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PHYSICO-CHEMICAL AND MICROBIOLOGICAL STUDIES ON QUALITY OF DRINKING WATER IN DIFFERENT AREAS OF GAUTAM BUDH NAGAR, (U.P) INDIA

LAKY TIMON WANI KUNDU[1], AJAY KUMAR[1*], GARIMA BARTARIYA[2], PRAGATI SAINI[1], MONIKA CHAUHAN[1], DIWAKAR CHAUHAN[3] AND RAJENDRA SINGH[4]

[1,3]*Department of Bio Sciences, School of Basic and Applied Science, Galgotias University, Greater Noida, U.P., India*
[2]*School of Life Science and Technology, IIMT University, Meerut, U.P., India*
[4]*Lagion Lab Pvt Ltd, Kasna Industrial Area UPSIDC, Greater Noida, U.P., India*

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ABSTRACT

Physico-chemical and Microbiological Studies on the Quality of Drinking Water in Different Areas of Gautam Buddha Nagar (U.P) India ", which includes tests for Turbidity, pH, conductivity, total dissolved solids, total hardness, acidity, alkalinity, chlorides...etc., and biological tests is one of the most important work in an integrated industrial complex in the state of Gautam Buddha Nagar U.P., where a number of electronic industries, chemicals, textile industry, distillery units, and large number of small and medium industries are situated. A water quality standard is a legal requirement that specifies the uses of a body of water or water segment as well as the water quality requirements required to protect those uses. This present work tests the average temperature, pH concentration, turbidity, total dissolved solids (TDS), total hardness, alkalinity, and chloride, among other things. The results from the metrics used to determine water quality are practically within the acceptable range of the drinking water standard. (IS:10500) except from a few places.

KEY WORDS : Physico-chemical, Microbiological, Turbidity, Conductivity, Total dissolved solids, total hardness and total coliform.

INTRODUCTION

Water is a crucial resource for growth and is necessary for all types of economic activity. Given that it is a known source of life, it is a tremendously valuable resource on our planet. Although it does not produce colour, water is nonetheless regarded as a nutrient because it contributes to the structural makeup of cells and is a crucial part of the diet (Dugan, 1972). Drinkable water has the proper ratio of sensory, physical, chemical, and bacteriological properties. Water must be pure in order to be utilised as a drink for humans. must be devoid of pathogenic organisms, as well as minerals and other compounds that might have a negative physiological impact. Drinking water must be aesthetically pleasing, devoid of any offensive tastes, colours, odours, or apparent turbidity. Additionally, drinking water must be at a comfortable temperature (Agarwal, 2021). The sustenance of life depends on a coordinated system of biological metabolic reactions in an aqueous solution. In water, all biological processes happen. Most human activities include the use of water in some way. It should be emphasised that man's earliest settlements and civilizations developed alongside riverbanks. Although roughly 71 percent of our planet's surface is made of water, only 3 percent of it is. 3% is available as fresh water in rivers, lakes, and ponds that are safe for human use, whereas 70% of it is trapped in glaciers and arctic icebergs, 24% in groundwater, and 1% is in groundwater (Dugan, 1972). The need for water supply has been rising dramatically as a result of rising industrialisation on the one hand and a population that is booming on the other. Additionally, a sizable portion of this water is polluted by sewage, industrial waste, and a variety of synthetic chemicals. Fresh water, a valuable and finite resource, must be conserved, protected, and used properly by humans. Unfortunately, this has not been the case, as seen by the world's lakes, rivers, and streams that are polluted. Nearly 70% of India's water supply is polluted, (National Environmental Engineering Research Institute in Nagpur, Pani, 1986). Water makes up between 60 and 70 percent of the human body, and any decline in this proportion can be fatal. A guy can go for months without eating, but he would struggle to survive without water. Water is necessary for various indoor and outdoor purposes, as well as to produce food. Water can only be found in significant quantities on Earth in all three phases (solid, liquid, and vapour). Water is necessary for all life on earth, therefore keeping water sources safe is essential to guaranteeing human survival. Seas and oceans cover the majority of the earth's surface. But it is not good for drinking because of the salt concentration. There is just 1% of fresh water (lakes, rivers, streams, and groundwater) available for household, agricultural, and industrial applications (Gupta *et al.,* 2008). Water, the most precious natural resource, ought to be clean. Without easy access to clean water, life is impossible. Today, almost everywhere access to clean drinking water has improved, but more than 2.5 billion people still lack access to even the most basic sanitation, and around 1 billion people still do not get clean water (Gao *et al.,* 2013). More than 70% of the fresh water used by people is used for agriculture. Water is one of nature's most significant and priceless gifts. Approximately 1.0 % of our planet's Water is clean and suitable for drinking, bathing, irrigation, and other home applications. Water is one of the most valuable and necessary elements for both industrial development and human existence. Nearly 70% of Indians rely on groundwater for their primary source of drinking water because they think surface water to be more contaminated (Krishan *et al.,* 2015). Water is a vital natural resource and is required for all life to exist sustainably. In addition to being the most important component of all living things, including plants, animals, and other species, water is essential for human survival in the biosphere. It is the vitality of the environment. The existence of Hunan is entirely dependent on the supply of fresh water, which is a "saviour of life" in its unaltered natural state. Therefore, it is now vital and crucial to assess ground water for irrigation and drinking in order to monitor and evolve the quality of ground water for residential and agricultural operations internationally. It has turned into a necessity to keep it reliable for future use (Chopra and Gopal, 2014; Liu *et al.,* 2008).

