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Metal-ion Analysis of Drinking Water in and Around Samastipur District

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Abstract: The metal-ion analysis of water samples from different parts of Samastipur District were carried out. The metal-ion concentrations have mean values (mg/l) Ca (106.28), Mg (37.60), Na (89.10), K (4.50), Cl (130.87), F (0.23), nitrate (13.17) phosphate (0.04) while heavy metals were not detected. These metal-ion values are within the acceptable value range in the World Health Organisation Guidelines value for Drinking Water Quality.

Key words: Metal-ion concentration, mean value and drinking water quality.

INTRODUCTION

Water is the most necessity of life including food, drinking water, health, energy and shelter. However, pure water needed for human consumption does not always occur in nature, due to the presence of dissolved or suspended impurities in most natural water bodies[1].Its proper management is the most pressing challenge of all. Without water, we have no society, no economy, no culture and no life. Although water is a global issue, the problems and solutions are often highly localised. Bore well water is the main source of water for domestic use in Samastipur and area around it. It is generally pumped into houses or fetched manually for washing, cooking and even drinking. The determination of metal-ion content in the water samples is of great importance, because despite the fact that trace elements are essential to man, at elevated levels, essential and non-essential elements can cause morphological

abnormalities: reduce growth, increase mortality and mutagenic changes[2-4]. It is reported that two thirds of all illness in India are related to waterborne diseases. Comparison of the results of metal-ion analysis of the water samples so obtained with that of potable water standards by WHO[5] will therefore enable us to know the portability of the water samples to be used here.

MATERIALS AND METHODS

Sampling: Samples of water were collected from different locations of Samastipur District. Pre-cleaned sterilized containers were used for the collection of the water samples and labelled appropriately. The above samples were analysed according to the standard methods for 8 parameters (metal-ions) namely calcium, magnesium, sodium, potassium, chloride, fluoride, nitrate and phosphate ions. Chloride, fluoride and nitrate were determined by using ELEICO-CL360 flame photometer.

Metal Analysis: Atomic absorption spectrophotometer (AAS) was used for the determination of metals including calcium, magnesium, sodium, potassium, potassium and heavy metals[6]. Ions like Cl^-, F^-, NO^{3-}, PO_4^{3-} were analysed by using ion-analyser. The range, maximum, minimum and mean of the results were carried out.

RESULTS AND DISCUSSION

The analytical data and statistical calculations relating to the concentrations of metal-ions have been presented in **Table-1** and a comparison of analysed drinking water samples has been made with WHO (1988) and ISI (1991) drinking water standards **(Table-2).**

Table-1: Metal-ion concentrations of water samples under study area.

S.N	Depth(ft)	Na^+	K^+	Ca^{+2}	Mg^{+2}	Cl^-	F^-	NO^{3-}	PO_4^{3-}
1.	254	92.5	2.8	94.8	29.3	128.7	0.51	11.2	0.03
2.	260	73.1	7.2	72.5	23.6	83.9	0.31	7.1	0.05
3.	264	113.5	0.8	138.9	39.5	242.5	0.42	1.6	0.04
4.	270	111.6	7.8	122.1	49.5	241.9	0.40	32.1	0.06
5.	180	57.4	3.3	76.2	26.7	130.1	0.37	31.2	0.05
6.	326	168.9	9.7	354.1	107.2	693.1	0.32	1.6	0.00
7.	274	115.4	6.5	94.2	37.6	203.2	0.36	8.9	0.01
8.	234	107.6	10.6	85.6	26.8	181.6	0.25	9.1	0.08
9.	184	69.3	1.4	63.9	64.7	109.1	0.26	11.9	0.05
10.	207	78.4	4.2	154.1	13.2	190.2	0.18	12.1	0.03
11.	170	50.9	3.7	41.4	24.6	90.3	0.28	8.2	0.05
12.	214	72.4	3.3	69.8	44.7	98.7	0.42	8.6	0.02
13.	267	70.2	4.4	128.7	37.7	184.6	0.43	31.1	0.05
14.	274	109.4	2.1	90.1	21.0	150.3	0.22	15.9	0.06
15.	204	78.9	2.3	66.8	18.7	102.1	0.05	10.1	0.07
16.	167	56.2	1.9	47.3	36.9	36.8	0.44	10.8	0.00
17.	Minimum	50.9	0.8	41.4	13.2	63.8	0.05	1.6	0.00
18.	Maximum	168.9	10.6	354.1	107.2	693.1	0.51	32.1	0.08
19.	Mean	89.1	4.5	106.2	37.6	130.8	0.23	13.2	0.04
20.	Median	78.6	3.7	87.8	33.1	140.2	0.34	10.4	0.05

All parameters are expressed in mg/L

Table-2: Comparison of drinking water quality of the study area with WHO and ISI drinking water standard

Metal-ion	WHO standard 1988		ISI standard 1991		Observed value	
	P	E	P	E	Min.	Max.
Na^+	200	--	150		50.9	168.9
K^+	-	-	-	-	0.8	10.6
Ca^{++}	75	200	75	200	41.4	354.1
Mg^{++}	50	150	30	100	13.2	107.2
Cl^-	200	600	250	1000	63.8	693.1
F^-	0.5	1.0-1.5	0.6-1.20	1.5	0.05	0.51
NO_3	50	100	45	100	1.6	32.1
PO_4	-	-	-	-	0.00	0.08

P = Permissible limit, E = Excessive limit.

