EPH - International Journal of Applied Science
ISSN (Online): 2208-2182
Volume 09 Issue 02 June 2023
DOI:https://doi.org/10.53555/eijas.v9i2.158

A STUDY ON ASSESSMENT OF GROUNDWATER QUALITY AND ITS SUITABILITY FOR DRINKING IN DUNGARPUR DISTRICT OF RAJASTHAN, USING STATISTICAL TECHNIQUES

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Abstract
Water supplies must be unusually pure, free of microbes and chemical pollutants, in order to be used for drinking and other domestic purposes. But because of rapid urbanisation and population increase, as well as ignorance of how to coexist peacefully with nature, water quality has declined, leading to water contamination. Because of this, pollution of water resources needs quick and significant intervention, as shown by routine water quality testing. In the Aspur and Sagwara blocks of the Dungarpur district, the current investigation was carried out to evaluate the quality of the ground water. In the pre-monsoon, monsoon and post-monsoon seasons of the year 2020 and 2021, the randomly selected samples were gathered from several communities within the block. A variety of physico-chemical parameters, including pH, electrical conductivity, total dissolved solids, total hardness, chloride (Cl^-), fluoride (F^-), and nitrate (NO_3^-), were used to analyse the samples that were collected. Additionally, the one-way ANOVA test was used to determine the significance of the results. As a result, it was observed that almost parameters were obtained comparatively high in the pre-monsoon seasons, with the exception of pH and Total alkalinity. According to the one-way ANOVA test it was concluded that the research area's ground water is slightly polluted and unfit for drinking. The graphical display illustrates how the concentration of main ions varies over time between the pre-monsoon, monsoon and post-monsoon seasons.

Keyword: *Groundwater, Physico-chemical Parameters, Bar-graph, Groundwater Contamination One way ANOVA.*

INTRODUCTION

Water is a vital resource for all living beings on the planet. Water can be found as surface water in oceans, rivers, ponds, and glaciers as well as underground water beneath the earth's surface. The hydrological cycle, on the other hand, ensures that fresh water is constantly replenished. In the form of evapotranspiration, precipitation, and runoff, it regulates the temporal and spatial distribution of water. Ground water recharge is the natural or artificial process through which water percolates down the soil and reaches the water table. Ground water recharge amount and rate are inherently dependent on effective ground water resource management. Water is an important resource for industrial and economic growth. It's used for domestic, agricultural and industrial purpose. It also helps to keep the environment healthy. (Mishra and Pandey, 2008) In general, groundwater quality is defined by the aquifer's physiochemical characteristics and composition. The qualities of the soil and rocks in the aquifer media control this state. (Acheampong and Hess 1998; Foster *et al*. 2000; Raji and Alagbe 1997) Different hydrogeochemical processes influence the physicochemical features of groundwater, especially in the saturation zone. (Islam *et al.* 2017; Ahmed e*t al*. 2020; Bhuiyan *et al.* 2016)

Ground water is hidden resource and at present its purity and availability were taken for granted which is a serious issue. Contamination and scarcity are now major concerns. According to Parihar *et al.* (2012), ground water accounts for more than 95% of all fresh water available for use and approximately 95% of rural residents rely on ground water as it is an important source of water in regions where rainfall is scanty, surface water sources are less or absent, and all domestic and agricultural needs are fulfilled with groundwater.

Currently physico-chemical properties of groundwater is deteriorating around the world due to various activities such as land application of agricultural chemicals and organic wastes, infiltration of irrigation water, septic systems, and infiltration of effluent from sewage treatment plants, pits, lagoons, and ponds used for storage.

The current study conducted to focus on the problem of the people of study area, where they are facing problem related to availability of water and its quality, as ground water is the primary supply of water for human, agricultural and industrial uses. According to Upadhyay and Rai (2010) the availability of water influences the location and activities of humans in a given place, and our rising population is putting a strain on natural freshwater resources.

Aspur and Sagwara blocks are rural area of the district where most people rely on groundwater for domestic and agricultural purpose in the lake or absence of surface water sources. As an alternative, people use bore wells and hand pumps, and they drink ground water without any treatment which led to water related complications, which become a major concern. According to Chavan and Zambare (2014) toxic elements, living and non-living organisms, and excessive amounts of minerals in water may be harmful to health should be avoided in drinking water. Alternative sources of groundwater, such as hand pumps and bore wells, have seen their water quality deteriorate in recent years. Therefore, it is very essential to assess the quality of drinking water of study area.

