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Heavy Metal Contamination of Water and their Toxic Effect on Human Health Area of Kishangarh Block of Alwar District (Rajasthan)

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Abstract: ***Heavy metals are prevalent in various states of industrial wastewater and natural water, including groundwater. The drinking water, contaminated by these toxic elements, poses severe and chronic health risks, leading to genetic disorders, neurotoxicological issues, and carcinogenic effects. In India, the consistent discharge of toxic heavy metals into aquatic environments is a consequence of rapid industrial development. Groundwater is particularly vulnerable to contamination, posing a significant challenge. Water, a dynamic and essential resource for human and ecosystem health, exhibits varying levels of heavy metal contamination, including Pb, Zn, As, Cr, Ni, in different water sources like groundwater, surface water, and tap water. This review study focuses on assessing heavy metal concentrations, specifically Zn, Fe, and As, across different seasons (Pre-monsoon, Monsoon, and Post-monsoon) Kishangarh Block of Alwar District (Rajasthan). The recorded values are compared against drinking water standards set by WHO and BIS (IS 10500:2012), aiming to accurately evaluate potential health risks. The study emphasizes the need for effective management strategies and essential water treatment to ensure the safety of water sources.***

Keywords: heavy metals, water contamination, health risks, India, water treatment

1. Introduction

The global concern over the presence of heavy metals in water sources is particularly pertinent in India due to the rapid industrial growth, resulting in the regular discharge of toxic elements into aquatic environments, especially impacting groundwater. Recognizing water as a dynamic and vital resource for both human survival and ecosystem well-being, it becomes crucial to comprehend and address the challenges posed by heavy metal contamination. This study seeks to conduct a thorough evaluation of heavy metal contamination, specifically focusing on Zinc (Zn), Arsenic (As), and Iron (Fe), across various water sources, including groundwater, surface water, and tap water. Through the collection and analysis of data across different seasons, the study aims to compare the findings with established drinking water standards. The overarching objective is to precisely assess potential health risks and ascertain the need for effective management strategies and essential water treatment to ensure the well-being of both human populations and ecosystems.

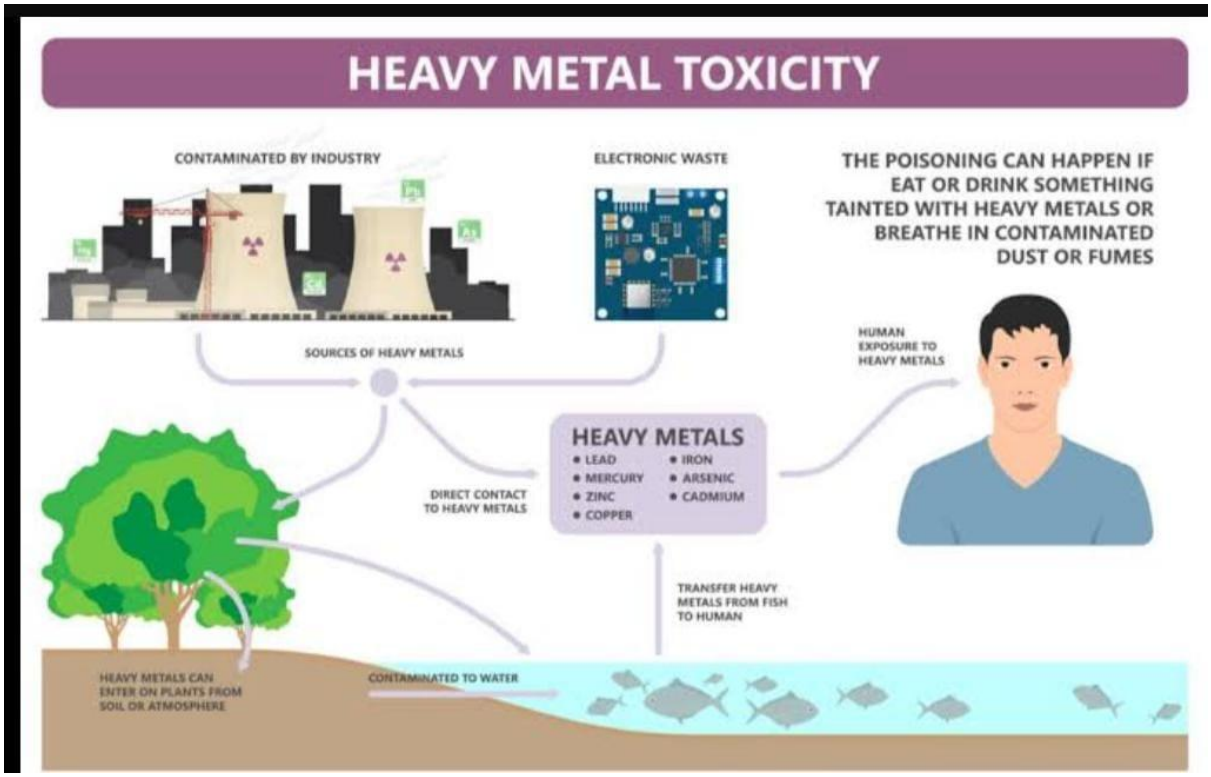
Therefore, the primary objective of this research is to examine the contamination of heavy metals in water and its adverse effects on the health of residents in the Kishnagarh Block of Alwar District, Rajasthan.

