Assessment of Ground Water Quality in Sakara and Muraul Block of Muzaffarpur District, Bihar

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Abstract: A study was conducted to evaluate the ground water quality of 40 samples collected from the hand-pumps of different villages during pre and post monsoon period. The water quality parameters were analyzed to ascertain the potability of drinking water against recommended limits of WHO and BIS. The electrical conductivity for all the samples were above the WHO standards, while the bicarbonates in 81 per cent samples were found to be above critical level. The maximum TDS (680-748 mgL^{-1}) value was recorded in Dholi village during post monsoon period. The bicarbonate concentration was found in all the samples and it was maximum in Sakara village while carbonates content was absent in these samples.

Keywords: *BIS, physio-chemical characters, total solids dissolve, water quality*

Introduction

Among the various sources, groundwater is the most important source of water supply throughout the world (Mariappan *et al.* 2005). The quality of ground water in some part of the country, particularly shallow ground water is changing due to human activities. Fresh ground water supply is necessary for human survival, as it is considered the only source of drinking water in rural areas and also for industrial development. The growing urbanization and industrialization have led to increased use of agro-chemicals in recent times, as well as improper and inadequate management of water systems that has caused serious problems of water availability and quality (Krishnan *et al.* 2007). About eighty per cent of our drinking water, which is depleting at an alarming rate compounded with large scale contamination. The water with a TDS above 500 mgL^{-1} is not recommended for use as drinking water as per the EPA guidelines. It warrants periodical monitoring and evaluation based on standard water quality parameters to confirm its suitability for drinking and agricultural use (Ashfaq and Ahmad 2014) and also to work out the future plan for maintaining the water quality (Deshmukh and Urkude 2014). Hence, the present study was undertaken to determine the quality of groundwater being pumped out through hand pumps in some villages of Muzaffarpur district of Bihar.

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Materials and Methods

   The study was undertaken in 5 villages *viz.* Dholi, Muraul and Lautan representing Maraul block and Sakara and Sakara Bazitpur of Sakara block of Muzaffarpur district, Bihar. The average annual rainfall received during mid-June to first week of October was around 1187 mm. The inhabitants of the area use drinking water in daily life either through privately or by public bored hand pump. A total of forty water samples (after 30 minutes of pumping) were collected from randomly selected hand pump during May (pre-monsoon) and October (post-monsoon), 2014 and transferred into pre-cleaned amber bottle and analyzed for pH, EC, TDS, Chloride, CO_3^-, HCO_3^-, phosphate, total alkalinity, total hardness, sodium and potassium following standard analytical procedures (Saxena 1987) and American Public Health Association (1989).

   Analyzed parameters were compared with the standards prescribed by the WHO (World Health Organization 2011) and BIS (Bureau of Indian Standards 1993). The meteorological data (Fig. 1) were correlated with concentration of cations and salts.
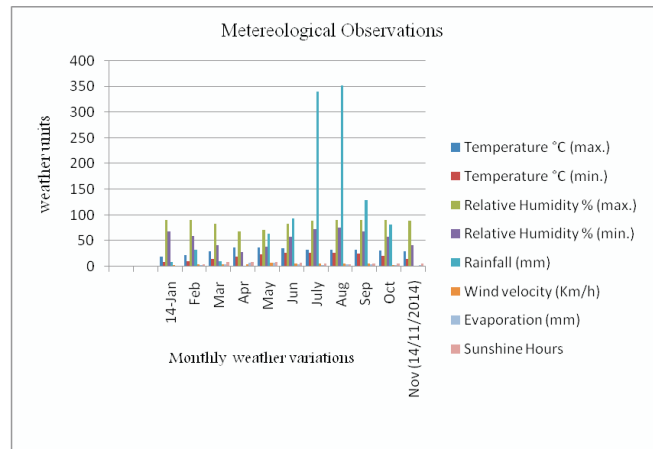
Fig.1 Meteorological data during the study period

Results and Discussion

   The pH of water samples collected during pre-monsoon and post-monsoon period varied from 6.9 to 7.6 and 6.7 to 7.8 respectively (Table 1 and 2). Prescribed limits of pH by BIS is 6.5-8.5 and by WHO is 8.5. The pH was neutral during post monsoon season at all the sites except Sakara village which had slightly alkaline (Table 2). Roy *et al.* (2012) reported that pH of well water used for drinking in Nari area of Nagpur ranged from 7.3 to 8.3. The presence of carbonates, bicarbonates and some dissolved contaminant gases might be related to the alkalinity (Gaikwad *et al.* 2010).