Material and Methods

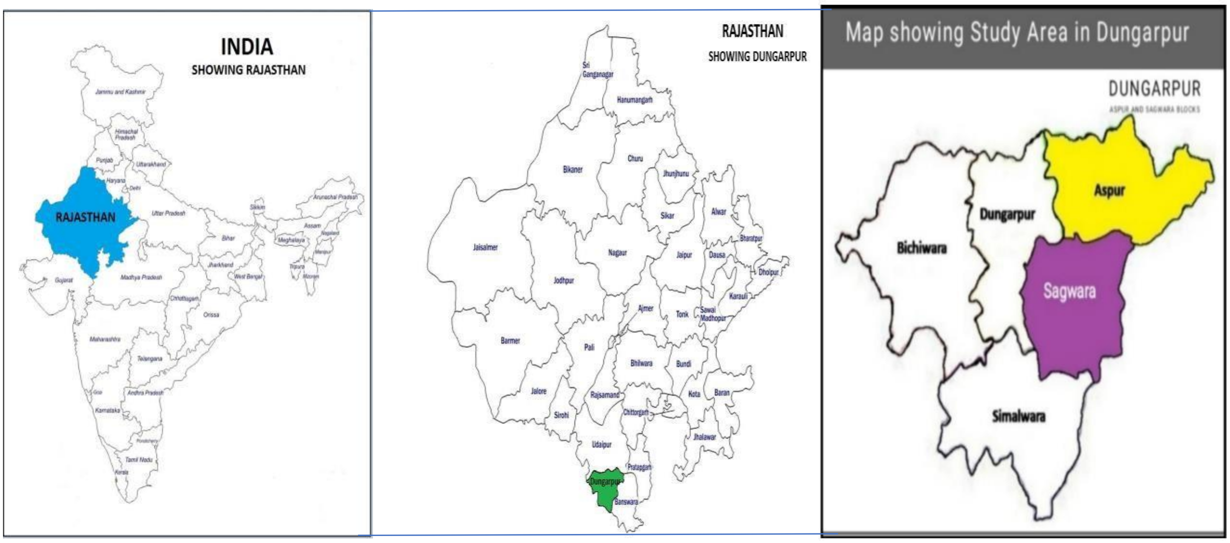

Fig. 1: Maps showing the study area in India, Rajasthan and Dungarpur.

Dungarpur district is third smallest district in Rajasthan, which is tribal rural area, situated in the southern part of Rajasthan and western part of India. The geology of the district belongs to pre–Cambrian Aravalli and district has semi-arid dry climate with a very hot summer season which receives an average annual rainfall of 761.7mm. It is located between 23.20' and 24.01'N latitude and 73.22' and 74.23'E longitude. It is bounded on north by Udaipur district and east by Banswara district, in its south and west has common border with Gujarat state. A major part of Dungarpur district is characterized by a rugged terrine, it has an area of 3781 sq. km and a population 1,388,906 (2011). There are five blocks in Dungarpur district Aspur, Bicchiwara, Dungarpur, Sagwara and Simalwara, out of which Aspur block is selected for present investigation.

Therefore, groundwater samples were randomly collected from hand pump and bore wells in acid washed new samplings bottles from 30 villages of Aspur and Sagwara blocks. All the collected samples were analysed for a period of two-year during pre-monsoon, monsoon and post monsoon seasons. The physico-chemical parameters were analysed as per the standard methods described in APHA (2017) The physico-chemical parameters like pH, electrical conductivity, Total alkalinity, Total dissolved solids, Total hardness, Chloride, Fluoride and Nitrate were analysed and each parameter was compared with standard values given by the BIS (1991) and WHO (1993). The one-way ANOVA test also applied to check the significance of the results.

Results and Discussions pH (potential of hydrogen ions) pH is the negative exponent of the concentration of H^+ ions. The pH value of water indicates the amount of hydrogen ions present in water.

In the present study pH value ranged between 6.84 to 7.90 in Sagwara block while in Aspur block it ranged from 6.87 to 7.61 which is within accepted range.

A one-way ANOVA test was also conducted for comparison of the pH value of both the blocks. The results of the one-way ANOVA test reveal that the mean value of pH with S.D. of water samples for Sagwara block is found to be 7.338 ± 0.206 and for Aspur block it is 7.366 ± 0.123. The mean difference is found to be 0.028 and the 't' value is 1.124, and p = 0.263 which is greater than 0.05. It infers that there is no significant difference in the pH value of Sagwara and Aspur blocks.

