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Physicochemical examination and quality assessment of ground-water (Hand-Pump) around Patna main town, Bihar state, India

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ABSTRACT

Groundwater samples from hand pipes were collected from six different locations situated in Patna town and analyzed during December 2010 to February 2011. Ten physicochemical parameters were analyzed and the results were compared with water quality standards prescribed by ISI 10500-91, WHO and CPHEEO In the present study, two water samples showed high EC, two water samples had high pH, one water sample had border-line turbidity, three sample showed high TA, two sample revealed high TH values indicating poor water quality and beyond maximum acceptable limit.

Keywords: Hand-pump, Groundwater, Physicochemical parameters.

INTRODUCTION

Water is extremely essential for survival of all living organisms. Life can not exist on this planet without water. Approx 97.2% of water on earth is salty and only 2.8% is present as fresh water from which about 20% constitutes ground-water [1]. Hand pumps are manually operated pumps; they use human power. They are widely used in every country in the world for a variety of industrial, marine, irrigation and leisure activities. Most hand pumps have plungers or reciprocating pistons, and are positive displacement [2]. Groundwater is generally considered to be much cleaner than surface water. However, several factors such as discharge of industrial, agricultural and domestic wastes, land use practices, geological formation, rainfall patterns and infiltration rate affects the groundwater quality and once contamination of groundwater in aquifers occurs, it persists for hundreds of years because of very slow movement in them[3].

Water pollution are mainly due to contamination by foreign matter such as microorganism, chemicals, industrial or other wastes or sewage which deteriorate the quality of the water and render it unfit for its intended uses. Ingestion of polluted water can result various health hazards. Disposal of sewage water into fresh water aquifers is the main cause of groundwater pollution. Hence determination of groundwater quality is important to observe the suitability of water for particular use. Groundwater monitoring of hands pump is one of the important tool for evaluating groundwater quality. Considering these aspects of hand-pump water pollution the present study of groundwater monitoring was undertaken to investigate physicochemical characteristics of some groundwater samples from different area located in Patna proper town.

EXPERIMENTAL SECTION

Study area

Patna town (25.611^0N 85.144^0E) is capital of Bihar and located on the south bank of the Ganga River. A characteristic of the geography of Patna is its confluence of rivers. Patna is unique in having four large rivers in its vicinity. It is the largest riverine city in the world. Patna has a humid subtropical climate. Highest ever recorded temprature is 47 °C, lowest ever is 1 °C and annual rainfall is around 1100 mm. At the census of 2001 the population of Patna was about 1.6 million and the population density was 1,405 people per square kilometer. The present study was planned by selecting six different zones located in Patna town proper. The literature survey showed that no groundwater by hand pumps studies were made in these localities so far. Hence the present study was undertaken.

Collection of water samples

The samples of groundwater from hand-pump were collected in plastic canes of three liters capacity as per standard procedure. Water samples from six sampling points situated at different zones were collected during a post-monsoon period of three months (*December 2010 to February 2011*). The samples were kept in refrigerator maintained at 4^{oC}. The sampling zones and sources of ground-water are given in Table 1.

Table 1. Sampling Points

Serial No.	Different Zones	Sample No.	Source of Sample
1	Patna City Area	S1	Hand pump
2	Agam Kuan Zone	S2	Hand pump
3	Pathar Ki Masjid Zone	S3	Hand pump
4	Makhania Kuan Area	S4	Hand pump
5	Patna Railway Station Area	S5	Hand pump
6	Rajabazar Area	S6	Hand pump

Analysis of water samples

The physicochemical parameters such as pH, Turbidity(Turb), Electrical Conductivity(EC), Total Alkalinity(TA), Total Dissolved Solids(TDS), Dissolved Oxygen(DO), Total Hardness (TH), Calcium(Ca^{2+}), Magnesium(Mg^{2+}), Chloride(Cl^-), were determined using standard methods[4-6]. Specific reagents were used for the analysis and double distilled water was used for preparation of solutions. The methods used for estimation of various physicochemical parameters are tabulated in Table 2.

Table 2. Methods used for estimation of physicochemical parameters

S.No.	Parameters & units	Method
1	pH	pH Metry
2	Turbidity (NTU)	Turbiditi metry
3	EC(micromhos/cm)	Conductometry
4	Total Alkalinity(mg/l)	Titration method
5	Total Dissolved Solids (ppm)	Filtration method
6	Dissolved Oxygen (mg/l)	Iodometric method
7	Total Hardness (mg/l)	EDTA titration
8	Calcium(mg/l)	EDTA titration
9	Magnesium(mg/l)	EDTA titration
10	Chloride(mg/l)	Silver Nitrate method

RESULTS AND DISCUSSION

The average results of the physico-chemical parameters for water samples are presented in Table -3.