MATERIALS AND METHODS

Study Areas

The 10 locations/areas are selected for drinking water studies are (Surajpur, Eicher, Beta-1, Omega-4, Pali, Kasna, Sigma-3, Kheri, Lakhnawali, Aimnabad), as under the greater Noida is one of the major cities in Uttar Pradesh's Gautam Buddha Nagar district (India). It is located at latitude 28.47 44°N and longitude 77.50 40°E. It has 124 settlements with a total of 107,676 residents (till March 2014). Greater Noida is a territory in the North West that is roughly 40,000 hectares in size and is bounded by National Highway NH-24. The town is a part of Delhi's NCR (National Capital Region). Only 30.0 hectares of the total land area, or 13,570.00 hectares, is bordered by a commercial area, and 1,970.03 hectares are bordered by an institutional area. Water is delivered to the area via supply lines, tube wells, overhead tanks, and trunks. Currently, the sewer network is about 460 kilometres long. There are 500 km of drainage lines and around 500 km of water delivery lines dispersed throughout the region.

Sampling location and analysis of water

Several physical and chemical features of the drinking water from various places/areas have been studied, including colour, taste, odour, pH, turbidity, total dissolved solids (TDS), total hardness, chloride, and alkalinity. Plastic 1.5-liter bottles were used to collect samples. Each bottle was washed with 2% nitric acid and then rinsed three times with distilled water. After that, the bottles were kept in a pristine environment. No air was allowed in the bottles, which were then fully filled and sealed to prevent leakage. Name, sampling date, and location were clearly marked on each container

Alkalinity measurement

2 to 3 drops of the phenolphthalein indicator were added to 25 ml of each of the water samples. The sample's phenolphthalein alkalinity was calculated after being titrated with 0.02N H_2SO_4 to pH 8.3. (Phenolphthalein indicator was changed colour

from pink to colourless at pH 8.3). Finally, the following formula was used to determine the water's phenolphthalein alkalinity.

$$\text{Phenolphthalein Alkalinity (mg/L) as } CaCO_3 = \frac{A1 \times N \times 50 \times 10}{V}$$

Where:
A1 = volume of H_2SO_4 in ml,
N = normality of H_2SO_4 used to titrate,
V = volume of sample used in ml

Determination of pH: The pH of each sample was measured with portable field pH meter.

Electrical Conductivity (EC) measurement

EC was determined using a combination TDS/conductivity metre model 4200 by moving one of the instrument's four buttons. The quality of the distillate water was tested before the probes were rinsed with it to conduct the measurement. The probe was then lowered into a beaker filled with a water sample and dragged up and down along a piece of tape to clear any air bubbles from the electrodes. Then information was logged for every sample.