Table 1: ANOVA Test Applied for pH Parameter of Two Blocks

Blocks	N	Minimum	Maximum	Mean	Standard Deviation	Mean Difference	't' Value	'p' Value	Result
Sagwara	90	6.84	7.90	7.338	0.206	0.028	1.124	0.263	NS
Aspur	90	6.87	7.61	7.366	0.123				

In the graphical representation the bars of the graph do not show noticeable variation in both the blocks during 2020 and 2021, but seasonal variation is clearly observed. In the pre-monsoon season, the mean values of pH were found to be higher than in the monsoon and post-monsoon seasons.

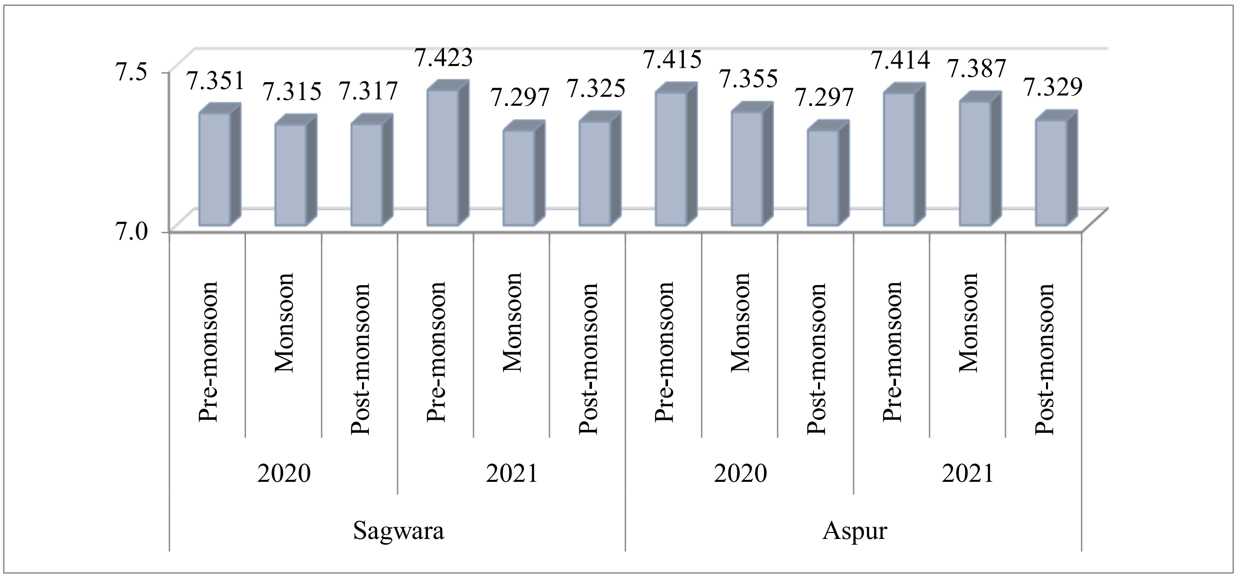

Fig. 2: The Mean Value of pH in Groundwater of Aspur and Sagwara Blocks During Different Seasons of Year 2020 and 2021

The non-significant result could be related to the both natural and anthropogenic factors like geology of catchment region (distribution of minerals bearing rocks that could enter the soil profile and groundwater), perception and evaporation pattern as well as mining, discharge of municipal, domestic trash and agricultural residue in to the groundwater Chandra *et al.* (1981), Largent (1961), and which could also cause a change in the soil characters according to Rao (2003). The amount of dissolved carbon dioxide, carbonates, and bicarbonates in the water can also influenced the pH of the water.

ELECTRICAL CONDUCTIVITY (EC)

Electrical conductivity is also a useful tool for determining groundwater quality. It's a numerical representation of a water sample's ability to transmit electrical current, which varies depending on the amount and type of ions present. The electrical conductivity of a water or soil sample is proportional to the amount of dissolved material in the sample.

