ISSN 2063-5346

EVALUATION OF PHYSICOCHEMICAL PARAMETERS OF GROUND WATER IN RAIPUR DISTRICT, CHHATTISGARH, INDIA

Jagriti Dewangan[1] , Priyanka Gupta[2]
[1, 2] Department of Chemistry, Kalinga University, Naya Raipur, Chhattisgarh
Mail id: [1]jagriti.s.d.10gmail.com,[2]priyanka.gupta@kalingauniversity.ac.in

Article History: Received: 03.04.2023 **Revised:** 13.05.2023 **Accepted:** 23.06.2023

Abstract
The chemical and physical characteristics of groundwater determine its potential for agricultural, industrial, and in implements, thus groundwater assessment of vital quantity. A vital natural resource is water. In supporting life and the environment, but exploitation has cause the water's quality to fail in the past decade. When the end point is sustainable development which keeps humankind at the center, a crucial topic for research is water quality. Over 94% of the demand of drinking water is met by groundwater, so it is the case in both urban and rural locations. The study's findings were that ground water quality was purpose and availability for human use in the majority of rural Raipur District Chhattisgarh State India. The intent of the present (2022–2023) study was to identify the physicochemical elements in ground water at eight different sampling sites. In the months of December and January, groundwater samples were taken at eight different locations throughout the Raipur district. The samples were tested in the laboratory. Turbidity, Total hardness, Alkalinity, Chloride, Electrical Conductivity, and TDS the traits analyzed. pH demonstrates that groundwater is not usually alkaline. The WHO set limits for turbidity, DO, BOD, and COD were found had been above. Observed chemical values for a variety of properties in samples of water were contrasted with the minimum standards the WHO recommends for human consumption to ascertain the degree of deterioration. The variation in water quality in the research area is most likely caused by sewage and industrial effluents.

Key words: Ground water. Physicochemical parameters, water quality.

1. Introduction
Water is regarded as a crucial element in the ecosystem. In addition to urbanisation and industrial expansion since the 1990s, poisoning of all water bodies has played a significant influence in the world's population growth rates (Gupta et.al 2022).Organic and inorganic contaminants, toxic elements, and non-dissolving compounds are among the toxins found in sewage(Meher et.al 2023). Water scarcity is a global concern, and wastewater treatment is becoming increasingly important to meet the growing demand for freshwater (Tileshwari et. al 2023). Human diseases are brought on by dirty, unimproved water sources, poor sanitation practices, and poor drinking water quality. (Prüss-Ustün et al.2019). The primary supply to water to drink is underground, agricultural, or commercial uses. Surface and subterranean water quality has declined due to the growing

population and its needs(Dhiviyaa Pranavam,et. al. 2011). Because the public is the main first to benefit from clean and safe water supply feel in effects the declining water quality of World Health Organization recognizes of significance the public engagement the monitoring of the quality of drinking water (WHO, 2011) Drinking water and the presence or absence of health concerns the length about various health problems; as well as how widely the public is aware of the situation all influence public views of drinking water health risks. (Doria et.al.2010). Public perceptions of water quality issues play a significant impact in shaping health-seeking habits and practices (Slagle et.al. 2015) (Bhambulkar, 2011).Water supplies, particularly unimproved sources, are contaminated not just as a consequence of anthropogenic activities, as value but also a result of natural processes like flooding, the climate, and the deterioration of the parent material, the topography, and others.(Vadde et.al. 2018).

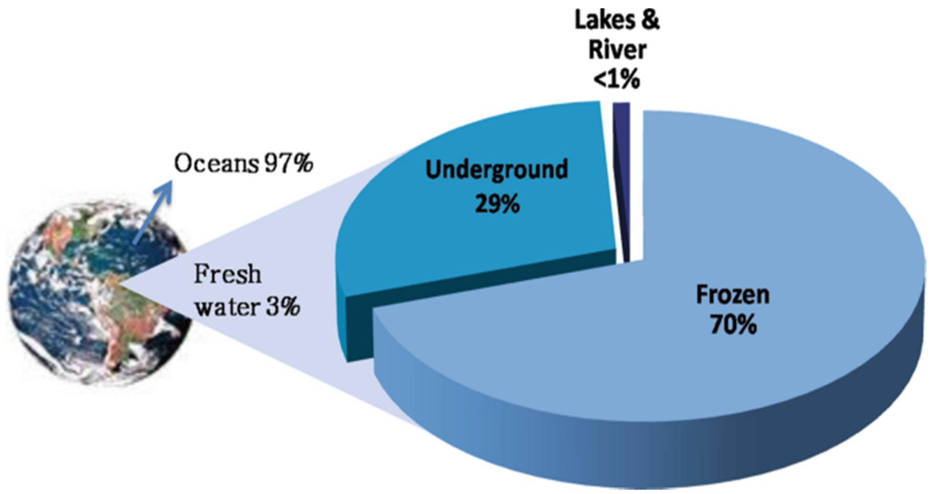


Fig 1 Global water resources (Ayyam et al. 2019)

Chhattisgarh villages in the Raipur district are distinguished by several varieties of basement complex formations. Even though there are now no significant industries in or close to the study region, municipal sewage and residential waste are nonetheless dumped there. Since groundwater is frequently used to furnish drinking water without any biochemical processing, the degree of pollution has become a major source of worry. Industrial activities, agriculture, and the disposal of waste are examples of anthropogenic sources.(Jurri et.al 2023). Drinking water should be free of dangerous compounds, living and non-living animals, and a high concentration of potentially harmful minerals. With this in mind, the general water quality of the ground water in Chhattisgarh's Raipur area was investigated (Istifanus et al. 2013).For the most effective attempts of the government and non-governmental organizations, a substantial number of water supply plans remain inadequate, requiring users to collect drinking water from undeveloped sources, posing health risks and lowering productivity. Additionally, families are hesitant to fetch water from unimproved sources due to discontent, inadequacy, income, distance, and lengthier waiting times. (Addisie et al. 2021).

