Original research article

Determination of trace elements (lead, zinc, chromium and copper) in water samples of Jhalawar (Rajasthan)

Sumit Kumar [1], Dr. Ummed Singh Solanki [2], Dr. Shantnu Singh Shekhawat[3], Dr. Sujeet Kumar Jangir[4]

[1] Msc (Final year) Department of Biochemistry Jhalawar Medical College, Jhalawar (Rajasthan)

[2]Associate Professor Department of Biochemistry Jhalawar Medical College, Jhalawar (Rajasthan)

[3]MD (Final year resident) Department of Biochemistry Jhalawar Medical College, Jhalawar (Rajasthan)

[4]MD (Final year resident) Department of Biochemistry Jhalawar Medical College, Jhalawar (Rajasthan).

Corresponding Author: Dr. Sujeet Kumar Jangir

Abstract

Background: Drinkable safe water is absolutely important and is the basic need for all human beings on earth. Concentrations of trace elements in water vary because of physiological, environmental and other factors (industrial & human activity). Trace elements constitute a relatively small amount of total body tissues, these are essential for many vital processes. Deficiency & excessive level of trace element can have hazardous effect in body process.

Objectives: To determine level of Cu, Zn, Cr & Pb in drinking water samples from different sources in Jhalawar district of Rajasthan and its adjacent areas and compare the results with WHO criteria.

Methods: Thirty different water samples for determination of trace element Cu, Zn, Cr & Pb in drinking water were obtained from different sources and estimation of these elements were done by Atomic Absorption Spectrophotometry (AAS). Statistical comparison was done using ANOVA test & results were expressed as Mean ± SD, p value <0.05 was considered to be statistically significant.

Results and Conclusion: Copper, zinc and chromium concentrations in all the water sources were within permissible limit as per W.H.O. however, lower than normal concentration of zinc was found in all water sources as per ICMR guidelines. Lead concentration in all water sources was above permissible limit as per W.H.O. guidelines.

Keywords: Drinking water, Trace elements, Zinc (Zn), Copper (Cu), Chromium (Cr), Lead (Pb), Atomic Absorption Spectrophotometry (AAS)

Introduction

Water is the elixir for all living things. Drinkable safe water is absolutely important and is the basic need for all human beings on earth[1].

Majority of the groundwater comes from rain that soaks into the soil and passes down to the aquifer. Different rocks, for example, basalt, sandstone and limestone all have different minerals and thus groundwater in contact with these different geological materials will have different compositions. Some of the constituents found in groundwater, however, are not abundant in common rocks and minerals, for instance, sulfate and chloride. The possible source for these chemicals is rainwater[2].

Groundwater pollution is defined as an undesirable change in natural groundwater quality resulting due to addition of solid, liquid or a gaseous waste and physical, chemical or biological agents or addition of sewage or industrial effluents. Hydrological connectivity between groundwater and the land surface provides the opportunity for the contamination of groundwater and a subsequent reduction in water quality. Water pollution can be classified into four categories viz., physical, chemical, biological and physiological pollution of water.
The word "trace elements" is used for elements existing in natural and perturbed environments in small amounts, with excess bioavailability having a toxic effect on the living organism[3].
Generally, trace elements are present in small concentration in water system. Their presence in surface water and groundwater may be due to the dissolution of minerals containing trace elements in the soil zone and aquifer. Moreover, human activities such as mining, smelting of ores and improper disposal of industrial waste can also lead to the deposition of toxic elements in water body[2]. Concentrations of trace elements in water alter because of physiological, environmental & other factors [4].
Trace elements have several role in living organism. Some are essential components of enzymes where they attract substrate molecules and facilitate their conversion to specific end products[5].
The toxic effects of these elements include health issues such as abdominal pain, high blood pressure, kidney damage and eventually failure, irritability, skeletal harm and degradation, cancer, nerve damage, headaches, and neurodegeneration and its consequences on the intellectual system[6].
Such studies has not been done till now in Jhalawar & adjacent areas. So we decided to undertake this study with aim to determination of trace element Cu, Zn, Cr & Pb in water samples of Jhalawar & adjacent region.

Material and Methods

The study was conducted at department of Biochemistry Jhalawar Medical College Jhalawar from August 2020 to October 2020.

Source of Samples and Study Area

Thirty different water samples were collected from Jhalawar& its adjacent regions. These water samples were classified into five groups. These groups comprised of 13 tap water samples (group – I), 8 pond water samples (group – II), 2 river water samples (group – III), 3 well water samples (group – IV), 4 camper & package water sample (group – V).

Sample collection

Samples of drinking water were collected in 1.0 L capacity polythene bottles from the source and from various tanks and taps using trace metal clean techniques. Prior to filing, the sample bottles were rinsed two or three times with water to be collected. Estimation of copper, zinc, chromium and lead was done by atomic absorption spectrophotometer (AAS) in the Department of Biochemistry, Jhalawar Medical College, Jhalawar (Rajasthan) on the collected sample.

Ethical consideration and permission

Ethical permission was taken from the institutional ethical committee.

Statistical analysis

Microsoft Excel worksheets were used and data were analyzed using SPSS version 20.00. ANOVA test were used in data analysis. The data in the study was expressed as mean ± SD, and P value of < 0.05 was considered as statistically significant.