Table 2: ANOVA Test Applied for Electrical Conductivity Parameter of Two Blocks

Blocks	N	Minimum	Maximum	Mean	Standard Deviation	Mean Difference	't' Value	'p' Value	Result
Sagwara	90	880	1920	1305.167	221.925	459.222	7.194	0.000	HS
Aspur	90	860	3200	1764.389	563.487				

In the present investigation, the electrical conductivity value of groundwater samples from Aspur and Sagwara blocks was analysed. The electrical conductivity ranged between 880 and 1920 umhos/cm with a mean ± S.D. at 1305.167 ± 221.925 in the Sagwara block, where as in the Aspur block it ranged from 860 to 3200 umhos/cm with a mean ± S.D. at 1764.389 ± 563.487. The results of conductivity were compared with the drinking water standards of BIS and WHO and it was found to be higher in both the blocks than the desirable limit proposed by BIS and WHO. The graphical representation of the statistical analysis is applied to compare the mean value of electrical conductivity of Aspur and Sagwara blocks in different seasons of the years 2020 and 2021.

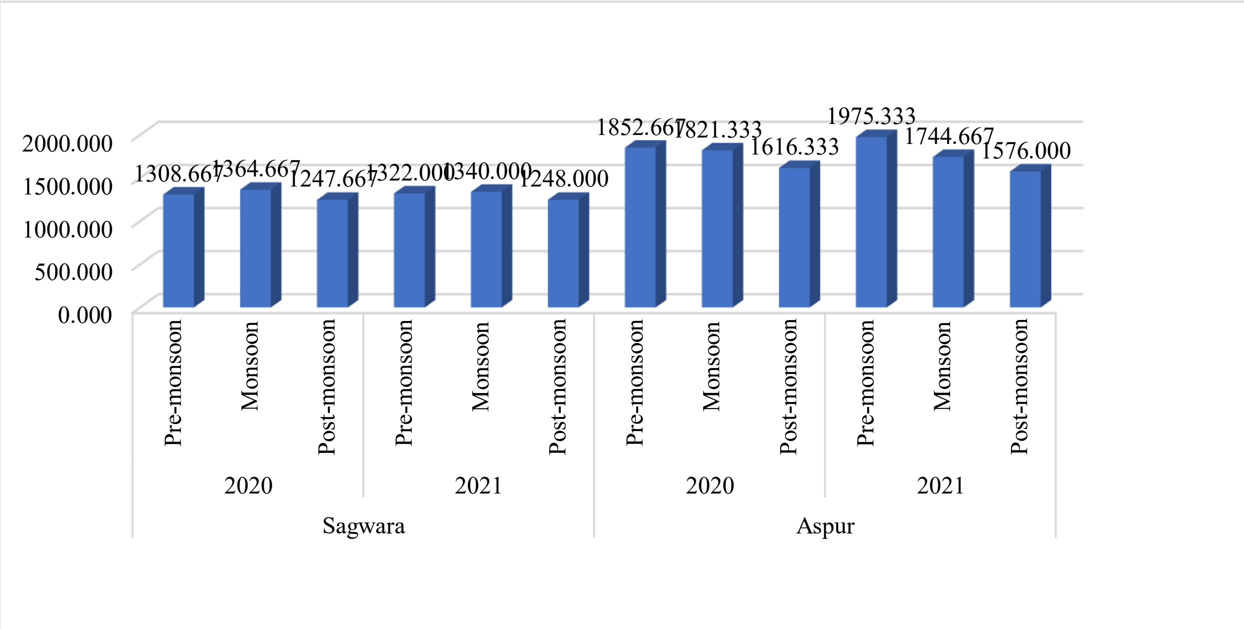

Fig. 3: The Mean Value of Electrical Conductivity in Groundwater of Aspur and Sagwara Blocks During Different Seasons of Year 2020 and 2021

The bars of the graph clearly show that the mean value of EC is comparatively higher in the Aspur block than in the Sagwara block. The graph also shows that the mean values of conductivity were found to be comparatively high in the pre-monsoon season in Aspur, while in Sagwara it was high during the monsoon season.

The results of the one-way ANOVA test showed a highly significant difference in the conductivity of Aspur and Sagwara blocks ($t = 7.194$, $p = 0.000$). Upadhyay and Rai (2010) discovered a positive and significant correlation of EC in their study.

Higher electrical conductivity values usually imply a higher dissolved salt concentration in river water Abdullah (1999). The fact that the finding is significant that indicates the salinity is high. The significant difference in mean values between blocks could be due to a variety of factors, including the geological composition of rocks, low precipitation and high evaporation patterns in the area, and the discharge of domestic, hazardous, and non-hazardous wastes Yadav *et al.* (2013).