Water is absolutely necessary for all living things to survive. Quality of the world's water is a crucial problem for the humanity because it is directly tied to people's welfare.(Patil et.al. 2010). Among the most vital components of life is water, and having access to excellent water is essential crucial to raising standard of living. The quantity, quality, and use of water are significantly impacted by the rapid growth in anthropogenic population as well as expanding industrial, agricultural, and forestry activities. Only 2.5% of the world's water supply comes from freshwater sources, and there is concern that in the near future, good-quality water may become limited.

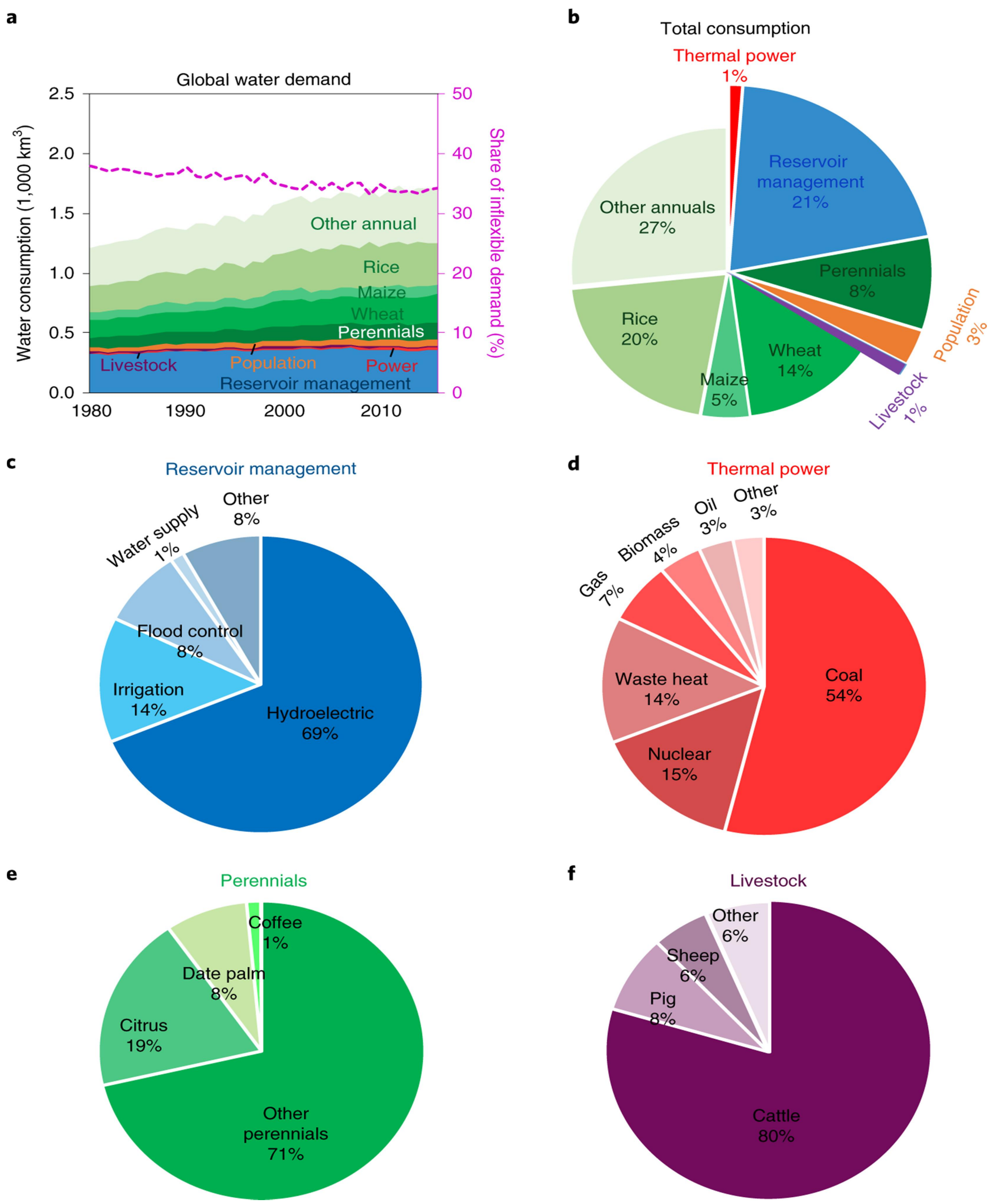


Fig. 2 | Global and sectoral water consumption. a, Historical inflexible water consumption from reservoir management (blue), thermal power generation (red), livestock (purple), human population (orange) and perennial crops irrigation (dark green), as well as flexible irrigation water consumption from annual crops (wheat, maize, rice and other annual crops; light green). b, 2016 percentage contributions of flexible (smaller pie) and inflexible (bigger pie) water consumption to global total water consumption. c–f, 2016 inflexible water consumption from reservoir management by

main dam purposes (c), thermal power generation by fuel types (d), irrigated perennials by crop types (e) and livestock by species (f).(Qin et.al. 2019)

The physicochemical properties of water are used to evaluate its quality characteristics of the groundwater are crucial. Consequently, it is crucial to examine drinking water. In addition to the physicochemical characteristics, there are a few more concerning groundwater quality criteria. The impacts indicated by many companies have been worrying, and the presence of poisonous metals generated significant difficulties in unique areas of the arena. The term "heavy metals" refers to the classification of metals and metalloids having atomic densities larger than 4 g/cm3.(Gupta et al. 2021).

