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Chemical Assessment of Copper in the Groundwater of Saharsa District, Bihar

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Abstract : Present paper describes the concentration of copper in the groundwater of Saharsa District, Bihar which is situated at latitude $25^0 35^{'}$-$26^0 28^{'}$ N and longitude $86^0 18^{'}$- $86^0 51^{'}$ E. Groundwater samples were collected for two seasons namely pre-monsoon (May-June) and post-monsoon (October-November) in the year 2022. All the ten community development blocks of Saharsa district have been selected as sampling sites and from each block two samples either from well or tube well, on the basis of availability of functioning well or tube-well, have been collected for analysis. Thus, all together twenty samples were collected. Descriptions of these samples are given in the Table-1. These samples were analyzed for the concentration of copper and the analytical results have been tabulated in the Table-1. The value of copper (Cu) was found to be ranged between 0.211 ppm to 0.312 ppm and 0.206 ppm to 0.308 ppm for pre- and post-monsoon seasons respectively. The average value was between 0.210 ppm to 0.310 ppm. The acceptable value of copper is 0.05 ppm as prescribed by USPH but the maximum allowable limit is 1.5 ppm prescribed by both USPH and WHO. Though all the values are higher than 0.05 ppm but these are within the maximum allowable limit of 1.5 ppm.

(Keywords : Industrial Uses and Pollution Sources, Biochemical Effects, Toxicology and Toxicity, Environmental Levels and Ecological Effects).

Introduction

Copper is one of the earliest known metals. Bronze, an alloy of Cu and Sn was invented as early as 500 B.C. The presence of copper in animal and plant tissues was recognized more than one and half centuries ago. It is present in all land and main organisms. In 1847, copper was shown to be present in combined form with the blood proteins of snails. Later, it was demonstrated that copper in addition to iron, is necessary for blood formation. Soon after this discovery, several reports appeared regarding disorders of grazing sheep and cattle due to deficiencies of copper and their recovery after providing copper supplements. Several enzymes such as tyrosinase, cytochrome oxides uricase, ascorbic acid oxidase, monamine oxidase and δ-amino-levulinic acid dehydrase contain copper. Many of the manifestations of copper deficiency in animals seem to be related to the decreased tissue concentrations of some of these enzymes. Environmental pollution by various chemical elements including several toxic heavy metals is typically noticed as extremely increasing problem throughout the world[1-2]. Especially, toxic chemical elements such as Cu, Hg, Cd, Pb and Cr are the main pollutants which are highly released into the environment and also greatly affecting the environment and human health[3-7]. It is worth noting that these pollutants are released in different ways and reach into groundwater - table, eventually poisoning the drinking water. Particularly, copper contamination in drinking water has been identified and recognized to be among the global environmental pollution concern during the 1990s due to the introduction of various health based regulations[8-12].

Industrial Uses and Pollution Sources

Copper is a chalcophile element which is mostly found in sulfide deposits along with lead, cadmium and zinc. It is lustrous, malleable, ductile, soft, tough, corrosion resistant and a

good conductor of heat and electricity. Hence it is widely used in industry. It is used in the manufacture of alloys, paints, ceramics and pesticides.

Contamination of air with copper usually occurs near industrial smelters used for producing zinc and other non-ferrous metals. Copper is carried away to long distance (about 8 km) from these industrial areas by air and water. Iron and steel industries, fertilizer industries and burning of wood are other sources of copper in the atmosphere. Water pollution due to copper also results from the discharge of mine tailings, disposal of fly ash and disposal of municipal and industrial wastes.

Biochemical Effects, Toxicology and Toxicity

Laboratory studies have shown several physiological functions involving copper. Defects in pigmentation, bone formation, reproduction, myelination of the spinal cord, cardiac function and connective tissue formation, in addition to defects in growth and hematopoiesis were found to be the manifestations of copper deficiency.

Many copper protein compounds were isolated from living tissues, most of which were found to be enzymes with oxidative function. These copper enzymes help in catalyzing the reduction of molecular oxygen to water. Tyrosinase, laccase, ascorbic acid oxidase, cytochrome oxidase, uricase, monoamine oxidase, δ-aminolevulinic acid dehydrase and dopamine-β-hydroxylase were all identified as copper enzymes. Whenever the tissue concentrations of these enzymes are low, manifestations of copper deficiency are observed, thus revealing the basic biochemical defects.

As stated earlier, copper is essential for the normal biological activities of amino-oxidase and tyrosinase enzymes. The former is involved in the formation of the elastin and collagin both of which are important proteins. Elastin is a constituent of large blood vessels and collagin is the constituent of tendons and bones. Tyrosinase is required for the catalytic conversion of tyrasine to melanin, the vital pigment located beneath the skin which protects the skin from dangerous radiations.

A daily dietary intake of 2 to 3 mg of Cu is recommended for human adults. Copper is mainly absorbed from the duodenum in man and chicks. Copper absorption and retention depends on factors such as the chemical form in which the metal is ingested, by the dietary levels of other minerals and organic substances, and the acidity of the intestinal contents in the absorptive area.