This investigation aims to shed light on the specific challenges faced by communities in this region concerning heavy metal exposure and its potential health implications. By focusing on the city of Kishanghar Block, the study aims to provide valuable insights into the localized impact of heavy metal contamination, contributing to a broader understanding of the complex interplay between industrial development, water quality, and public health in the region.

2. Material and Method

Groundwater samples were gathered from diverse locations in Kishangarh Block, Alwar District, Rajasthan, encompassing villages such as Ghasoli, Khanpur Mewan, Khohra Peepli, Kolgaon, and Moosa Kheda. The samples were drawn from various sources, including bore wells and hand pumps, at different depths. Clean screw-capped polyethylene bottles were employed to collect water samples from different points in Kishangarh Block during the three seasons: pre-monsoon, monsoon, and post-monsoon. Sampling locations included Kolgaon Masjid, the Government hospital bank, Madrasa, areas near the government tank, PNB tank, pond, Ghasoli Government hospital, Govt. School, panchayat office, private school, govt. Dispensary, bus stand, Moosa Kheda Government hospital, Govt. Tank, Atal Seva Kendra, Masjid, hand pump, Ayush health and wealth center, areas near the gurudwara, Khohra Peepli - Govt. School, Dispensary, pond, hand pump, and Khanpur Mewan near the bus stand, pond, Govt. School, near PNB Bank. A total of 30 samples were collected across pre-monsoon, monsoon, and post-monsoon periods, and the values of Arsenic, Zinc, and Iron were determined using an Absorption Spectrophotometer. The findings contribute insights into the water quality in five distinct minority areas of Rajasthan.

Heavy Metals in Water & Effect on Human Health:



Arsenic (As)

Arsenic toxicity is linked to a syndrome sometimes confused with Guillain-Barre disease, an autoimmune disorder affecting the Peripheral Nervous System. Arsenic, a concerning heavy metal environmentally and health-wise, exists as toxic metallic forms and salts. It ranks 20th among Earth's abundant metals, posing risks through geological systems. Arsenic adversely impacts cell functions, causing respiratory and enzymatic malfunctions. Exposure occurs through inhalation, ingestion, or contaminated food/water, leading to cardiovascular effects, liver damage, and hormonal disruptions, emphasizing the need for comprehensive mitigation measures.

Zinc (Zn)

Zinc, a vital mineral for biological and human health, holds particular importance during prenatal and perinatal development. Approximately two billion people globally suffer from zinc deficiency, leading to various illnesses. In children, it results in developmental delays, delayed sexual development, infection susceptibility, and diarrhea. Zinc deficiency, often due to poor diet, can also be linked to conditions like malabsorption, Acrodermatitis enteropathica, liver and renal damage, sickle cell disease, and diabetes. At-risk groups include the elderly, children in developing nations, and those with renal deficiency. Mild zinc deficiency exhibits symptoms like stunted growth, diarrhea, weakness, delayed sexual development, alopecia, eye and skin issues, decreased appetite, altered perception, compromised immune function, impaired carbohydrate utilization, and reproductive issues.