Table -1 The WHO and NDWQS acceptable limits to assess drinking water quality (Rahmanian et al. 2015)

Parameter	WHO limits	NDWQS limits
Ph	6.5-8.5	6.5-9
Conductivity (μS/cm)	—	1000
Turbidity (NTU)	5	—
TSS (mg/L)	—	25
TDS (mg/L)	1000	1000
Cu (mg/L)	2	1
Zn (mg/L)	None	3
Mg (mg/L)	None	150
Fe (mg/L)	0.3	0.3
Cd (mg/L)	0.003	0.003
Cr (mg/L)	0.05	0.05
Pb (mg/L)	0.01	0.01
As (mg/L)	0.01	0.01
Hg (mg/L)	0.006	0.001
Sn (mg/L)	—	—

Table 2 Physicochemical parameters with their health impact (Saravanakumar et. al 2011)

Parameters of water analysis	BIS Guideline values (Max. allowable)	Potential health effects	Reference
Temperature	-	-	Ref.4,5 and 8
pH	6.5-8.5	corrosive; damages mucous membrane; harsh flavor	Ref.4,5 and 8
Total Alkalinity	600 mg/l	boiled rice becomes yellow	Ref.4,5 and 8
Total Hardness	600 mg/l	scale formation, poor soap lathering, and declining clothing quality	Ref.4,5 and 8
Chloride	1000 mg/l	Impacted flavor; corrosion	Ref.4,5 and 8
Sulphate	400mg/l	Gastrointestinal discomfort and altered taste	Ref.4,5 and 8

Fluoride	1.5 mg/l	Fluorosis of the teeth and skeleton; non-skeletal symptoms	Ref.4,5 and 8
Total Dissolved Solids	200 mg/l	unpleasant flavor, digestive, corrosive, or incrustation	Ref.4,5 and 8

2. Materials and Methods

2.1Study area

Raipur is located near the center of the vast and fertile Chhattisgarhi plain. Situated between 22°33'N and 21°14'N latitude and 82°6'E to 81°38'E longitude, it is surrounded by Bilaspur in the north, Durg in the west , Bastar in the south and Raigarh in the east. These consist of eight samples of hand-pumped water taken from villages in India's Chhattisgarh State's Raipur District. Samples were gathered in order to monitor and evaluate the quality.

2.2 Sample Collection:

All samples were accrued in sterilized acid-washed polyethylene terephthalate (PET) bottles and straight away transported to the laboratory. Before sample taking, all the bottles of sampling were soaked into 10 % solution of Nitric acid .Bottles were correctly cleaned before being used to collect the sample. The months of December and January 2022-2023 saw the collection of water samples from eight different locations.