Results

The present study was performed at Jhalawar Medical College Jhalawar. In this study 13 samples of Tap water, 8 samples of Pond water, 2 sample of River water, 3 sample of Well water and 4 sample of Camper and Package water were studied which is shown in Table 1. Trace element concentration in different sources has been presented in Table 2.

Table 1: Category of sample for study

S. No.	Group of sample	Number of sample
1	Group I (Tap water)	13
2	Group II (Pond water)	8
3	Group III (River water)	2
4	Group IV (Well Water)	3
5	Group V (Camper & Package water	4
	Total	30

Table 2: Trace element concentration in different water sources

Trace element	Water sources	Mean ± SD	P - Value
Copper	Tap Water	0.0780 ± 0.04348	0.008*
	Pond Water	0.0639 ± 0.04788	
	River Water	0.0484 ± 0.00403	
	Well Water	0.0350± 0.00425	
	Camper & Package Water	0.1603± 0.06402	
Zinc	Tap Water	0.0245 ± 0.00784	0.055
	Pond Water	0.0322 ± 0.00198	
	River Water	0.0318 ± 0.00106	
	Well Water	0.0219± 0.01534	
	Camper & Package Water	0.0335± 0.00434	
Chromium	Tap Water	0.0209 ± 0.00912	0.185
	Pond Water	0.0167± 0.01181	
	River Water	0.0258 ± 0.01160	
	Well Water	0.0200 ± 0.01113	
	Camper & Package Water	0.0075 ± 0.00887	
Lead	Tap Water	0.0142 ± 0.01611	0.663
	Pond Water	0.0243 ± 0.01810	
	River Water	0.0201± 0.00042	
	Well Water	0.0248 ± 0.01682	
	Camper & Package Water	0.0174± 0.01316	

Discussion

Copper in Drinking Water

In these observations P values < 0.05 which indicates statistically significant difference between copper concentrations of these groups. The highest concentration of copper was found in camper & package water and was significantly different from the concentration found in the water samples from other water sources. Well water was found to have the least concentration and was closely followed by samples from river water. However in all these samples Copper level was in permissible limit of W.H.O. criteria. According to W.H.O. criteria permissible limit of Copper is 2.00 ppm. Copper is required for adequate growth, cardiovascular integrity, lungs elasticity, iron metabolism, energy production, melanin synthesis [7]. Excess of Cu concentration in human causes “Wilson disease [8].Copper deficiency due to celiac disease suggested that ataxia associated with celiac disease was likely due to a copper deficiency myeloneuropathy[9].

Zinc in Drinking Water

P values > 0.05 which indicates no statistically significant difference between zinc concentrations of these groups. We have also seen an interesting fact that the zinc concentration of all water sources is within permissible limit according to W.H.O. criteria (5.0 ppm) but according to ICMR criteria we have seen that concentration of zinc is very low from the desirable limit of zinc (minimum desirable limit 0.1 ppm). Therefore it was concluded that water sources in Jhalawar district of Rajasthan and its adjacent areas, have lower than normal zinc concentration. Low level of zinc in soil may be associated with deficiency of zinc in water sources. Low level of zinc in water sources may cause nutritional deficiency of zinc in human body which may cause zinc deficiency in general population. Zn metalloenzymes and transcription factors can act as a master hormone, particularly in relation to cell division and growth[10].Toxicity of zinc such as abdominal pain, high blood pressure, kidney damage, irritability, skeletal harm and degradation, cancer and neuron degeneration. Zn deficiency includes depressed growth, increase incidence of infection, possibly related to alterations in immune function and reproductive function[11].

Chromium in Drinking Water

P values > 0.05 which indicates no statistically significant difference between chromium concentrations of these groups. The chromium concentration in river water represents the leaching from topsoil & rocks and industrial activity. Lowest concentration was found in camper & package water. However in all these samples was found chromium concentration is within the permissible limit according to WHO According to W.H.O. permissible limit of chromium is 0.05 ppm. Chromium is essential nutrient that play role in glucose, fat and protein metabolism by potentiating that action of insulin[12]. Chromium toxicity is associated with increased incidence of lung cancer, dermatitis and skin ulcers[13].

Lead in Drinking Water

No statistically significant difference between lead concentrations of these groups (P values > 0.05). However in our study we have also observed that the level of lead concentration detected in water sources was above the range of permissible limit of W.H.O. criteria (0.01 ppm). It may be due to different sources of lead. The main source of lead in groundwater is from the rocks containing lead sulfide and oxides. The household plumbing fixture made up of lead may contribute lead in the drinking water. The other contributors are the leaded gasoline and lead in paint. Long-time exposure to lead has been reported to cause anemia, along with an increase in blood pressure. Severe damage to the brain and kidneys, both in adults and children, were found to be linked to exposure to Pb resulting in death. In pregnant women, high exposure to lead may cause miscarriage. Chronic lead exposure was found to reduce fertility in males[14].

Conclusion

After observing all the results of our study it was concluded that zinc concentration in all the drinking water sources was below the desirable limit whereas lead concentration was above the permissible limit, which could, in theory cause deficiency and toxicity of these trace elements respectively. Therefore, in the light of our observations it becomes important to monitor the concentrations of zinc and lead in drinking water regularly, in order to effectively combat the deficiency/toxicity of these trace elements caused by their improper levels in drinking water.

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