Iron (Fe)

The presence of elevated iron levels in water can have detrimental effects on human health. While iron is an essential mineral, excessive amounts can lead to toxicity. Prolonged exposure to high iron concentrations in drinking water has been associated with various health issues. Gastrointestinal problems, such as nausea and abdominal pain, are common manifestations of iron toxicity. Regular monitoring of iron levels in water sources is crucial to prevent adverse health effects. Implementing effective water treatment measures and raising public awareness about the potential risks associated with elevated iron concentrations are essential for safeguarding human health and ensuring access to safe drinking water.

3. Result and Discussion

Comparison with Standards

The recorded values for *Zn*, *Fe*, and *As* were compared against the drinking water standards outlined by WHO and BIS. Deviations from these standards were identified.

In this specific investigation, the levels of Iron(Fe) in the gathered water samples varied from 0.02 to 0.38 mg/L. Moreover, the recorded concentrations for Arsenic (As) and Zinc (Zn) were below respectively 0.01 mg/L and 0.02 mg/L. The presence of toxic heavy metals in the environment raises significant concerns, given their potential harm to human health and the surrounding ecosystem. Even though the measured levels of arsenic and zinc in this study were below 0.01 mg/L, it is imperative to consistently monitor and effectively manage the contamination of heavy metals. This proactive approach is essential due to the potential adverse impacts these substances can have on both human life and the environment.