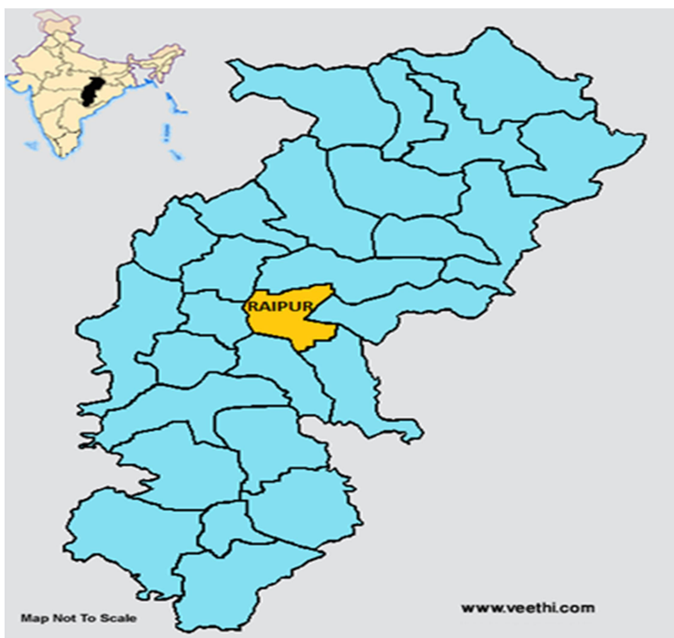


Fig-3 Map of Study area Raipur District

Fig 4 Water samples collected from various locations

3. Assessment of Water Quality

To examine the chemical and physical features of the water specimen's standard procedures were employed. Physical criteria included color, odour, pH, and conductivity of electrical current, Total Dissolved Solid, Turbidity, and Total Hardness. Calcium, Sulphates, Chloride, Nitrates, Copper, Nickel, Lead, Chromium, Zinc, and Cadmium are all constituents. The collected water samples underwent analytical testing for a number of Some of the characteristics that can be measured are pH, Temperature, Turbidity, COD, BOD, DO, Conductivity, Total Dissolved Solid, Alkalinity, Sulphate, Nitrate, and Phosphate parameters measured.(Jingxi Ma et.al. 2020).Using a pH meter calibrated with buffer pH of 4.7 and 7.0, the potential hydrogen (pH) was measured. A conductivity meter was used to determine the electrical conductivity of the water samples and a potassium chloride (KCl) standard, and the turbidity of the samples was assessed using a calibrated turbid meter. With the use of a Lovibond comparison disc, the colour was determined. The alkalinity was assessed using titrating with 0.02M HCl while using phenolphthalein indicator solution is the titrimetric method. Utilizing a calibrated dissolved oxygen meter with the temperature and DO probes submerged in the sample, the amount of dissolved oxygen was calculated. After incubation for five days, the biological oxygen demand (BOD) was calculated. (Adewoye et.al.2013)The argentiometric method was used to determine the amount of chloride, and the brucine method was used to determine the amount of nitrate. The turbid metric method and the colorimetric method were used, respectively, to determine the concentrations of sulphate.

Table 3 Methods used to estimate various physicochemical characteristics (Saravanakumar et. al 2011)

Parameters	Method
Temperature	Thermometer
pH	pH Meter
Total Alkalinity	Titration
Total Hardness	EDTA Titration
Turbidity	Turbidity Meter
Chloride	Silver Nitrate Method
Sulphate	Turbidometric Method
Fluoride	Ion Selective Electrode
Total Dissolved Solids	Conductivity Meter

Conductivity	Conductometry

4. Results and Discussion

4.1Physicochemical water quality

Total Hardness: Bicarbonate, chloride, and dissolved sulphate levels that are too high in water cause it to become hard. Total hardness levels varied from 252 mg/l to 304 mg/l and was identified as being in the WHO's allowable limit. Some classifications classify water with a hardness up to 75 ma/l as soft, while water with a hardness between 76 and 150 mg/l as moderately hard. Sample F contained both the lowest and greatest hardness values, 1500 and 6850, respectively.

Total Alkalinity: The total alkalinity is a gauge of water's acid-neutralizing power. As the concentration of dissolved carbonate and bicarbonate rises, alkalinity rises as well. Groundwater has an alkalinity level that is identical to mg/l. Without alkalinity, the overall alkalinity value for all samples. The total alkalinity of water is a measure of how well it can neutralize acids. Alkalinity increases along with dissolved carbonate and bicarbonate concentration. Alkalinity levels are equivalent to mg/l in groundwater. When there is no alkalinity, the average alkalinity scores across all samples.

Chloride: Chloride levels in unpolluted waters are often below 10 mg/L and sometimes below 1 mg/litre (4). Chloride in water may be considerably increased by treatment processes in which chlorine or chloride is used. Water with high chloride content contains organic waste, especially waste from animals. Concentrations of chloride ranged from 129 mg/l to 224 mg/l. All samples were confirmed to be under the WHO-permitted level.

pH: The pH of the water is one of the most important variables. The pH scale is used to detect whether the water is acidic or alkaline. If the pH of a sample is less below 7.0, it is considered acidic. It is alkaline if the pH is more than 7.0. Steel tubing and pipes can corrode when exposed to acidic water. Meanwhile, alkaline water disinfects water. According to WHO and NDWQS recommendations, All of these water-to-drink sample have pH levels ranging from 6.67 to 7.79, with samples D and C having the lowest and highest values.

Electrical Conductivity: Every medium's capacity to carry an electric current, in this case water is known as electrical conductivity. A water sample's ability to transport an electric current that is reliant on the presence of dissolved minerals such as calcium, chloride, and mg. Figure 6 shows a plot to all the Conductivity values measured in drinking water samples. 1000 S/cm is the maximum allowable conductivity level according to NDWQS. According to the findings, the average conductivity value for all water samples is 766 S/cm, and the measured conductivity ranges from 297 S/cm to 106 S/cm. In accordance with the samples B and F, the lowest and maximum conductivity values are found. Because dissolved solids, turbidity colloids, and other contaminants are removed using the reverse osmosis treatment method, this can be explained. Giving the water a cleaner, clearer appearance. The large variations in electrical conductivity of groundwater are unknown. discussed the variances based on many circumstances, agriculture and industrial activity, as well as land use, all have an impact on mineral concentrations and, as a result, the electricity conductance of the drinking water. The health of humans is directly impacted by conductivity. It is assessed for a variety of reasons, including determining mineralization (the presence of minerals like K, Ca, salt) and quantifying the quantity of chemical treatments required to purify the water. Superior conductivity reduces the water's aesthetic appeal and gives it a metallic taste. Conductivity of agricultural and industrial operations is being monitored and intensity the essential. Water with a high conductivity can corrode the faces and surfaces of machinery like boilers. Home appliances like washing machines and faucets can also use it. Excessive conductivity also destroys plant species that provide food and provide habitat.