Table 3. Average results of the physicochemical parameters

Serial no.	Parameters	Sampling points						ISI 10500-91
		S_1	S_2	S_3	S_4	S_5	S_6	
1	pH	8.65	8.92	8.06	8.23	7.93	7.95	7.0-8.5*
2	Turbidity (NTU)	0.5	0.9	0.3	0.0	0.4	1.0	1*
3	EC(micromhos/cm)	1559.62	1233.74	1248.79	1540.05	1254.24	953.33	1400
4	Total Alkalinity (mg/l)	300	280	185	190	180	210	200
5	Total Dissolved Solids (ppm)	490.81	480.07	427.13	426.53	475.16	450.46	500
6	Dissolved Oxygen (mg/l)	4.46	5.60	6.24	5.20	7.36	5.76	5.0#
7	Total Hardness (mg/l)	400	290	330	260	250	280	300
8	Calcium(mg/l)	36.07	28.06	48.09	44.08	36.07	40.08	75
9	Magnesium(mg/l)	35.42	23.60	21.16	38.42	27.98	23.09	<30
10	Chloride(mg/l)	28.4	56.8	92.3	71.0	35.5	142.0	200*

**CPHEEO(Central Public Health and Environmental Engineering Organization of India) #WHO*

pH

pH is a measure of the intensity of acidity or alkalinity and the concentration of hydrogen ion in water. pH value below 4 produces sour taste and a higher value above 8.5 give alkaline taste[7]. In the present study, the pH values of water samples varied between 7.93 to 8.92 (Table 3) and samples **S1** & **S2** were found beyond the limit prescribed by CPHEEO.

Turbidity

Turbidity makes water unfit for domestic purposes, food and beverage industries and many other industrial uses. In the present analysis, turbidity values varied between 0.0 to 1.0 NTU and found within the normal limit prescribed by CPHEEO.

Electrical conductivity (EC)
Electrical conductivity is capacity of water to convey electric current. It indicates the amount of total dissolved salts[8]. EC values were observed in the range of 953.33 to 1559.62 micromhos/cm. EC values were found within ISI 10500-91 limit except sampling sites **S1** and **S4** indicating the presence of high amount of dissolved inorganic substances in ionized form.

Total Alkalinity
Total Alkalinity is a total measure of substance in water that has "acid-neutralizing" capacity. The main sources of natural alkalinity are rocks which contain carbonate(CO_3^{2-}), bicarbonate(HCO_3^{1-}) and hydroxide(OH^{1-}) compounds; silicates(SiO_4^{3-}) and phosphates(PO_4^{2-}) may also contribute to alkalinity[8]. Total alkalinity values for tested samples **S1**, **S2** and **S6** were found to be greater than the value prescribed by ISI 10500-91.

Total dissolved solids (TDS)
High concentrations of total dissolved solids may cause adverse taste effects. TDS values varied from 426.53 mg/L to 490.81 mg/L. The all investigated samples showed within the normal limit prescribed by ISI 10500-91 except **S1** sample.

Dissolved oxygen (DO)
Dissolved oxygen reflects the physical and biological processes prevailing in the water which indicate the degree of pollution present in water bodies. In the present study of water samples, DO value varied from 4.46 to 7.36. The sampling points **S1** showed low DO values indicating borderline contamination by organic matter according to WHO.

Total hardness (TH)
Hardness in water is due to the natural accumulation of salts from contact with soil and geological formations or it may enter from direct pollution by industrial effluents. Hardness of water mainly depends upon the amount of calcium or magnesium salts or both[8]. In the present study, total hardness varied from 250 mg/L to 400 mg/L. The values for sample **S1 was** higher than the prescribed limit by ISI 10500-91.

Calcium (Ca^{2+})
Water with high calcium content is undesirable for household uses such as washing, bathing and laundering because of consumption of more soap and other cleaning agents. In the present investigation, calcium concentration ranged from 28.06 mg/L to 48.09 mg/L and all samples showed normal limit prescribed by ISI 10500-91.

Magnesium(Mg^{2+})
At high concentrations, Magnesium salts have a laxative effect particularly when present as magnesium sulphate[9]. Magnesium content in the investigated water samples was varied from 21.16 mg/L to 35.42mg/L and found above prescribed limit in samples **S1** and **S4** according to ISI 10500-91.

Chloride (Cl^-)

The most important source of chlorides in the waters is the discharge of domestic sewage[10]. In the present analysis, chloride concentration was found in the range of 28.40 mg/L to 142.0 mg/L. The values ware within the limit according to CPHEEO.

CONCLUSION

In the current study, the groundwater samples collected from hand-pumps showed deviations from water quality standards indicating groundwater contamination. The ground water (**S1)** from the Patna city zone showed high EC,TDS, TA,TH than the prescribed limits given by water quality standards indicating poor water quality and water from this sites is unfit for drinking purpose and on other hand water samples **S2, S3, S4, S5** and **S6** from different zones showed most of the parameters within the limits of water quality standards showing good water quality and the water from these sampling points is fit for drinking purpose and house-hold use.

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