Table 1. Water quality parameters of ground water collected during pre-monsoon period.

Parameters	Dholi	Muraul	Lautan	Sakara	Sakara Bazitpur
No. of samples	4	4	4	4	4
pH	7.1-7.4	6.9-7.3	7.1-7.6	7.3-7.5	7.0-7.3
EC (μSm^{-1})	754-823	805-831	534-664	860-975	732-760
TDS (mgL^{-1})	520-640	630-650	425-470	640-725	540-560
Chloride (mgL^{-1})	15.0-27.0	9.8-12.0	48.9-62.1	26.0-36.8	9.6-12.0
Carbonate (mgL^{-1})	NIL	NIL	NIL	NIL	NIL
Bicarbonate (mgL^{-1})	510.0-534.0	456.0-567.0	268-304	302-490	326-400
Phosphate ($mg\ L^{-1}$)	2.4-4.0	4.6-6.8	6.2-9.0	6.4-8.6	3.0-5.6
Total alkalinity (mgL^{-1})	101.5-120.8	96.5-132.0	108-139.6	150-188.3	139-176.0
Total hardness (mgL^{-1})	138.9-180.0	120.5-140.6	168.0-198.5	186.5-210.0	152.6-183.0
Sodium (mgL^{-1})	40.2-60.0	19.7-30	15.8-24.0	44.0-73.0	10.0-16.6
Potassium (mgL^{-1})	2.1-5.1	3.6-7.0	1.6-3.2	6.0-8.0	1.4-3.6

Table 2. Water quality parametersof ground water collected during post-monsoon period

Parameters	Dholi	Muraul	Lautan	Sakara	Sakara Bazitpur
No. of samples	4	4	4	4	4
pH	6.9-7.2	6.8-7.2	7.0-7.4	7.5-7.8	6.7-6.9
EC (μSm^{-1})	814-920	780-820	540-590	740-783	640-690
TDS (mgL^{-1})	680-748	645-710	390-500	500-610	520-620
Chloride (mgL^{-1})	14.0-24.0	11.0-18.0	33.0-58.0	26.1-31.0	5.3-10.8
Carbonate (mgL^{-1})	NIL	NIL	NIL	NIL	NIL
Bicarbonate (mgL^{-1})	480.9-549	450.0-521.0	268-310	365-396	350-380
Phosphate (mgL^{-1})	2.0-3.6	5.0-6.0	4.0-5.0	6.8-11.8	3.0-4.6
Total alkalinity (mgL^{-1})	98.0-105.0	80.4-112.0	100-112.8	188.6-207.8	162.6-188
Total hardness (mgL^{-1})	200.4-220.8	177-195.4	189--227	230.8-261	168.5-206
Sodium (mgL^{-1})	80.5-90.1	25.6-36.8	15-22.0	68.0-78.6	40.0-58.0
Potassium (mgL^{-1})	3.4-5.0	4.8-8.0	2.0-4.2	6.4-13.0	2.4-3.8

The EC of water samples varied from 534-975 μSm^{-1}. The highest electrical conductivity (860-975 μSm^{-1}) was recorded in Sakara village during pre-monsoon period (Table 1). The mean electrical conductivity of all the drinking water samples were higher than the limit (400 μSm^{-1}) prescribed by World Health Organization. Raju (2007) reported that 23 per cent of tested samples were beyond the WHO guidelines in Cuddapah district of Andhra Pradesh. High values of electrical conductivity in water might be due to high accumulation of calcium, magnesium and sodium salts in the surrounding soil.