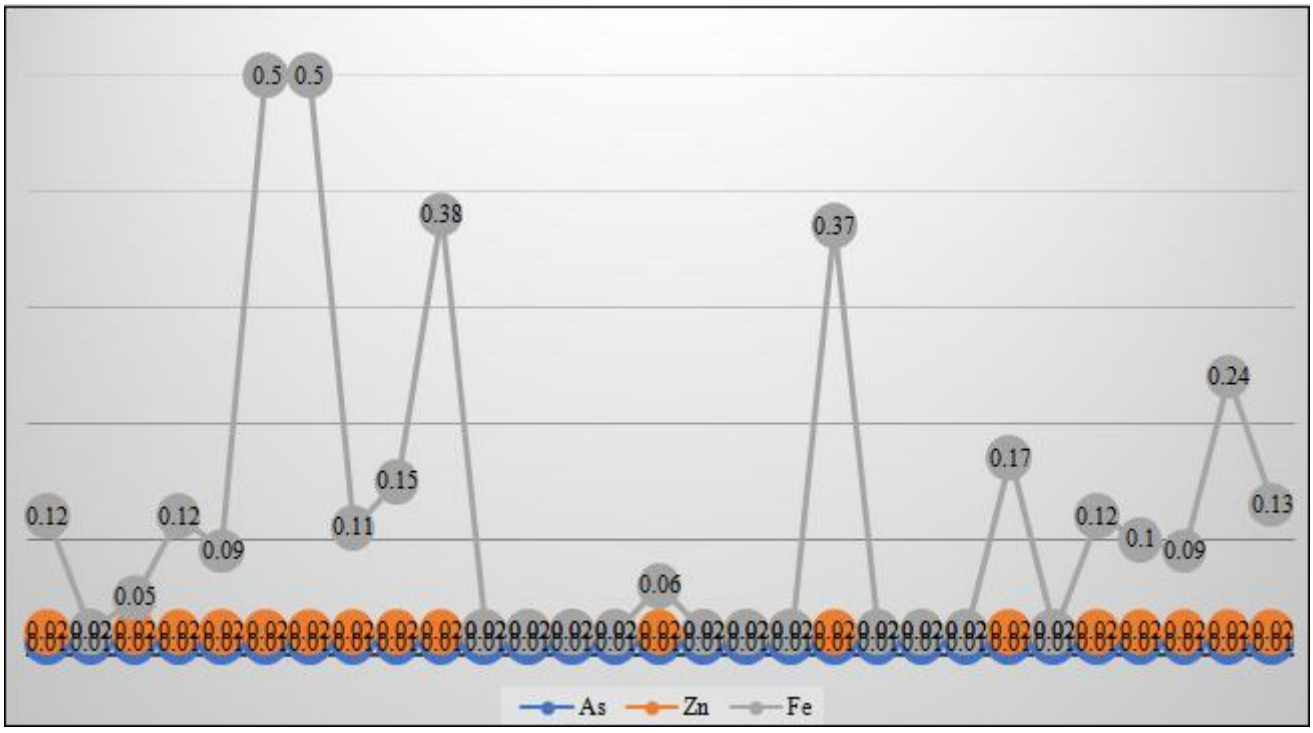
Table 1: Sampling code with Period

Sample Code	Sampling Period
S1	Pre Mansoon
S2	Pre Mansoon
S3	Pre Mansoon

S4	Pre Mansoon
S5	Pre Mansoon
S6	Pre Mansoon
S7	Pre Mansoon
S8	Pre Mansoon
S9	Pre Mansoon
S10	Pre Mansoon
S11	Mansoon
S12	Mansoon
S13	Mansoon
S14	Mansoon
S15	Mansoon
S16	Mansoon
S17	Mansoon
S18	Mansoon
S19	Mansoon
S20	Mansoon
S21	Post Mansoon
S22	Post Mansoon
S23	Post Mansoon
S24	Post Mansoon
S25	Post Mansoon
S26	Post Mansoon
S27	Post Mansoon
S28	Post Mansoon
S29	Post Mansoon
S30	Post Mansoon

Table 2: Physico chemical parameters of ground water of sampling sites of Kishanghar Block and its nearby Villages

Sample Code	Arsenic (As)	Zinc (Zn)	Iron (Fe)
S1	<0.01	<0.02	0.12
S2	<0.01	<0.02	0.12
S3	<0.01	<0.02	0.02
S4	<0.01	<0.02	0.05
S5	<0.01	<0.02	0.12
S6	<0.01	<0.02	0.09
S7	<0.01	<0.02	0.5
S8	<0.01	<0.02	0.5
S9	<0.01	<0.02	0.11
S10	<0.01	<0.02	0.15
S11	<0.01	<0.02	0.38
S12	<0.01	<0.02	<0.02
S13	<0.01	<0.02	<0.02
S14	<0.01	<0.02	<0.02
S15	<0.01	<0.02	<0.02
S16	<0.01	<0.02	0.06
S17	<0.01	<0.02	<0.02
S18	<0.01	<0.02	<0.02
S19	<0.01	<0.02	<0.02
S20	<0.01	<0.02	0.37
S21	<0.01	<0.02	<0.02
S22	<0.01	<0.02	<0.02
S23	<0.01	<0.02	<0.02
S24	<0.01	<0.02	0.17
S25	<0.01	<0.02	<0.02
S26	<0.01	<0.02	0.12
S27	<0.01	<0.02	0.1
S28	<0.01	<0.02	0.09
S29	<0.01	<0.02	0.24
S30	<0.01	<0.02	0.13



4. Conclusion

This extensive research illuminates the concerning levels of heavy metal contamination in diverse water sources across India. The identified potential health risks, spanning genetic disorders, neurotoxicological disorders, and carcinogenicity, underscore the pressing need to address this issue urgently. Through a thorough comparison of recorded values with established standards, the study establishes a basis for implementing effective management strategies and water

treatment measures. The recommendations underscore the critical role of regulatory measures, water treatment, and public awareness in ensuring the safety of water sources and safeguarding the health of communities and ecosystems. Persistent efforts are essential to tackle the dynamic challenges posed by heavy metal contamination and secure sustainable water resources for future generations. As India progresses towards development, particularly driven by its industrial and mining sectors, various trace elements, some potentially toxic, find their way into surrounding groundwater through multiple pathways. Rapidly growing industrial regions, mine tailings, improper disposal of metal wastes, leaded gasoline, and paints contribute to groundwater pollution by major heavy metals. A crucial imperative is the enforcement of regulations on the disposal of polluted industrial water sources to curb anthropogenic pollution of heavy metals in groundwater. It is recommended to enhance public awareness about the toxicity of drinking contaminated groundwater to promote responsible water consumption habits.

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