Sodium (Na^+) and Potassium (K^+): Na^+ and K^+ are natural occurring cations. They are found in the ground water by weathering of rocks and minerals. Domestic as well as industrial wastes are responsible for adding sodium to the ground water. Excessive amount of sodium in drinking water affects the palatability of water and water containing up to 100 mg/l sodium may generally be physiologically tolerable. Relatively high concentration of sodium may adversely affect soil structure particularly the permeability resulting in alkaline soils. The sodium content in study area ranged from 50.9 to 168.9 which is well within the WHO permissible limits (200 mg/l). In spite of the abundance of potassium in nature it is found relatively in small concentration in most natural waters. It is because of its nature of conversion into insoluble secondary minerals formed in the process of weathering. Potassium is an essential nutrient for both plant and animal life. However, ingestion of excessive amount (200 mg/l) to human body may cause a disorder in nervous and digestive systems[7].

Calcium (Ca^{+2}) and Magnesium (Mg^{+2}): Calcium and magnesium are most abundant ions in natural surface and ground water and exist mainly as bicarbonate and chloride. The level of calcium and magnesium salts regulates the hardness of water bodies. In present study calcium content ranged from 41.4 to 354.1 mg/l. One of the bore wells showed above the excessive limit (200 mg/l). It is thought that it might be the outcome of the contact of ground water with sedimentary rocks particularly calcite, dolomite and gypsum[8]. The content of magnesium was found to range from 13.2 to 107.2 mg/l, which is well within the excessive limit (150 mg/l) prescribed by WHO.

Chloride (Cl^-): Chloride-ion occurs in all natural waters in widely varying concentrations. Weathering and leaching of sedimentary rocks and soils, infiltration of sea water, domestic and industrial waste discharge as well as municipal effluents etc. are considered to be the source of chloride in drinking water. Chloride in excess (>250 mg/l) imparts salty taste to water and people not accustomed to high chlorides may be subjected to laxative effects. In present study the chloride content was found to range from 63.8 to 693.1 mg/l. The WHO and ISI permissible limit of chloride for drinking water is 200 and 250 mg/l respectively. The chloride values of the water samples studied are well within the permissible limit of WHO and ISI. The high value of chloride (>100 mg/l) may be attributed to the seepage of domestic and industrial effluents.

Fluoride (F^-): Fluoride is considered to be the geochemical contaminant. The concentration of fluoride in drinking water depends principally on the solubility of F^- containing rocks. Intake of excess fluoride cause dental and skeletal fluorosis. Its content under investigation area was found to range from 0.05 to 0.51 mg/l which is well within the permissible limit (0.6 to 1.2 mg/l) of ISI standard for safe drinking water.

Nitrate (NO^{3-}): Domestic activities as well as agricultural runoff dissolved in rainwater leach into the ground water[9] are said to be the main source for the presence of NO^{3-} in drinking water. Nitrate above than 50 mg/l in drinking water has adverse effect to the health. Nitrate is non- toxic but when ingested with food or water it will be reduced by bacterial action to nitrite (NO^{2-}) and then to ammonia (NH_3) which are toxic. Since nitrate has greater affinity for oxygen than haemoglobin of blood, hence it gets oxygen from blood to be oxidised to nitrate (NO^{3-}). This depletion of oxygen in blood causes suffocation and ultimately death. In study area the nitrate was found to be 1.6 to 32.1 mg/l which is well within the permissible limit of WHO and ISI.

Phosphate (PO_4^{3-}): The presence of phosphate content in drinking water in general is due to the leaching from mineral ores, agricultural runoff and municipal sewage mainly due to utilization of synthetic detergents. Combustion of organic materials, industrial waste gases and fossil fuel burning may add phosphate to water. Phosphate is essential for bone and some enzyme system. Its low concentration may not cause any harm to human and animal. But excess consumption of phosphate produce phosphine gas (PH_3) which reacts with gastric juice. This could even lead to the death of the consumer[10]. In present study phosphate, content was found to vary between 0.0 to 0.08 mg/l.

CONCLUSION

The result of the present study indicates that the quality of drinking water varies from well to well. Higher value of certain parameters at certain bore wells indicate that the water of those bore wells is not suitable for drinking as such. Hence it is suggested that any ground water source in the study area should be analysed before use for its suitability for domestic purpose. The results also suggest that the contamination problem is not alarming at present but ground water quality may deteriorate with time. Hence, proper care must be taken to avoid any contamination of drinking water and its quality to be monitored periodically.

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