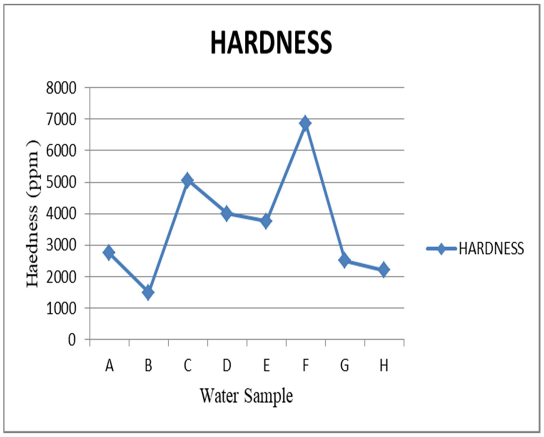
DO: Most aquatic creatures require free oxygen, or DO, for respiration, making dissolved oxygen the most crucial gas for them. Fish cannot survive in DO concentrations below 1 ppm; the majority of the fish population normally requires concentrations between 5 and 6 ppm. River water's average quality is indicated by the average value of DO levels (6.5 mg/l). 1.0 to 2.4 ppm was the range of DO concentrations in our investigation. For sample B, the DO values ranging from 1.0 to 2.4 were determined to be the lowest and highest, respectively.

BOD: According to the World Health Organization, water bodies should have a limit of fewer than 5.0 mg/l. BOD values range widely; generally, pristine waters have a value below 1 mg l^{-1}, moderately polluted waters 2–8 mg l^{-1}, and treated municipal sewage 20 mg l^{-1}. Standards for the discharge of effluent from WWTPs have the range 20–30 mg l^{-1} and require a minimum flow in receiving waters to ensure sufficient dilution. In our investigation, BOD levels varied between 2.4 and 3.0 ppm. Sample D had the lowest BOD reading of 2.4 and the highest reading of 3.0.

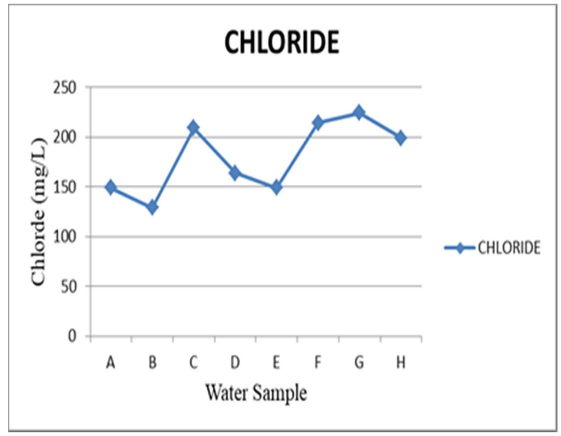
COD: The COD is well suited for the characterization of fairly polluted waters. Municipal wastewater consumes O2 in the range from 300 to 1000 mg. Organic chemicals that are resistant to life. The COD values in the current investigation ranged from 22.5 to 23.3 ppm. The amount of organic matter in water is determined by the COD measurement. Because of this, COD can be used to detect organic pollution in surface water. The COD test works well in conjunction with the BOD test to identify harmful situations.

Turbidity: Another important factor in the examination of drinking water is turbidity, which is water cloudiness caused by different particles. The presence of disease-carrying organisms in water that could be caused by soil discharge is also related to this issue. Figure 10 shows the turbidity values for each of the 8 water samples that were examined. 5 Nephelometric turbidity units (NTU) is the normal upper turbidity limit for drinking water that has been established by WHO and NDWQS. For the samples, the lowest turbidity value was 001 NTU and the maximum value was 010 NTU. The lowest turbidity readings were found in the supposedly purest water was mineral water. The results reveal that none of the examined samples had turbidity levels higher than the permitted upper limit of 5 NTU. Due to the filtration mechanism that a RO dispenser machine has, which is equipped to assure effective removal of undesirable materials and organisms from turbid water, water from the It is also expected that the machine would have a low turbidity value.

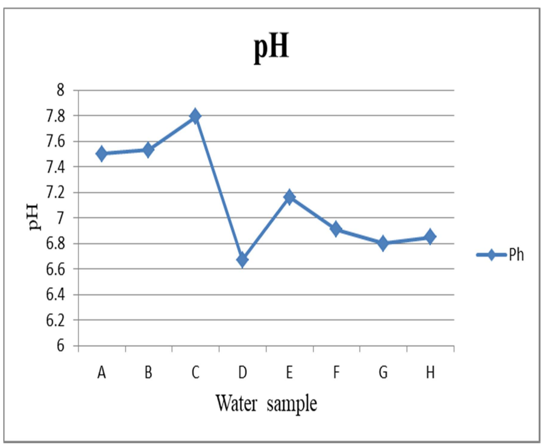
Sulphate (SO_4^{2-}): The concentration of sulphate that is naturally present in water varies greatly, mostly when it comes into contact with gypsum or other common minerals. Its concentration tends to rise with the release of residential sewage and industrial garbage. The levels of SO4 3-A to J for the current investigation were 012 to 088, respectively. Additionally, the tested readings fell within the SON standard range of 100 mg/L. In terms of its sulphate concentration, this result further supports the spring water's suitable for drinking and other home purposes. Sample D had the lowest sulphate result, 012, and the highest value, 088.