Chloride ion determination

A conical flask was filled with 25 ml of each water sample. pH was also tested and adjusted to a range of 7-9. After that added 3 drops of potassium chromide indicator (K2CrO4), and then titrated with standardised silver nitrate solution to produce a brick red precipitate end point, and the volume of titrant employed was noted down as V1. In a similar manner, a blank titration was performed using 25 mL of distilled water in place of the sample, following the same steps, and recording the end volume as V2.

$$\text{Chloride Concentration (mg/l)} = \frac{(V1\text{-}V2) \times 35.5 \times 1000}{V}$$

Where:
V_1 = volume of titrant consumed for water sample.
V_2 =Volume of titrant consumed for blank,
N = normality of silver nitrate and
V sample = volume of sample used (ml)

The Total Hardness Testing

To calculate the total hardness of the water samples, 25 ml of each sample was pipette out and placed in a conical flask that had been cleaned. After adding 3 to 4 drops of the Eriochrome Black-T indicator and added 8 to 10 drop of ammonia buffer solution (NH4CL) the solution's colour changed to a deep wine colour. This solution was titrated against an ethylenediaminetetraacetate (EDTA 0.01N) solation taken in the burette until the end point was reached and the colour changed from wine red to sky blue. The burette's final reading was recorded, and the titration was repeated to obtain a concordant value. The total hardness of the water sample was finally calculated analytically and expressed in mg/l of $CaCO_3$.

Determination of Total Dissolved Solid (TDS), Total Suspended Solid (TSS) and Total Solid (TS)

100 ml of the water sample from each was filtered through a pre-weighed filter paper to measure the total suspended solid (TSS). The filtered sheets were dried in an oven at 103 to 105°C, and TSS was calculated using the formula below.

$$\text{TSS (mg/l)} = \frac{\text{Filter post weight - Filter Pre Weigh}}{V}$$

TDS was measured using combined pH/T°/TDS and conductivity meter model 4200 whereas TS was

Table 1. Details of Sample location

S. No.	Sample Location	Location coordination Latitude	Longitude	Code sample	Sources	Analysis duration
1	Surajpur	28.5281221	77.5067443	11-150422-1	Borewell	15 – 25/04/2022
2	Eicher	28.475412	77.5037037	11-150422-2	Borewell	15 – 25/04/2022
3	Beta-1	28.467548	77.4974542	11-150422-3	Borewell	15 – 25/04/2022
4	Omega-4	28.4617921	77.5197248	11-150422-4	Borewell	15 – 25/04/2022
5	Pali	28.5282934	77.5084316	11-150422-5	Borewell	15 – 25/04/2022
6	Kasna	28.444749	77.5275368	11-160422-1	Borewell	25 – 06/05/2022
7	Sigma-3	28.4452328	77.5499807	11-160422-2	Borewell	25 – 06/05/2022
8	Kheri	28.4949222	77.5070542	11-160422-3	Borewell	25 – 06/05/2022
9	Lakhnawali	28.5252028	77.4843522	11-160422-4	Borewell	25 – 06/05/2022
10	Aimnabad	28.558368	77.4476669	11-160422-5	Borewell	25 – 06/05/2022

measured from the two parameters of TDS and TSS given by:

TS (mg/l) = TDS (mg/l) + TSS (mg/l)

Calicium Testing

To test for calcium, 25 mL of each sample were pipetted out and put in a conical flask that had been cleaned. The pH was then raised to 11–12 by adding 15–20 ml of NaOH. 20g of murexide indicator was added, and the solution was titrated with EDTA until it became purple from pink.

Irons Testing

A volumetric flask containing 25 ml of each sample was pipette-out, filled with 1 ml of diluted HCl and 1 ml of hydroxylamine HCl 10%, and heated for 30 minutes. After cooling, the sample was mixed with 5 ml of an ammonium acetate buffer and 1 ml of phenolphthalein 0.1 percent, checked for accuracy, and then filled to a volume of 50 ml. The newly created standard is evaluated using a cubet in a UV spectrophotometer in the 510 nm absorbance light range.

Fluoride Testing

A volumetric flask of 50 ml was cleaned and filled with 25 ml of each sample. To this, 10 ml of the spands solution was added, and the mixture was shaken well to combine. The flask was then allowed to stand for two minutes. and then added 50 ml of distillate water to the volumetric flask. The newly developed standard is examined using a cubet in a UV spectrophotometer with an absorption light range of 570 nm.

