

A Study on Physico-chemical and Microbiological Parameters of Ground Water in Different Locations of Gwalior City (M.P.), India.

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Abstract: The present study was aimed at assessing the ground water quality characteristics of Gwalior City. A comprehensive physico-chemical and microbiological analysis was conducted after the ground water samples were collected from different sampling locations. The study was carried out by collecting four ground water samples (two bore wells and two municipal supply water) during January-March 2012. The results were compared with Standards prescribed by WHO and ISI-10500-91. The parameters include temperature, total dissolved solids (TDS), pH, Electrical conductivity (EC), Total alkalinity (TA), Chlorides (Cl⁻), Total hardness (TH), Dissolved oxygen (DO), Total aerobic microbial count (TAMC) and Bacterial count (MPN/100 mg/l coliforms). The observation of the study strongly suggests that water of Gwalior region is of very high TDS and needs to be lowered down within prescribed limits before using it for drinking purposes. The present work is primary attempt to examine the water quality of various potable water resources in and around Gwalior City of M.P., India.

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Introduction

We live on a Planet that is dominated by water. More than 70% of the Earth's surface is covered with this simple molecule. Scientists estimate that the hydrosphere contains about 1.36 billion cubic kilometres of this substance mostly in the form of liquid (water) that occupies topographic depressions on the earth. Water is the major constituent of almost all life forms. Most animals and plants contain more than 60% water by volume. Without water, Life would probably never have developed on our Planet.

Water plays a vital role in human life. The consequence of urbanization and industrialization leads to spoiling the water. Ground water represents an important source of drinking water and its quality is currently threatened by a combination of over abstraction, microbiological and chemical contamination, (Ayadin, 2007). The value of ground water lies not only in its wide spread occurrence and availability but also in its consistent good quality, which makes it an ideal supply of drinking water (UNESCO, 2000).

Ground water pollution has become a major subject of public concern the world over. There are several ways as groundwater is contaminated in rural and urban areas such as municipal sewage disposal to nearby water bodies, disposal or seepage of effluent from industries and use of inorganic fertilizers in agricultural farming. (Shrivastava and Pandey, 2011). Ground Water contamination is generally irreversible i.e., once it is contaminated, it is difficult to restore the original quality of the aquifer. (Khanna *et al.*, 2011).

Consequently, a number of cases of water-borne diseases have been seen which is the cause of health hazards. Therefore, it is necessary to assess the quality of underground water used for drinking purposes so that appropriate steps may be taken for groundwater resource management practices. The aim of the study was to determine the physico-chemical condition of ground water sources from different sites of Gwalior City and to assess qualitative and quantitative microbial analysis. The analysed data were compared with standard values recommended by WHO and ISI 10500-91.

Materials and Methods

Description of study area

Gwalior city is a district in Madhya Pradesh state near Agra. It lies between 26°13'2.97"N and 78°11'2.20"E. The new station of the city called Lashkar. Lashkar is few miles south of the old city. It is the site of factories producing cotton, yarn, paint, ceramics, chemicals and lather products. The old city is covered with white sandstone Mosque, Palaces, Rock temples and statues of archaeological and architectural interest. The monitoring network is the study area consists of 4 sites. Ground water occurs under unconfined conditions and is mostly tapped by dug-cum bored wells.

Sample collection

Total 4 water Samples were collected in winter season i.e., from January to March 2012 from different locations (Anupam Nagar, Govindpuri, Gole Ka

Mandir and Lashkar in Gwalior, M.P., India. (Table 1). All the samples were collected in sterilized bottles and were stored at 4°C till further investigation. For analysis, all the chemicals used were AR Grade.

Table: 1 Showing Sampling Locations of study area

Sample No.	Sampling Locations	Type of Location
S1.	Anupam Nagar	Bore Well
S2.	Govindpuri	Bore Well
S3.	Gole Ka Mandir	Municipal Supply
S4.	Lashkar	Municipal Supply

Physico-chemical and Microbiological Parameters

The collected water samples were analyzed for various physico-chemical and microbiological parameters. The procedure for analysis was followed as per standard methods are given by APHA (2012) and Aneja (2003). Statistical calculations were done by the method given in (Bailey, 1999).

The physico-chemical parameters analyzed were temperature, total dissolved solid, pH, electrical conductivity, alkalinity, chloride, total hardness, and dissolved oxygen. The temperatures of the samples were measured in the field itself at the time of sample collection.