HARDNESS
Haedness (ppm)
8000
7000
6000
5000
4000
3000
2000
1000
0
A B C D E F G H
Water Sample
HARDNESS

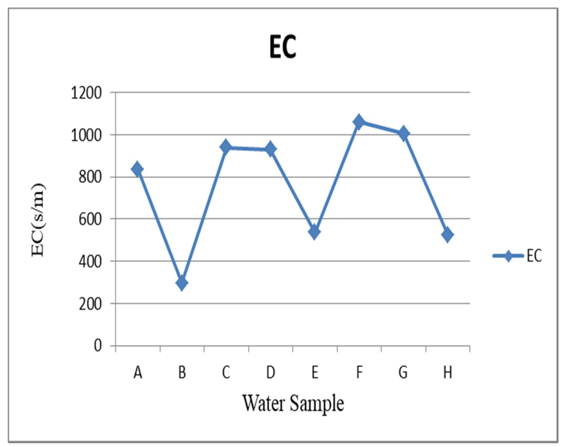
(a)


CHLORIDE
Chlorde (mg/L)
250
200
150
100
50
0
A B C D E F G H
Water Sample
CHLORIDE

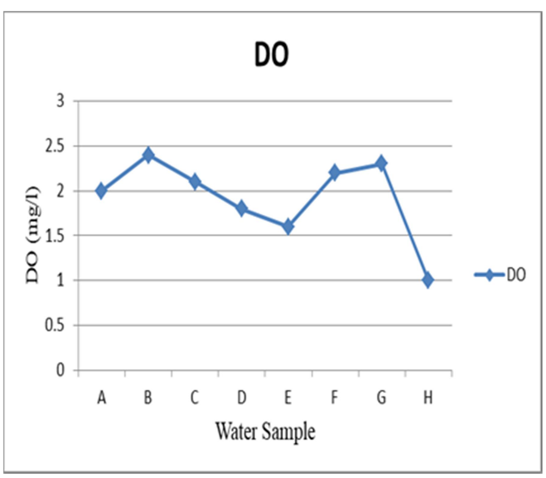
(b)


pH
pH
8
7.8
7.6
7.4
7.2
7
6.8
6.6
6.4
6.2
6
A B C D E F G H
Water sample
Ph

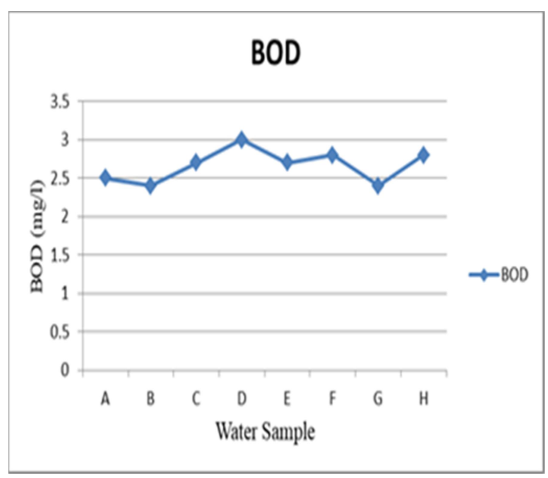
(c)


EC
EC(s/m)
1200
1000
800
600
400
200
0
A B C D E F G H
Water Sample
EC

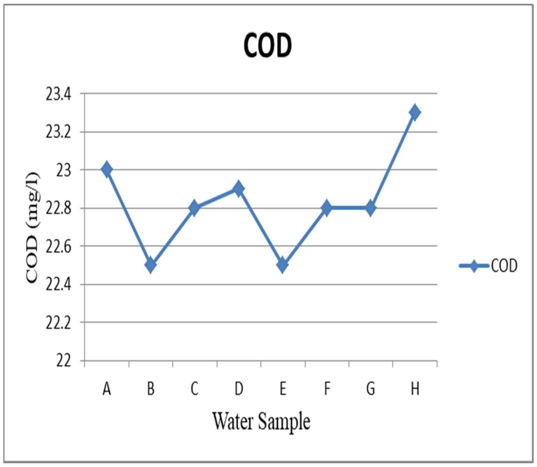
(d)


DO
DO (mg/l)
3
2.5
2
1.5
1
0.5
0
A B C D E F G H
Water Sample
DO

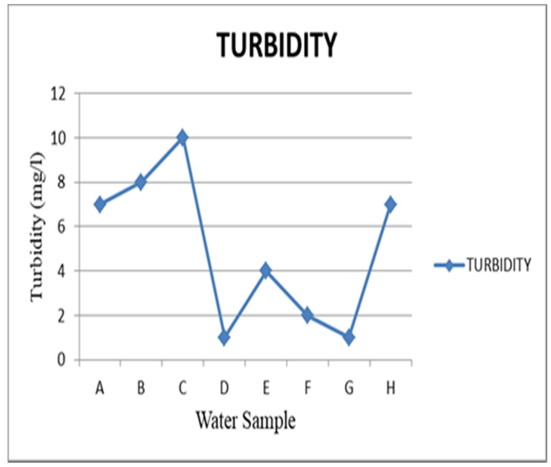
(e)


BOD
BOD (mg/l)
3.5
3
2.5
2
1.5
1
0.5
0
A B C D E F G H
Water Sample
BOD

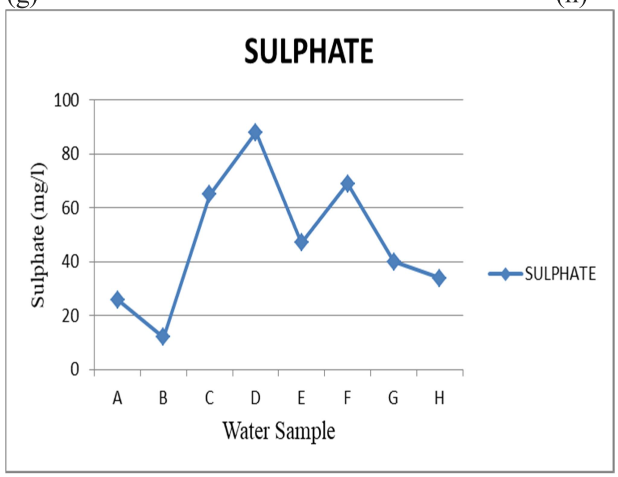
(f)