Total dissolve solids (TDS) in sampled water collected during pre-monsoon period varied from 425 to 725 mgL^{-1}. The maximum value (725 mgL^{-1}) was recorded in Sakara village, whereas low concentration (425 mgL^{-1}) was Lautan village. The continuous intake of water with high TDS may cause kidney stones and heart diseases (Garg *et al*. 2009). The highest TDS (680-748 mgL^{-1}) was recorded in Dholi village during post monsoon period. About 81 per cent of the ground water samples had TDS beyond the recommended admissible limits of 500 mgL^{-1} as per BIS. The chloride concentration in water samples varied from 9.6 - 62.1 mgL^{-1} during pre-monsoon period. It was high in Lautan village (48.9 - 62.1 mgL^{-1}) and the lowest concentration (9.6 - 12.0 mgL^{-1}) was observed in Sakara Bazitpur village. Its concentration varied from 5.34 to 58.8 mgL^{-1} at the end of monsoon (Table 2). The higher chloride level (33.0 - 58.4 mgL^{-1}) was observed in water collected from Lautan village, while it was in lower range (5.3 - 10.8 mgL^{-1}) in Sakara Bazitpur village (Table 2). The reduced level of chloride during post monsoon might be due to its dilution. All water samples had permissible limits of chloride as per prescribed limit of WHO and BIS.

Bicarbonate concentration in drinking water (Table 1 and 2) ranged from 268 to 567.4 mgL^{-1} during pre-monsoon. The higher quantity of bicarbonates (567.4 mgL^{-1}) was detected in Muraul village than the other points. The bicarbonates content in post-monsoon sampled water varied from 268 - 559 mgL^{-1} and majority of samples had their concentration above the recommended levels. Roy *et al.* (2007) reported bicarbonates content in well water ranging from 208 mgL^{-1} (rainy season) to 342 mgL^{-1} in winter season of Nagpur district of Maharashtra. Elevated bicarbonate concentration in ground water might be due to presence

of carbonaceous minerals in soil system. The phosphate content in water samples ranged from 2.4 to 9.0 mgL^{-1} during pre-monsoon period and it was higher in Lautan village (Table 1). In post-monsoon water samples, the phosphate content varied from 2.0 to 11.2 mgL^{-1} while elevated concentration of phosphate (11.8 mgL^{-1}) was associated in Sakara village. The alkalinity varied from 96.5 to 188.3 mgL^{-1} during pre-monsoon period. The post-monsoon sample of Sakara village had higher value of total alkalinity (207.8 mgL^{-1}), whereas, lower total alkalinity was reported in Lautan and Sakara Bazitpur villages (Table 2). The alkalinity is not much harmful to human health though its presence in the water imparts unpleasant taste.   All the water samples compared with BIS limits and the total alkalinity was found to be under the permissible limits prescribed by BIS (200-600 mgL^{-1}) and WHO (500 mgL^{-1}).

The total hardness is an important factor which reflects the quality of potable water. The hardness of water mainly depends on the amount of calcium and/or magnesium salts in water. Total hardness varies from 121-141 mgL^{-1} and 187-210 mgL^{-1} in the Muraul and Sakara village, respectively during pre-monsoon period. Total hardness in post-monsoon water samples ranged from 169 to 261 mgL^{-1}. The maximum hardness (261 mgL^{-1}) of water was detected in the Sakara village and minimum value (177 mgL^{-1}) was found in Muraul (Table 2). These water samples were found to be below the recommended prescribed limits of BIS (300-600 mgL^{-1}) and WHO (500 mg L^{-1}). Sodium concentration in drinking water samples ranged from 10 to 73 mgL^{-1} during pre-monsoon period (Table 1) and its concentration was low (15 mgL^{-1}) during past monsoon period (Table 2). The water samples were found to be within the safe limits (200 mgL^{-1}) prescribed by WHO. Similarly, potassium concentration varied from 1.4 to 8.0 mgL^{-1} in pre-monsoon period while in post-monsoon sampled water it varied from 2.0-13.0 mgL^{-1}. The data (Table 2) revealed higher content of potassium in Sakara and lower in Lautan village. The values of potassium content in all the water samples were well within the prescribed limits of 50 mgL^{-1} as per WHO standards (2011).

Conclusion

The drinking water collected from handpumps from Sakara and Muraul blocks of Muzaffarpur district of Bihar during pre and post-monsoon period indicated that phosphate, total alkalinity and potassium were found to be below the recommended permissible limit of WHO and BIS. The electrical conductivity, bicarbonates and total dissolved solids were above the potable limit of drinking water.

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