Microbiological Analysis

Microbiological quality of water was determined using MPN methods. The test was performed within 24 hr. of sample collection. The MPN method was used to determine the presence of gas producing lactose fermenters and most probable number of coliforms present in 100 mg/l of water. The standard MPN method (nine multiple tube dilution technique) was used for detection of total coliforms by inoculation of samples into tubes of lactose broth (LB) and incubation at 37°C for 48hr. The positive tubes were sub cultured into Brilliant Green Lactose Broth (BGLB) and were incubated at 44.2°C for 48 hr and checked for Total Aerobic Microbial Count.

Results and Discussion

Temperature

The parameter of temperature is basically important for its effects on the chemistry and biological reactions in the organisms in water. The mean temperature of the different water samples was fluctuated from 20°C to 24°C from the month of January to March. The variation in the water temperature may be due to different timing of collection and influence of season. Water temperature varies with changing climatic conditions. The rise in temperature of water accelerates chemical reactions,

reduces the solubility of gases amplifies taste and odour and elevates metabolic activity of organisms.

Total Dissolved Solid (TDS)

Total Dissolved Solids indicate the salinity behaviour of ground water i.e., comprises inorganic salts and a small amount of organic matter. The TDS concentration is considered as a secondary drinking water standard. According to ISI-10500-91, water containing more than 500mg/l of TDS is not considered desirable for drinking water supplies. However, Water with a high TDS concentration may indicate elevated levels of ions that do pose a health concern such as aluminium, arsenic, copper, lead, nitrate and others. In the present study, the TDS values of all the samples were varied from 750-1600 mg/l which showed the higher TDS value than the prescribed limit given by ISI 10500-91 that is 500 mg/l. It is represented graphically in fig. 1. The most remarkable observation of investigation was the alarmingly high level of Total Dissolved Solid in all water samples.

pH

pH is a term used to express the intensity of the acidic or alkaline condition of a solution. The pH is affected not only by the reaction of carbon dioxide but also by the organic and inorganic solutes present in water. According to ISI-10500-91 and WHO (1993), the prescribed limit of the value of pH range between 6.5-8.5. The study showed that the pH of the water samples was in the moderately alkaline range between 7.4 to 8.7 (within the permissible limit) indicating the presence of very weak basic salt. The pH value of water at Site IV has relatively higher pH (slightly more than prescribed limit) than other sites. A little bit increase in pH level may depress the effectiveness of the disinfectants like chlorination's thereby requiring the additional chlorines. The high value of pH results due to waste discharge, microbial decomposition of organic matter in the water body. Graphically, the pH values for all sampling points are shown in fig. 2.

Electrical Conductivity (EC)

Electrical Conductivity is a measure of water capability to transmit electric current and also it is a tool to assess the purity of water. It signifies the amount of total dissolved salt present in water. It is generally measured with the help of a conductivity meter having a conductance cell containing electrodes of platinum coated with Pt. black or carbon. These electrodes are mounted rigidly and placed parallel at a fixed distance. Conductance, when measured between the electrodes having a surface area of 1cm² and placed at a distance of 1cm, is called electrical conductivity. In the present study, Electrical

Conductivity found in the range between 1210-3000 mho/cm. High Electrical Conductivity were observed for two sampling points, SP-3 and SP-4 (One municipal supply water and one bore well) indicating the presence of high amount of dissolved inorganic substances in ionized form while SP-1 and SP-2 showed EC value within the standard limits of 1400 mho/cm prescribed by ISI 10500-91 and WHO, which is shown graphically in fig. 1.

Total Alkalinity (TA)

Total Alkalinity is the measure of the capacity of the water to neutralize a strong acid. The Alkalinity in the waters is generally imparted by the salts of carbonates, bicarbonates, phosphates, nitrates, borates, silicates, etc. together with the hydroxyl ions in free states. The prescribed value for total alkalinity by WHO is 120mg/l and by ISI-10500-91, its value is 200mg/l. The values of Total Alkalinity of water samples varied from 110 to 140 mg/l. Total Alkalinity values for all the investigated samples SP-1 to SP-4 lie within the prescribed limits given by ISI-10500-91 but Total Alkalinity observed for SP-1 and SP-2 were under the prescribed limit given by WHO and for SP-3 and SP-4, the values were found to be greater than the value prescribed by WHO as shown in fig. 1.

Chloride

Chlorine is widely distributed element in all types of rocks present in different forms. Therefore, in ground water of the places where the temperature is high and rainfall is less, its concentration is high. The Chloride concentration serves as an indicator of pollution by sewage. (Balamurugan and Dheenadayalan, 2012). The main form in which chloride is found in the ground water is Sodium Chloride. The higher consumption can cause a significant increase in the development of hypertension, the risk for stroke, renal stones and Asthma in human beings. (Mc Carthy, 2004; Ramesh and Surya, 2012). In the present work, Chloride concentration varied from 98 mg/l to 210 mg/l in the samples taken from the study areas whose graphical representation is shown in fig. 1. The values of all the samples were below the permissible limit of WHO and ISI-10500-91.