(g)



(h)



(i)

Fig 5 Graphical representation of different Physicochemical parameters values a) Total Hardness b) Chloride c)pH d) Electrical Conductivity e) DO f) BOD g) COD h) Turbidity i) Sulphate

Table 4 Water quality parameters of groundwater of research area

Sample	**Hardness (mg/l)**	**Alkalinity (mg/L)**	**Chloride (mg/L)**	**pH**	**EC (µS/cm)**	**DO (mg/L)**	**BOD (mg/L)**	**COD (mg/L)**	**Turbidity (NTU)**	**Sulphate (mg/l)**
A	2750	BDL	149	07.5	836	2.0	2.5	23.0	007	026
B	1500	BDL.	129	07.53	297	2.4	2.4	22.5	008	012
C	5050	BDL	209	07.79	940	2.1	2.7	22.8	010	065
D	4000	BDL	164	06.67	929	1.8	3.0	22.9	001	088

E	3750	BDL	149	07.16	536	1.6	2.7	22.5	004	047
F	6850	BDL	214	06.91	1061	2.2	2.8	22.8	002	069
G	2500	BDL	224	06.80	1006	2.3	2.4	22.8	001	040
H	2200	BDL	199	06.85	524	1.0	2.8	23.3	007	036

Conclusion

The significance of using visually appealing characteristics and water quality indicators for measure the purity of water for the well-being of people cannot be underestimated. Utilizing families' opinions about the water quality, visual characteristics like color, odor, and taste were assessed. It was discovered that flavor was the primary indication of water quality. The likelihood of rejecting better water supplies for drinking reasons rose because of the taste. It was unexpected to see that the perceptions and laboratory data produced the same results. Despite the fact that some individuals dislike chlorination, the only sources of water that exceed standards for water quality are those that include chlorine. All water sources have been contaminated by total and faecal coliforms, with the exception of tap water, which is well-treated.In the study area, total eight groundwater samples (from bore wells) had been taken and analysed for their physicochemical parameters. The analytical effects of physicochemical properties have been as compared with the usual tenet values recommended via the WHO and BIS for consuming purposes. The physicochemical evaluation indicated that DO values ranging from 1.0 to 2.4 were determined to be the lowest and highest, respectively and Hardness (ranges from 252 mg/L to 304 mg/L).Similarly other parameters like pH, conductivity, D.O., BOD, COD, turbidity and sulphate of all groundwater samples values are within the range and meet WHO criteria. So, the results of the present study useful in assessment of the water quality parameters and will be valuable database for future estimations of the impact of the water pollution.

References

1. Addisie, M. B., Gelaye, T. Y., & Teshome, W. M. (2021). Households' reluctance to collect potable water from improved sources, Ethiopia. Journal of Water Supply: Research and Technology-Aqua, 70(6), 868–878.
2. Adewoye S. O, Adewoye A.O, Opasola O.A and Elegbede J.A.(2013), "Physicochemical Parameters And Heavy Metal Analyses Of Water Samples From Hand Dug Wells In Gambari, Ogbomoso," Oyo State, Journal Of Environmental Science, Toxicology And Food Technology , Volume 5, Issue 1, PP 22-30
3. Ayyam, V., Palanivel, S., Chandrakasan, S. (2019). Water Resources and the Changing Needs. In: Coastal Ecosystems of the Tropics - Adaptive Management. Springer, Singapore. https://doi.org/10.1007/978-981-13-8926-9_8.
4. Bhambulkar, A., V., (2011). Effects of leachate recirculation on a landfill. Int J Adv Eng Sci Technol,11(2), 286-291.
5. Chindo, Istifanus Y., Karu,E., Ziyok I., Ephraim D. Amanki E.D., (20123) "Physicochemical Analysis of Ground Water of Selected Areas of Dass and Ganjuwa Local Government Areas, Bauchi State, Nigeria." World