Navale *et al.* (2018) noted seasonal change in the conductivity at Chembur in the Mumbai District's South Mumbai Region, according to them, salt content has increased due to evaporation, which is the main reason of high conductivity.

TOTAL DISSOLVED SOLIDS (TDS)

The total amount of organic and inorganic substances dissolved in water is known as the dissolved solids concentration. Although TDS isn't typically regarded as a major pollutant (i.e., it's not thought to have any negative impacts on health), it is employed as a measure of the aesthetic qualities of drinking water and as a collective signal of the presence of a variety of chemical compounds.

In the current investigation, the total dissolved solids value of groundwater samples from the Aspur block varied in the Dungarpur district from 550 mg/l to 1810 mg/l, with a mean ± S.D. of 736.333 ± 119.169. The Sagwara block saw a range of 520 mg/l to 1102 mg/l, with a mean ± S. D. of 1010.878 ± 335.676.

The findings of the analysis revealed that the groundwater's TDS value in Aspur block was higher than Sagwara block. The presence of numerous organic salts, such as sodium, potassium, calcium, and bicarbonate, as well as certain organic compounds from the nearby soil and rocks, may be the cause of the high TDS readings in the study area.

Table 3: ANOVA Test Applied for Total Dissolved Solids Parameter of Two Blocks

Blocks	N	Minimum	Maximum	Mean	Standard Deviation	Mean Difference	't' Value	'p' Value	Result
Sagwara	90	520	1102	736.333	119.169	274.544	7.312	0.000	HS
Aspur	90	550	1810	1010.878	335.676				

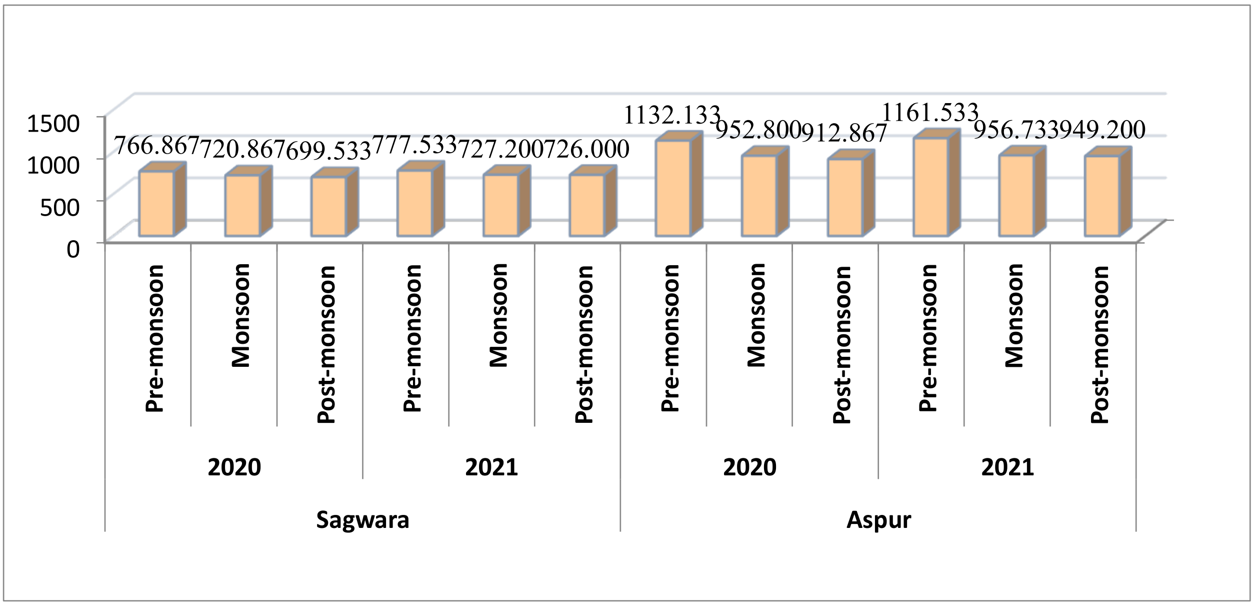

Fig. 4: The Mean Value of Total Dissolved Solids in Groundwater of Aspur and Sagwara Blocks During Different Seasons of Year 2020 and 2021

The ANOVA test results mentioned above indicate a highly significant difference in the total dissolved solids values in the water samples of the two blocks ($t = 7.312$, $p = 0.000$).