Total Hardness (TH)

The summation of calcium Hardness and Magnesium Hardness is regarded as the total Hardness of water. Hardness is the property of water which prevents the lather formation with soap and increases

the boiling point of water. (Trivedy and Goel, 1996). The WHO has suggested a limiting value 500 mg/l and according to ISI-10500-91, the limiting value is 300 mg/l of Total Hardness for Potable water. In the present investigation, this limit is not crossed on either side by any of the samples under study. However, In the S-4, the Total Hardness value (295mg/l) is about to reach the maximum permissible limit given by ISI-10500-91. The waters of remaining samples have registered values of Total Hardness in between the range from 120 mg/l to 195 mg/l which are within the prescribed limit by WHO and ISI -10500-91 as shown in fig. 1.

Dissolved Oxygen (DO)

Dissolved Oxygen is an important parameter in water quality assessment and reflects the physical and biological process prevailing in water. It is essential for the self-purification process in the natural water system and indicates the capacity of a natural body of water for maintaining aquatic life. Dissolved oxygen present in drinking water adds taste and it is highly fluctuating factor in water. (Mishra and Bhatt, 2008). In the present study, Dissolved Oxygen Content varied in a range of 4.6 to 7.0. The Sampling Points SP-1 and SP-2 showed DO values (4.6, 5.1 mg/l) respectively within the permissible limit given by WHO where as SP-3 and SP-4 showed higher values (7.0 and 6.8 mg/l) respectively indicating contamination by organic matter. Graphically, the values of DO for all sampling points are shown in fig. 2.

Microbiological Analysis

Total Aerobic Microbial Count (TAMC) and Most Probable Number (MPN)

The microbiological analysis of the water is also showed in Table-2. The total aerobic microbial count (TAMC) indicate that the highest microbial load 950 cfu/mg/l in S-3 after 24 and 48 hr. incubation and minimum load 125 cfu/mg/l in S-2. MPN indexing of analyzed water samples showed wide variation and was in the range of 2 to 15 Index/100 mg/l. The results showed that almost municipal supply water samples were contaminated than bore well water samples and not fit for drinking purposes as per ISI-10500-91 recommendations. Most Probable Number (MPN) is calculated to confirm the presence of lactose fermenting gas producing bacteria. The health effects of exposure to disease-causing bacteria, viruses and parasites in drinking water are varied. The most common symptoms of waterborne illness include nausea, vomiting and diarrhoea. (Shah *et al.*, 2012).

Table 2. Showing the average value of the physico- chemical and microbiological Parameters determined in different water samples.

SL No	Parameters	SL-1	SL-2	SL-3	SL-4	ISI 10500-91	WHO Standard 1993
1.	Temperature (°C) Mean±S.E.	21.3±0.21	20.5±0.09	23.5±0.38	24.8±0.54	-	-
2.	Total Dissolved Solid (TDS) (mg/l)	750±2.38	900±3.26	1550±4.54	1600±4.68	500	1000
3.	pH	7.4±0.08	7.9±0.12	8.5±0.24	8.7±0.32	6.5-8.5	6.5-8.5
4.	Electrical Conductivity (EC) (mho/cm)	1210±89.21	1360±98.68	3000 ±125.24	2290 ±112.62	1400	1400
5.	Total Alkalinity (TA) (mg/l)	110±1.08	120±1.12	132±1.18	140±1.21	200	120
6.	Chloride (mg/l)	98.6±2.24	138±3.06	126.8±2.89	210±4.68	250	250
7.	Total Hardness (TH) (mg/l)	120±2.32	195±3.26	180±3.21	295± 4.02	300	500
8.	Dissolved Oxygen (DO) (mg/l)	4.6±0.09	5.1±0.18	7.0±0.21	6.8±0.26	5	-
9.	Total Aerobic Microbial Count (TAMC)	228	125	950	524	-	-
10.	Most Probable Number (MPN) (Index/100mg/l)	02	04	15	09	10	-

The examined physico-chemical and microbiological parameters showed considerable variations in different samples. The observations are represented in Figure 1 and 2.