Ingestion of 15-75 mg of Cu causes gastro-intestinal disorders. Excessive intake of copper may cause hemolysis, hepatotoxic and nephrotoxic effects. Inhalation of air-borne copper causes irritation of the respiratory tract and metal fume fever. Workers involved in use of fungicides containing copper sulphate develop a respiratory disorder called “vineyard sprayer’s lung” which is characterised by the development of interstitial pulmonary lesions and nodular fibro-hyaline scars. This may lead to even lung cancer.

Copper poisoning can occur as an industrial hazard in workers engaged in copper mining and processing. Continuous ingestion of copper ion from food or water at intakes sufficient to induce chronic copper poisoning in man is unlikely. “Wilson’s disease” (or hepatolenticular degeneration), which is characterised by excessive concentrations of Cu in the tissues, arises from metabolic defects involving absorbed copper and not from the ingestion of excessive amounts of Cu. Other conditions which manifest increased Cu content in liver include thalassemia (Mediterranian anemia), hemachromatosis, cirrhosis, atrophy of liver, tuberculosis and carcinoma.

Table-1
Copper concentration in the groundwater of Saharsa District (Bihar) for pre- and post-monsoon seasons and their average in the year 2022

Sl. No.	Sampling site	Sample No.	Cu in ppm for pre-monsoon season	Cu in ppm for post-monsoon season	Average value of Cu in ppm for pre and post-monsoon	Maximum and Minimum values of Cu in ppm
1	Nauhatta	TW1	0.224	0.218	0.221	-
2	Nauhatta	TW2	0.245	0.238	0.242	-
3	Sattar Kataiya	W3	0.261	0.252	0.256	-
4	Sattar Kataiya	TW4	0.268	0.258	0.253	-
5	Mahishi	W5	0.252	0.250	0.251	-
6	Mahishi	W6	0.254	0.246	0.250	_
7	Kahra	TW7	0.211	0.208	0.210	0.210 (min)
8	Kahra	TW8	0.216	0.210	0.213	-
9	Sour Bazar	TW9	0.273	0.265	0.269	-
10	Sour Bazar	TW10	0.269	0.256	0.264	-
11	Patarghat	TW11	0.246	0.240	0.243	-
12	Patarghat	TW12	0.252	0.244	0.248	-
13	Sonvarsa	TW13	0.256	0.248	0.252	-
14	Sonvarsa	TW14	0.258	0.246	0.252	-
15	Simri Bakhtiyarpur	TW15	0.312	0.308	0.310	0.310 (max)
16	Simri Bakhtiyarpur	TW16	0.261	0.280	0.270	-
17	Salkhua	TW17	0.268	0.262	0.265	-
18	Salkhua	TW18	0.252	0.256	0.254	
19	Banma Itahari	TW19	0.213	0.206	0.210	-
20	Banma Itahari	TW20	0.211	0.208	0.210	_

Environmental Levels and Ecological Effects

Crustaceans and shellfish, particularly oysters and the organ meats (liver, kidney and brain) are the richest sources of Cu. These are followed by nuts, dried legumes, dried vine and cocoa. These contain Cu in the range 20 to 400 ppm. The poorest sources of Cu are milk, butter, cheese. white sugar and honey which consist of about 0.5 ppm Cu. The non-leafy vegetables, fresh fruits, refined cereals, including white flour and bread contain about 2 ppm Cu.

The concentration of Cu in air is in the range 0.2 to 0.83 μg/m^3 in urban areas like Bombay. Soluble copper levels in water lie in the range 0.5 to 2 μg/L. Water containing more than 1mg/L gives undesirable taste and odour. The level of Cu in sea water lies in the range 1 to 3 μg/L.

Copper is essential to plants for synthesizing chlorophyll and for the activity of some enzymes. However, at higher levels (about 0.1 mg/L) Cu can inhibit growth. Blue green algae are particularly by susceptible to Cu because it inhibits the nitrogen-fixing properties of these algae. In animals, the toxic effects of Cu result from the complexation of essential carboxylic acids. Researchers over the world are working continuously on water quality parameters to aware the people to use safe water for different purposes of domestic uses[13-42]. Present paper describes the chemical assessment of copper

(Cu) contamination in the groundwater of Saharsa District, Bihar which is situated at latitude $25^0 35' - 26^0 28'$ N and longitude $86^0 18' - 86^0 51'$ E.

Sampling Season

Samples were collected for two seasons namely pre-monsoon (May-June) and post-monsoon (October-November) seasons in the year 2022.