The significant variations in the mean value of TDS of the two blocks could be the result of a variety of processes, including evaporation, chemical weathering of the rocks nearby where the groundwater seeps out, and vegetative decomposition. According to Pandian et al. (2005), high TDS in groundwater may be caused by groundwater pollution, which occurs when wastewater from both residential and commercial units is dumped into pits, ponds, and wells, allowing the waste to migrate down to the water table. It may also be caused by taps that have broken, improper water purification techniques, pipeline dust, and chloride addition Atekwana *et al.* (2004). United States of America's University of Delaware reported that greater TDS concentration could produce organoleptism in people and scale-related decreased performance of pipelines, filters, and valves are two examples. According to Zinjad (2013) the discharge of sewage or industrial waste may be to blame for the high TDS value.

The graphical representation of the statistical analysis depicts the mean value of TDS of two blocks under the study area in the years 2020 and 2021. The bars of the graph clearly show that a comparatively high mean value of TDS is found in Aspur block than in Sagwara block, and the graphical representation also shows that TDS value decreases during the monsoon season as compared to the pre-monsoon season of years 2020 and 2021. Other researchers from various parts of India have similarly reported slightly lower TDS levels during the monsoon season than during pre-monsoon and post monsoon as Chandra et al. (2017).

TOTAL HARDNESS (TH)

Total hardness refers to the mineral content of a water sample that cannot be reversed by boiling. Water hardness is an important water quality characteristic, especially in relation to drinking water. The desired limit of total hardness in water, according to the drinking water quality standard, is up to 300 mg/l as proposed by BIS and WHO. However, the standards allow for a maximum total hardness limit of 600 mg/l; water that exceeds this limit is considered unfit for drinking purposes. The amount of calcium or magnesium salts in the water, or both, determines its hardness Patil and Patil (2010). Water hardness varies greatly from one location to the next, and surface water is generally softer than groundwater.

In this study, the total hardness value of groundwater samples from the Aspur block in the Dungarpur district ranged from 300 mg/l to 760 mg/l, and statistical analysis revealed that total hardness values with a mean ± S.D. of 511.478 ± 104.074, while it ranged from 300 mg/l to 780 mg/l in the Sagwara block, with a mean ± S.D. of 481.289 ± 93.147. In both the blocks, the value of total hardness in groundwater samples is found to be high, particularly in Aspur. Kale and Bandela (2016) observed high TDS values than permissible limit at 4185 mg/l at industrial waste water effluent treatment plant of Waluj in Aurangabad. According to them the main source of high TDS in the area was pharmaceutical manufacturing industries, food industries and steel industry, these industries release high amount of organic, inorganic and other dissolved materials.

Table 4: ANOVA Test Applied for Total Hardness Parameter of Two Blocks.

Blocks	N	Minimum	Maximum	Mean	Standard Deviation	Mean Difference	't' Value	'p' Value	Result
Sagwara	90	300	780	481.289	93.147	30.189	2.051	0.042	S
Aspur	90	300	760	511.478	104.074				

The results of the one-way ANOVA test show a significant difference in the total hardness values of both the blocks ($t = 2.051$, $p = 0.042$, which is<0.05). The natural accumulation of calcium, magnesium, chloride, and sulphate in the surrounding soil, as well as the geological creation of rocks through which the water drains out, could be the cause Raja and Venkatesan (2010).

The graphical representation of the statistical analysis based on the mean value of hardness in two blocks within the study region clearly shows that the total hardness value was higher in the Aspur block as compared to the Sagwara block. The bars of the graph also depict that the total hardness value is found to be high in the pre-monsoon season as compared to the monsoon and post-monsoon seasons.