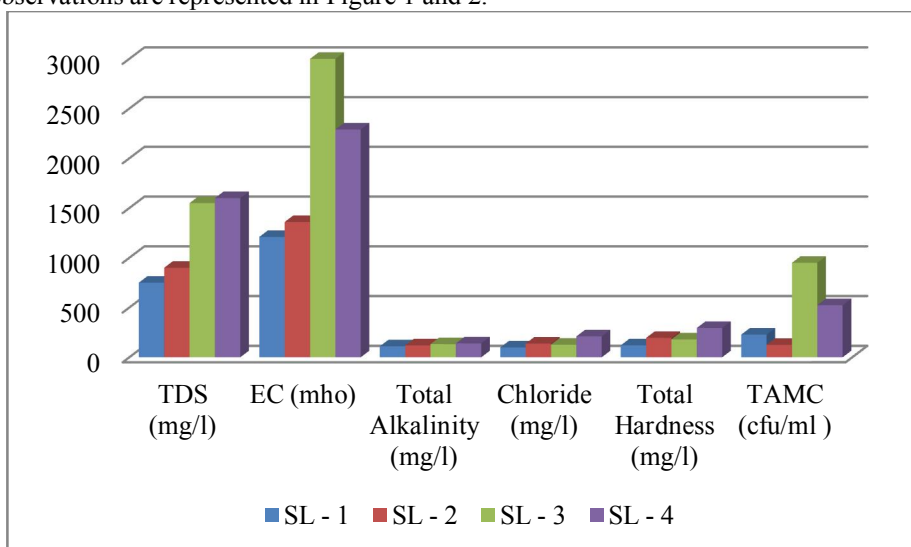


Figure 1. Showing the average value of the physico- chemical and microbiological Parameters determined in different water samples.

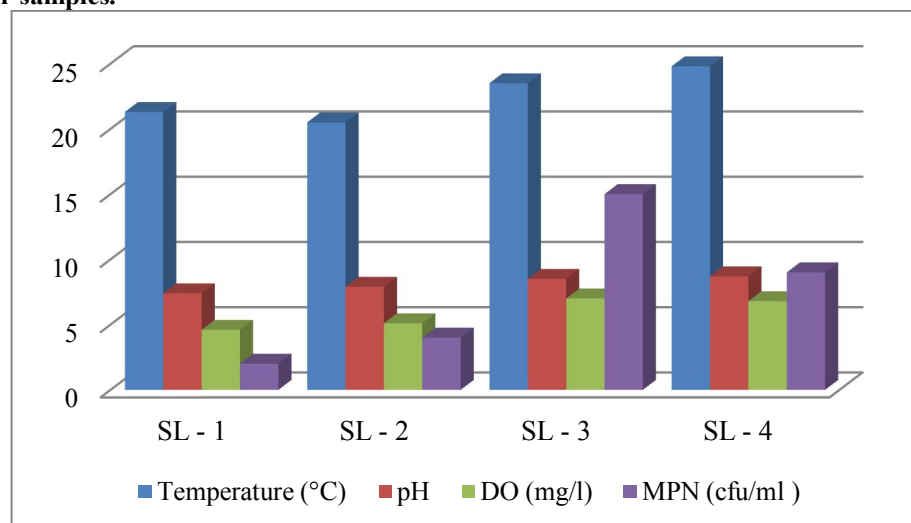


Figure: 2 Showing the average value of the physico- chemical and microbiological parameters determined in different water samples.

Table 2. Correlation coefficients between different parameters of ground water

	Temperature	TDS	pH	EC	Total Alkalinity	Chloride	Total Hardness	DO	TAMC	MPN
Temperature	1									
TDS	0.93	1								
pH	0.86	0.97	1							
EC	0.78	0.92	0.85	1						
Total Alkalinity	0.89	0.96	0.99	0.80	1					
Chloride	0.72	0.68	0.78	0.35	0.84	1				
Total Hardness	0.71	0.72	0.83	0.40	0.87	0.99	1			
DO	0.89	0.99	0.96	0.96	0.94	0.61	0.65	1		
TAMC	0.72	0.83	0.71	0.97	0.65	0.16	0.20	0.87	1	
MPN	0.71	0.89	0.82	0.99	0.76	0.29	0.36	0.93	0.97	1

Conclusion

The observation of the study strongly suggests that water of Gwalior region is of very high TDS and needs to be lowered down within prescribed limits before using it for drinking purposes. The water samples taken from Site III and Site IV are highly polluted and unfit for drinking purpose. The increase in the rate of TAMC and MPN index at these sites is alarming and measures should be taken to mitigate such types of problems. The sampling site I and II showed physico-chemical parameters within the water quality standards and the quality of water are good and it is fit for drinking purpose. Thus, as far as sample waters are concerned, the potential risk of getting infected by water-borne diseases is always there if used without proper disinfections. The water can be definitely used after practising suitable disinfections systems. Although, the present investigation is essentially a primary work and needs to be further investigated to arrive at a specified conclusion with respect to clinical implications.

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