Sampling sites

All the ten community development blocks of Saharsa district have been selected as sampling sites and from each block two samples either from well or tube well, on the basis of availability of functioning well or tube-well have been collected for analysis. Thus all together twenty samples were collected. Descriptions of these samples are given in Table-1

Results and Discussion

The analytical results of copper in the groundwater for pre- and post- monsoon seasons have been tabulated in the Table-1. The value of copper (Cu) was found to be ranged between 0.211 ppm to 0.312 ppm and 0.206 ppm to 0.308 ppm for pre- and post-monsoon seasons respectively. The average value was between 0.210 ppm to 0.310 ppm.The acceptable value of copper is 0.05 ppm as prescribed by USPH but the maximum allowable limit is 1.5 ppm prescribed by both USPH and WHO.Though all the values are higher than 0.05 ppm but these are within the maximum allowable limit of 1.5 ppm

References

1. N. Adimalla and H. Qian *Arch Environ Contam Toxicol* **801,**107(2021).
2. N. Adimalla *et. al*., *Ecotox Environ Safe* **203** : 111055 (2020).
3. N. Adimalla and H. Qian *Ecotoxicol Environ Saf* **176**, 153 (2019).
4. W. Dong, Y. Zhang and X. Quan *Chemosphere* 242 :125113 (2010).
5. N. Subba Rao *et. al., Environ Geochem Health* **422,** 579 (2020).
6. A. M. Taiwo *et. al., Biol Trace Elem Res* **1972,** 694 (2020).
7. Q. Zhang *et. al., Expo Health* **124**, 87 (2020).
8. D. J. Fitzgerald, *Regul Toxicol Pharmacol* **21** : 001 (1995).
9. *IPCS, Environmental health criteria for copper,* **Vol 200** WHO (1999).
10. USEPA *National primary drinking water regulations, environmental protection agency*. **40** CFR Part 141. Fed Reg **50**, 49767 (1985).
11. USEPA *Maximum contaminant level goals and national primary drinking water regulations for lead and copper; final rule*,40 CFR Parts 141 and 142. Fed Reg **56**,110 (1991).
12. WHO *Guidelines for drinking-water quality, 2nd ed. Addendumto vol. 2, health criteria and other supporting information.* WHO/EOS/98-1(1998).
13. Arjun Ram *et. al.,Applied water science* **11,** 46 (2021)
14. India Water Tool. In: World Resources Institute, Columbia Water Center, *India Water Tool* (2017).
15. A. K. Biswas & K. Hartley, From evidence to policy in India's groundwater crisis. *In The Diplomat* (2017).
16. R. Suhag, Overview of groundwater in India. New Delhi, India: *PRS Legislative Research* (2016).
17. B. Subhadra, *Nature*, **521**, 289 (2015).
18. World Bank India groundwater: A valuable but diminishing resource (2012).
19. Siebert *et. al*., *Hydrology and Earth System Sciences,* **14***,* 1863 *(2010)*.
20. Zaveri *et. al*., *Environmental Research Letters*, **11** (2016).
21. Siebert *et. al., Hydrology and Earth System Sciences*, **19**, 1521 (2015).
22. T. Shah, Groundwater governance and irrigated agriculture. In Global Water Partnership Technical Committee (TEC) Background Paper No. 19. Stockholm, Sweden: Global Water Partnership, (2014).
23. K. Rabindra and V. K. Garg, *Environ Monit Assess*, **132**, 33 (2007).

24. Li Peiyue, *Exposure and Health*, **8** (3), 1 (2016).
25. D. Han *et. al*., *Journal of Hydrology* (2011).
26. Proceedings *Water Quality Technology Conference and Exposition* (2006).
27. Vandenberghe, Veronique; van Griensven, Ann; Vanrolleghem, Peter. *Wastewater Quality Monitoring and Treatment* (2006).
28. Water Resources Department, International Institute for Geo-Information Science and Earth Observation (ITC), Enschede, Neth. *Environmental Monitoring and Assessment* **129** (1-3),115 (2007).
29. P. L.Bishop, *Water Science and Technology* **55,** (1) (2007).
30. David Brickman, Peter C. Smith, *Marine Pollution Bulletin*, **547.** 863(2007).
31. Anceno, Alfredo J. *et. al.International Journal of Environmental Health Research*, **174,** 297 (2007).
32. J. M. Malmaeus *J. Water Science and Technology,* 55(5, Forest Industry Wastewaters VIII), **81** (2007).
33. Madhusudan Pd. Yadav *et. al., J. Chemtracks*, **11(1),** 31 (2009).
34. Kusum Singh *et. al.*, *J. Chemtracks*; **12(1)** 49 (2010).
35. Jai Prakash Singh *et. al.,International Journal of Earth Sciences and Engineering*, **03(02),** 157 (2010).
36. "*Subdivision & Blocks | Saharsa District | India*". Retrieved 30 March (2022).
37. "Table C-16 Population by Mother Tongue: Bihar". censusindia.gov.in. Registrar General and Census Commissioner of India(2011).
38. U. S. *Groundwater Survey book*s. A1 (1979).
39. *Indian Standard Methods of Sampling and test (Physical and Chemical) of water* (1964).
40. *American Public Health Association book* (1976).
41. Hem, J.D., Study and interpretation of Chemical Characteristics of natural water, *U.S.G.S. water supply paper* (1959).
42. *Indian standard specification for Drinking water* IS-10500, (1983).

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