Sulphate Testing

One millilitre of Glatine sulphate and one millilitre of 1:9 hydrochloride acid was added to 25 millilitres of each sample, which had been pipetted out into a volumetric flask that had been cleaned. You then added 50 ml of distillate water to the volumetric tube. The manufactured standard is now tested using a cubet in a UV spectrophotometer at the 420 nm absorbance light range. the IS 3025 (P-24):1986 test protocol.

RESULTS AND DISCUSSION

In 10 various places around Gautam Buddha Nagar, UP, India, the current study examines the quality of the ground water. Recognize the importance of ground water quality, which serves as the main criterion for determining whether it is suitable for household and drinking uses. Table 2 displays the results of the physical-chemical, microbiological, and other groundwater parameters in Gautam Buddha Nagar, UP, India, along with the average values.

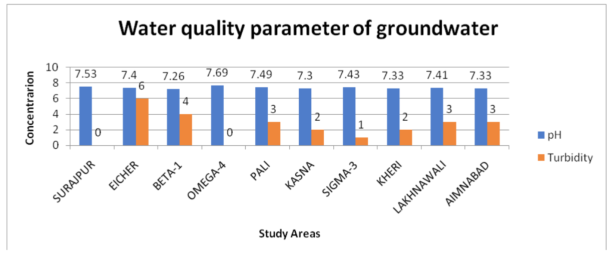

Fig. 1. Average of pH and Turbidity

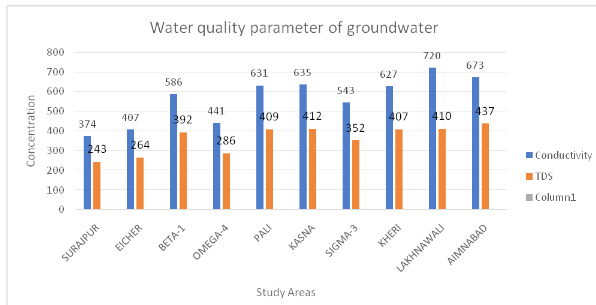

Fig. 2. Average of Electrical Conductivity (EC) and Total Dissolved Solid (TDS)

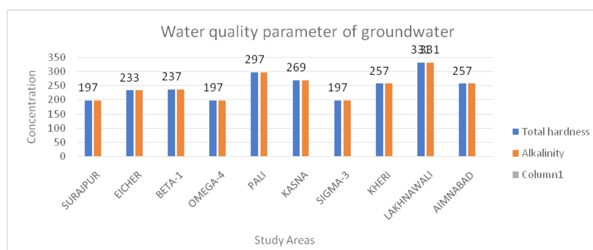

Fig. 3. Average of Total Hardness and Total Alkalinity

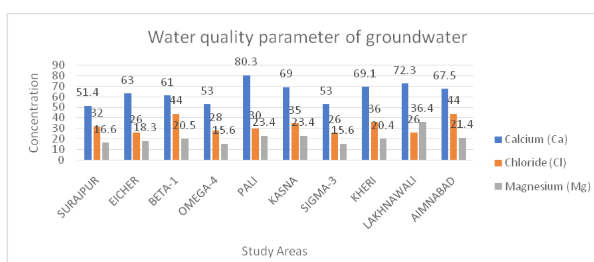

Fig. 4. Average of Calcium (**Ca**), Chloride (**Cl**) and Magnesium (**Mg**)

