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Assessment of Various Metal and Physio Chemical Properties on the Water Quality of West Bengal, India

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ABSTRACT:
Groundwater arsenic (As) contamination is a significant public safety concern. It causes several different types of cancer and respiratory and cardiac problems; thus, prolonged exposure to it considerably increases the risk of dying. The AAS (Atomic Absorption Spectroscopy) instrumental techniques mainly used in this study allow for measurements of arsenic and various metals (including some heavy metal) concentrations in drinking water samples collected from various locations across West Bengal, India. The selected cities were “Howrah, South 24 Parganas, North 24 Parganas, and Kolkata”. Total Hardness (CaCO3), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved oxygen (DO), Total Suspended Solids (TSS), and pH and various metals like “Cadmium (Cd), Cyanide (CN), Lead (Pb), Mercury (Hg), Molybdenum (Mo), Nickel (Ni), Chromium (Cr) and Arsenic (As)”, value were measured. The arsenic levels in the water samples were over the permissible limit of 0.01 mg/L(according to WHO), ranging from 0.22 to 1.72 mg/L. Research suggests that water contamination is very high, and around two million people are at risk for chronic arsenic poisoning from drinking this water since it has not been treated.

1. Introduction

The United States of America, along with Bangladesh, India, China, Nepal, Cambodia, Vietnam, Myanmar, Laos, and others, are among the countries gravely impacted by the high levels of arsenic in their groundwater (1). Chronic and prolonged exposure increases the risk of death from cardiovascular diseases. It may cause cancer to develop in the lungs, skin, liver, and bladder (2).Because there is evidence that poisoning can also lead to the death of neonates, a decrease in IQ, and difficulties with movement in youngsters (1). Groundwater arsenic levels are influenced not only by the presence of arsenic-containing host minerals but also by factors such as the solubility of these host minerals, prevailing redox conditions, and the pH of the environment. Research findings have shown that deposits rich in arsenic-bearing minerals are associated with Quaternary alluvial sediments dating back to the Holocene epoch. This research was conducted in the United States. (3). Arsenic is known to create difficulties with the kidneys, the digestive system, the neurological system, and the heart because it is a systemic poison. Arsenic has been associated with several cancers, including those of the bladder, kidney, skin, and liver, and long-term exposure to the substance has been shown to increase the risk of these diseases (4). The speciation of Arsenic is tied to the fact that inorganic Arsenic is a more dangerous form of the element than organic Arsenic. The inorganic forms of Arsenic, specifically As (III) and As (V), comprise the vast majority of Arsenic found in groundwater. When transformed to asphyxiation-inducing As (III), both inorganic conditions are hazardous to human health. The primary mechanisms responsible for the adverse effects are inhibiting several mitochondrial enzymes by As (III) and decoupling oxidative phosphorylation. The attraction of arsenic trioxide or As (III), for the sulfhydryl groups of enzymes and the chemical similarity between Arsenic and phosphorus, which causes PO_4^{-3} to be converted into AsO_4^{-3}, are the two factors that are responsible for these negative consequences (5,6).

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The goal of this study is to figure out how much Arsenic(As), Cadmium (Cd), Cyanide (CN), Lead (Pb), Mercury (Hg), Molybdenum (Mo), Nickel (Ni), and Chromium (Cr), pH value, Total hardness, Total Suspended Solids (TSS), Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD) and Dissolved Oxygen (DO) in drinking water in the South 24 Parganas, North 24 Parganas, Kolkata, and Howrah have been exposed to over time.

2. Methodology

The results of this study highlight the toxicity of the water samples collected from four regions of West Bengal from South 24 Parganas, North 24 Parganas, Kolkata and Howrah. The number of samples tested for arsenic concentration in each district are South 24 Parganas District (12 samples were tested), North 24 Parganas District: (15 samples were tested), Howrah District (16 samples were tested), Kolkata District: (15 samples were tested). The tests were performed in laboratory AAS instrumental techniques were mainly used for “Cadmium (Cd), Cyanide (CN), Lead (Pb), Mercury (Hg), Molybdenum (Mo), Nickel (Ni), and Chromium (Cr), Arsenic (As), detection”.

Dissolved oxygen (DO): Below method was used during the experiment for the DO.

First of all, a water sample was collected; then, after adding 300 mL water into a BOD bottle and 2 mL $MnSO_4$ (manganese sulphate monohydrate), added 2 mL alkali iodide azide, closed the bottle, allowed brown ppt to settle down, added 2 mL of conc. H_2SO_4 closed and mixed to dissolve the residue. A 50 mL water sample was taken, and titration was done with 0.025 N Sodium thiosulphate; at first, a few drops of sodium thiosulphate were added to the water sample for pale yellow colour, after that, an indicator (2 mL of starch), after adding 2 mL of starch indicator sample was be turns blue colour, continued titration, till sets clear, measured sodium thiosulphate.

Calculation = [8×1000×0.025/50 mL (sample taken for titration)] ×(Sodium thiosulphate)

BOD: Below method was used during the experiment for the BOD.

Water samples were collected, then 300 mL water was put into a BOD bottle, and 2 mL $MnSO_4$ added 2 mL alkali iodine azide, closed and mixed by inverting the bottle, allowing brown ppt to settle, added 2 mL conc H_2SO_4, closed and mixed to dissolve the ppt, incubator in BOD for 5 days after incubation added 50 mL water sample taken, titration was done with 0.025 N sodium thiosulphate, at first added few drops of sodium thiosulphate to the water sample for the pale yellow colour. After that, the indicator (2 mL of starch) was added, and after adding 2 mL of starch, the sample turned blue. The titration continued until transparent, and the mL of sodium thiosulphate was measured.