Journal of Analytical Chemistry 73-79, Volume 1, Issue 4

6. Dhiviyaa Pranavam T.S, Venkatesa Rao T, Punithavathi L, Karunanithi S and Bhaskaran A., (2011)," Groundwater pollution in the Palar Riverbed near Vellore, Tamil Nadu, India. Indian J. Sci. Technol. 4 (1), 19-21.
7. Doria, M., (2010). "Factors influencing public perception of drinking water quality." Water Policy 12, 1–19
8. Gupta ,P., and Tamrakar G., (2022), "HEAVY METAL POLLUTION IN GROUND WATER ANALYSIS IN CHHATTISGARH," JOURNAL OF EAST CHINA UNIVERSITY OF SCIENCE AND TECHNOLOGY VOL.65 ISS. 2, DOI: 10.5281/ZENODO.6782739.
9. Gupta, P., and Tamrakar G., (2022), "HPTLC Determination of Diazinon and Malathion Residues in water sample of Northern Bastar Area of Chhattisgarh," NeuroQuantology ,Volume 20 | Issue 6 | Page 4881-4886 | doi: 10.14704/nq.2022.20.6. NQ22489
10. Gupta, P., and Tamrakar G.,(2022) "Recent Advanced Techniques for the detection of Heavy
11. Gupta,N., Yadav,K.K., Kumar,V., and Singh,D.,(2013). "Assessment of Physicochemical Properties of YamunaRiver in Agra City." International Journal of Chem Tech Research, Vol.5, No.1, pp 528-531,
12. Gupta,P., and Tamrakar,G.,(2022), "HEAVY METAL POLLUTION IN GROUND WATER ANALYSIS IN CHHATTISGARH" Journal of East China University of Science and Technology, 65(2), 608–610.
13. Gupta,P., Biswas,S.,Tamrakar G., (2021) Comprising Analysis of Heavy Metals & Physicochemical properties in Ground Water of Northern Bastar Area of Chhattisgarh, India, Bulletin of Environment, Pharmacology and Life Sciences, Vol 10 [10] ,246-251
14. Iram, S., Kanwal, S., Ahmad, I., Tabassam,T., Suthar,V., & Mahmood-ul-Hassan M., (2013). Assessment of physicochemical parameters of wastewater samples. Environmental Monitoring and Assessment,185, 2503–2515 https://doi.org/10.1007/s10661-012-2727-5
15. Jindal, R., Sharma, C. (2011). "Studies on water quality of Sutlej River around Ludhiana with reference to physicochemical parameters." Environ Monit Assess, 174, 417–425 https://doi.org/10.1007/s10661-010-1466-8
16. Jurri,V.,and Gupta,P.,(2023), "POTENTIAL TOXICITY AND HUMAN HEALTH RISK ASSESSMENT OF HEAVY METALS IN SOIL OF CHHATTISGARH, INDIA, European Chemical Bulletin. 12, 726-734, DOI: 10.31838/ecb/2023.12.s1.077
17. Kumar,P., Srivastava,S.,Dwivedi,K., Sharma,S.,Chauhan,B.S.,Jain,S., , Gupta,P.,(2023) "IMPACT OF HEAVY METAL CONTAMINATION ON HUMAN HEALTH", Eur. Chem. Bull. 2, 12(Issue 8),1366-1379.
18. Ma,J.,Wu,S.,Ravi Shekhar,N.V., Biswas,S., and,A.K., (2020) Determination of Physicochemical Parameters and Levels of Heavy Metals in Food Waste Water with Environmental Effects. Bioinorganic Chemistry and Applications, Volume 2020, https://doi.org/10.1155/2020/8886093

19. Meher,B., and Gupta,P.,(2023), "Nanotechnology's Potential for Detecting Heavy Metals in Water", Journal of Survey in Fisheries Sciences, Vol. 10 No. 2S, 3236-3249
20. metal ions in Water" YMER, VOL 11(1),2712-2722
21. Ochoo, B., Valcour, J., & Sarkar, A. (2017). "Association between perceptions of public drinking water quality and actual drinking water quality: A community-based exploratory study in Newfoundland (Canada)." Environmental Research, 159, 435–443.
22. Pandey, P.,(2022), "Synthesis of nano particle for sensing some pharmaceutical", Journal of east China university of science and technology, volume 65, page no. 200-211.
23. Patil, V. T., &Patil, P. R. (2010). "Physicochemical analysis of selected groundwater samples of Amalner town in Jalgaon District, Maharashtra, India."Journal of Chemistry, 7(1), 111–116.
24. Prüss-Ustün, A., Wolf, J., Bartram, J., Clasen, T., Cumming, O., Freeman, M. C. Johnston, R. (2019). Burden of disease from inadequate water, sanitation and hygiene for selected adverse health outcomes: An updated analysis with a focus on low- and middle-income countries. International Journal of Hygiene and Environmental Health. doi:10.1016/j.ijheh.2019.05.004
25. Qin, Y., Mueller, N. D., Siebert, S., Jackson, R. B., AghaKouchak, A., Zimmerman, J. B., Davis, S. J. (2019). Flexibility and intensity of global water use. Nature Sustainability. doi:10.1038/s41893-019-0294-2 10.1038/s41893-019-0294-2.
26. Rahmanian, N., Ali, S. H. B., Homayoonfard, M., Ali, N. J., Rehan, M., Sadef, Y., & Nizami, A. S. (2015). Analysis of Physiochemical Parameters to Evaluate the Drinking Water Quality in the State of Perak, Malaysia. Journal of Chemistry, 2015, 1–10. doi:10.1155/2015/716125N.
27. Reda, A. H., 2015,"Assessment of Physicochemical Quality of Spring Water in Arbaminch, Ethiopia,"Journal of Environmental Analytical, Volume 2 • Issue 5 • 1000157
28. Sahu,T.,and Gupta,P.,(2023) "Fabricationand Applicationof Nano fibersfor Enhanced Wastewater Treatment: A Review ",BioGecko, Vol 12 Issue 03,pp-2541-2545
29. Saravanakumar,K., and Ranjith R. K., (2011). "Analysis of water quality parameters of groundwater near Ambattur industrial area, Tamil Nadu, India." Indian Journal of Science and Technology, Volume: 4, Issue: 5, Pages: 660-662
30. Slagle, K.M., Wilson, R.S., Heeren, A., (2015) "Seeking, thinking, acting: understanding suburban resident perceptions and behaviors related to stream quality." J. Am. Water Resour. Assoc. 51, 821–832. https://doi.org/10.1111/jawr.12277
31. Vadde, K., Wang, J., Cao, L., Yuan, T., McCarthy, A., & Sekar, R. (2018). "Assessment of water quality and identification of pollution risk locations in Tiaoxi River (Taihu watershed), China. Water, 10(2), 183. https://doi.org/10.3390/w10020183