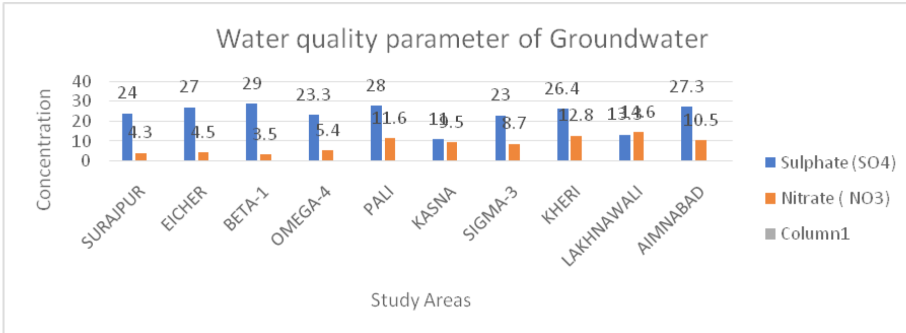

Fig. 5. Average of Sulphate (SO_4) and Nitrate (NO_3**)**

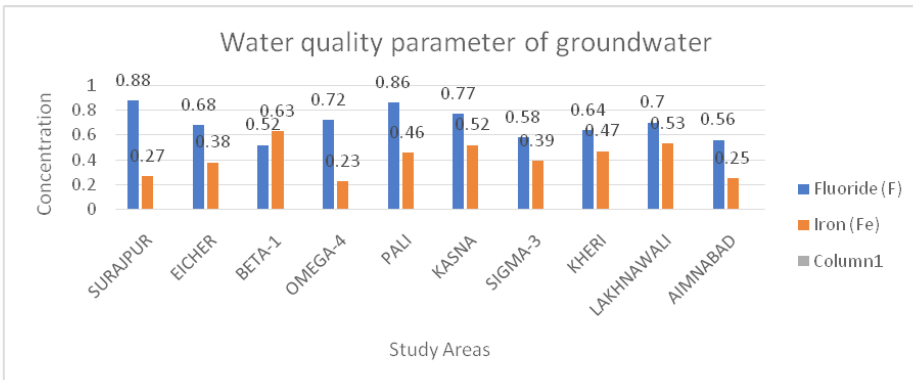

Fig. 6. Average of Fluoride (F) and Iron (Fe)

DISCUSSION

Turbidity

Turbidity was observed at SURAJPUR at a minimum of 0.0 NTU and at EICHAR a maximum of6 NTU. All the chosen stations were found to comply with the restriction established by BIS (5 NTU).

pH

The pH range that was found was between 7.3 and 7.69. At KASNA, the value was found to be 7.3, whereas at OMEGA-4, it was observed to be 7.69. The permitted limit set by BIS was found to be present at all the chosen locations (6.5-8.5).

Conductivity of electricity (EC)

The amount and type of ions present in the solution affect the electric conductivity of water, which is the ability of water to transfer an electrical current. The total EC was measured to be between 374 and 720 mg/l. The lowest value, 374 mg/l, was recorded at SURAJPUR, and the highest value, 720 mg/l, was recorded at LAKHNAWALI. All the chosen stations were discovered to be under the BIS-specified acceptable level (800 mg/l).

Total Dissolved Solid (TDS)

is a term that refers to both ionised and nonionized materials. The total dissolved solids were found to be between 243 and 437 mg/l. At SURAJPUR, the value was recorded as being 243 mg/l, whereas at AIMNABAD, it was recorded as being 437 mg/l. All the chosen stations were discovered to be within the BIS-specified acceptable level (2000 mg/l).

Total Hardness

The overall hardness was discovered to be between -197 and 331 mg/l. The bare minimum was 197 mg/l in SURAJPUR, and the highest concentration was 331 mg/l at LAKHNAWALI. All the chosen stations were discovered to be under the BIS-specified acceptable level (600 mg/l).

Alkalinity

The total alkalinity was discovered to be between 197 and 331 mg/l. The lowest value was 197 at SURAJPUR, and the highest value was 331 mg/l at LAKHNAWALI. All the chosen stations were discovered to be under the BIS-specified acceptable

Table 2.