Calculation = [8×1000×0.025/ 50 mL (sample taken for titration)] ×(Sodium thiosulphate uses ml)

COD: To prepare the collector water sample, start by taking 10 mL of the sample and placing it in a round-bottom reflux flask. Add a few glass beads to prevent the solution from splashing during heating. Next, introduce 1 mLof mercury sulphate solution into the flask and gently mix the contents by swirling the flask. Now, add 5 mL of potassium dichromate solution to the mixture, taking care to add it slowly and cautiously. Afterward, carefully and gradually introduce 15 mL of silver sulphate sulphuric acid solution into the flask. Connect the reflux condenser to the setup and proceed to digest the contents using a hot plate for a period of 2 hours.After the digestion process is finished, let the flask cool down, and wash the condensed materials with 25 mL of distilled water, collecting this rinse water in the same flask. To commence the titration procedure, introduce 2 to 4 drops of ferroin indicator into the flask, and conduct the titration using a 0.025M solution of ferrous ammonium sulphate until you achieve the endpoint. In a parallel manner, create a blank sample by using distilled water in place of the actual sample.

Calculation = [8×1000×DF× M (VB-VS)/ (volume of sample in mL)

DF= Dilution factor

M= Molarity of standardized Ferrous Ammonium Sulphate Solution

VB= Volume consumed in titration with blank preparation

VS= Volume consumed in titration with sample preparation

3. Result and Discussion:

Water samples were taken from “Howrah, South 24 Parganas, North 24 Parganas, and Kolkata, all in West Bengal”. The result shows arsenic and various metals (Cd, CN, Pb, Hg, Ni, Mo, and Cr) amount in drinking

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water and total dissolved solids ($CaCO_3$), total hardness ($CaCO_3$), BOD, and COD parameters also in the water. Acceptable ranges for As are 0.01 mg/L, for Cd are 0.003 mg/L ,for CN are 0.05 mg/L, for Pb 0.01 mg/L for Hg are 0.001 mg/L, for Mo are 0.07 mg/L, for Ni are 0.02 mg/L and 0.05 mg/L for Cr. $CaCO_3$ is 200 mg/L, total suspended solids are 75 mg/L, and dissolved oxygen is 4 mg/L.

S. No.	**District**	**Total Arsenic as As (mg/L)**	**pH**	**Total hardness as $CaCO_3$**	**TOTAL SUSPENDED SOLID**	**BOD**	**COD**	**DO**
1	Kolkata	0.22 to 0.98 mg/L	7.22-8.24	312-448 mg/L	24-58 mg/L	4-24 mg/L	16-31 mg/L	5.14-4.08 mg/L
2	South 24 Parganas	0.72 to 1.12 mg/L	7.14-8.44	250-548 mg/L	528-828 mg/L	4-12 mg/L	16-31 mg/L	4.38-5.48 mg/L
3	North 24 Parganas	0.92-1.72 mg/L	6.5-8.5	352-502 mg/L	145-2152 mg/L	12-28 mg/L	5-12 mg/L	4.44-5.24 mg/L
4	Howrah	0.58-0.98 mg/L	7.8-9.8	380- 908 mg/L	312-1044 mg/L	16-31 mg/L	6-11 mg/L	4.84-5.52 mg/L

These findings provide insights into the composition of the water sample, including levels of toxic substances (e.g., arsenic, cadmium, cyanide, lead, mercury) and various water quality parameters (e.g., pH, hardness, suspended solids, oxygen levels). The data reveals variations in these parameters, underscoring the importance of adhering to specific water quality standards and regulatory requirements, especially in cases where arsenic levels exceed the specified norm. The discussion below reveals the range of heavy metals and various physio chemical reveals the current situation in the selected area in West Bengal, India.

Toxic chemicals like arsenic, cadmium, cyanide, lead, and mercury are present at levels that are significantly higher than what is considered safe in South 24 Parganas. The levels of these contaminants, which are known to have negative effects on health, render the water unsafe for consumption. The water quality metrics, such as high total suspended particles and chemical oxygen demand, further complicate the situation by making the water unfit for daily use (7). Similar to North 24 Parganas, which is in a terrible state due to the high quantities of hazardous substances in its water supplies. Just the levels of arsenic are much above the allowable limit. This water supply poses a potential health risk to the surrounding people due to its high pH and total hardness values, higher suspended particles, and organic contaminants (8). Being an urban area, Kolkata is not except from these problems with water quality. Indicators of degraded water quality and toxic chemicals have been discovered at concentrations that seriously endanger public health. The information indicates serious pollution, making it obvious that the water cannot be consumed. Similar troubling patterns are also present in Howrah. The water is unsuitable for human consumption because it contains toxic substances and has poor water quality metrics that exceed permissible limits (9, 10). Due to a variety of variables, including industrialization, agricultural practices, and urbanization, West Bengal, with its diversified landscape, faces particular difficulties in sustaining water quality. In order to evaluate the environmental impact and potential health risks related to water sources, it is essential to comprehend the composition of water samples from various regions of the state. The results from water samples taken in South 24 Parganas, North 24 Parganas, Kolkata, and Howrah provide a thorough overview of water quality indicators and highlight any issues with the presence of harmful materials. These results not only help to monitor water safety but also provide a foundation for putting policies in place to safeguard the residents' health and well being. The results point to a worrying trend in water quality.

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Conclusion

The findings across South 24 Parganas, North 24 Parganas, Kolkata, and Howrah districts in West Bengal, India, unanimously signify a critical water quality crisis. The concentrations of hazardous elements and the overall poor water quality make it abundantly clear that urgent and comprehensive remedial actions are imperative to ensure safe and potable water for the communities in these regions. Addressing this issue is a matter of environmental concern and a pressing public health priority.

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