommended. The present study gives an overlook on various elements in various parts of the regions. It has been observed that due to industrial pollution, the metals like Cd, Pb, Al & Cr are found on the higher side in Western Uttar Pradesh .On the basis of present study we observed that due to the excess quantity of Cd, Pb, Al and Cr in western Uttar Pradesh , India, the human beings of that region are suffering with various diseases like like aggressive behavior, loss of appetite, eye and speech problem, lack of memory and aging in early age due to the excess of heavy metals like Co, Cu, Ca in ground water.

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