S. No	Parameters	Limits as Per IS 10500: 2012 Desirable	Permissible	Surajpur	Eicher	Beta – I	Omega – IV	Pali	Kasna	Sigma – III	Kheri	Lakhnawali	Aimnabad
	Ground Water												
	Chemical Testing			Test Results									
1.	Color (Hazen)	5	15	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
2.	Turbidity (NTU)	1.0	5.0	<1	6	4	<1	3	2	1	2	3	3
3.	pH at 25^0c	6.5- 8.5	NoRelaxation	7.53	7.4	7.26	7.69	7.49	7.3	7.43	7.33	7.41	7.33
4.	TDS (mg/l)	500	2000	243	264	392	286	409	412	352	407	410	437
5.	Alkalinity (mg/l)	200	600	197	233	237	197	297	269	197	257	331	257
6.	Calcium (as Ca) (mg/l)	75	200	51.4	63	61	53	80.3	69	53	69.1	72.3	67.5
7.	Chloride (as Cl) (mg/l)	250	1000	32	26	44	28	30	35	26	36	26	44
8.	Conductivity (µS/cm)	-	-	347	407	586	441	631	635	543	627	720	673
9.	Total Hardness (mg/l)	200	600	197	233	237	197	297	269	197	257	331	257
10.	Magnesium (as Mg) (mg/l)	30	100	16.6	18.3	20.5	15.6	23.4	23.4	15.6	20.4	36.4	21.4
11.	Sulphate (as SO_4) (mg/l)	200	400	24	27	29	23.3	28	11	23	26.4	13.3	27.3
12.	Nitrate (as NO_3) (mg/l)	45	NoRelaxation	4.3	4.5	3.5	5.4	11.6	9.5	8.7	12.8	14.6	10.5
13.	Fluoride (as F) (mg/l)	1.0	1.5	0.88	0.68	0.52	0.72	0.86	0.77	0.58	0.64	0.70	0.56
14.	Iron (as Fe) (mg/l)	0.30	NoRelaxation	0.27	0.38	0.63	0.23	0.46	0.52	0.39	0.47	0.53	0.25
	Microbiological analysis			Test Results									
15.	Total coliform (MPN/100ml)	Absent	No Relaxation	A	A	A	A	A	A	A	A	A	A
16.	E. coli (MPN/100ml)	Absent	No Relaxation	A	A	A	A	A	A	A	A	A	A

A: Absents

level (600 mg/l).

Calcium (Ca)

were discovered to range from 51.4 to 80.3 mg/l. The lowest value was 51.4 mg/l in SURAJPUR, and the highest was 80.3 mg/l in PALI. All the selected stations were found to be within the permissible range (75-200 mg/l) set forth by BIS).

(Cl) chloride

Chloride levels were determined to be between 26 and 44 mg/l. The lowest value, 26 mg/l, was recorded at EICHER, and the highest value, 44 mg/l, was recorded at AIMNABAD. Each of the chosen stations was found to be within the BIS-approved allowable limit of 1000 mg/l.

Magnesium

Magnesium levels were determined to be between 15.6 and 36.4 mg/l. At OMEGA-4 and SIGMA-3, the lowest value was recorded at 15.6 mg/l, and at LAKHNAWALI, the highest value was recorded at 36.4 mg/l. All the chosen stations were discovered to be within the BIS-specified acceptable level (30-100 mg/l).

Sulphate

The sulphate concentration was between 23 and 29 mg/l. The lowest result was 23 mg/l at SIGMA-3, and the highest value was 29 mg/l at BETA-1. All the chosen stations were discovered to be within the BIS-prescribed acceptable limit (400 mg/l).

The nitrate

The nitrate level ranged from 3.5 to 14.6 mg/l. At BETA-1, the value was found to be 3.5, and at LAKHNAWALI, it was found to be 14.6 mg/l. All the selected sites were found to be below the 45 mg/l acceptable level set by BIS.

Iron

The iron concentration was 0.23 to 0.63 mg/l. OMEGA-4 had the lowest value, 0.23, while BETA-1 recorded the highest, 0.63 mg/l. All the chosen stations were discovered to be within the BIS-specified acceptable level of 0.30 mg/l.

The fluoride element

The range of fluoride concentrations was found to be 0.52 to 0.88 mg/l. The value ranged from 0.52 at BETA-1 to 0.88 mg/l at SURAJPUR, with 0.52 being the lowest result. It was found that none of the selected stations exceeded the BIS-mandated permissible limit of 1.5 mg/l.

CONCLUSION

The research of physical, chemical, and biological (physic-chemical and microbiological) parameters of ground water quality at various places in the Greater Noida Gautam Buddha Nagar UP area used a total of 10 groundwater samples. The study's findings show that every test for ground water quality was within the BIS-recommended limit.

Suggestions and Recommendations

It is crucial to regularly check the quality of drinking water, especially in urban areas where there is rapid population growth and no other source of drinking water besides the ground. This is because unsafe drinking water is a problem that affects families in rural and economically disadvantaged areas of society. Additionally, a campaign should be launched to raise people's knowledge of the effects of contaminated water on health.

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