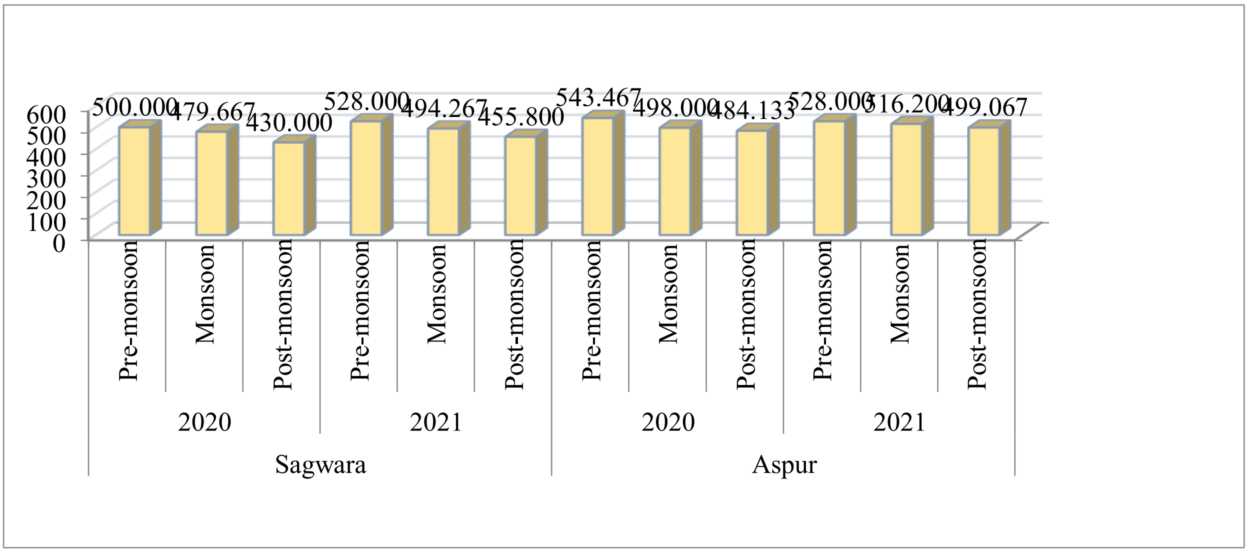

Fig. 5: The Mean Value of Total Hardness in Groundwater of Aspur and Sagwara Blocks During Different Seasons of Year 2020 and 2021

The significant difference in the mean value of Aspur and Sagwara blocks could be attributable to the calcium-containing rocks through which the water passes; it also depends on the area under investigation's precipitation and evaporation patterns, which mostly contribute to changing the water quality. The calcium and magnesium ions in groundwater influence hardness directly or indirectly. Atxotegi (2003) has investigated that if the pH is greater than 7, the water is most likely hard and contains calcium and magnesium.

However, both the block's samples fell into the category of very hard water. As a result, the water in these places is unsuitable for drinking, washing, cleaning, or laundering purposes.

CHLORIDE (Cl^-)

Chloride ions (Cl^-) are found in abundance in nature. Cl^- is found in almost natural water, mostly in the form of calcium, magnesium, and sodium sulphates. It is highly soluble in water and freely percolates through soil and rock. In the absence of any alternative source of water with a desirable concentration, the Bureau of Indian Standards has recommended a desirable limit of 250 mg/l of chloride in drinking water; in the absence of any alternative source of water with a desirable concentration, this concentration limit can be extended to 1000 mg/l of chloride. On the other hand, groundwater with a chloride concentration of more than 1000 mg/l should not be consumed. No health-based guideline levels have yet been proposed for chloride in drinking water. Its concentrations beyond 250 mg/l, on the other hand, can cause a perceptible taste in water (WHO, 2008, Chapter 10).

The current analysis demonstrates that the chloride concentration in the Aspur block is dispersed and ranges from 79 mg/l to 550 mg/l, with data after statistical testing revealing a value of chloride with a mean ± S.D. of 261.267 ± 82.960. While chloride concentrations in Sagwara block ranged from 90 mg/l to 275 mg/l, with a mean ± S.D. of 182.122 ± 44.099, According to the above results, the mean value of chloride concentrations in Aspur block is more than 250 mg/l, while in Sagwara it is under the desirable limit of chloride in drinking water, proposed by BIS. High chloride values (7048 mg/l) were observed by Kale and Bandela (2016) at industrial waste water effluent treatment plant of Waluj in Aurangabad. According to them the source of high chloride may be the presence of different salts of Ca, Na, K in the industrial effluent.

Table 5: ANOVA Test Applied for Chloride Parameter of Two Blocks

Blocks	N	Minimum	Maximum	Mean	Standard Deviation	Mean Difference	't' Value	'p' Value	Result
Sagwara	90	90	275	182.122	44.099	79.144	7.992	0.000	HS
Aspur	90	79	550	261.267	82.960				

The results of the one-way ANOVA test revealed that there is a highly significant difference in chloride concentrations between Aspur and Sagwara blocks (t = 7.992, p = 0.000).

The graphical representation of the statistical analysis using the mean value of chloride in two separate blocks within the study region clearly shows that the chloride concentration in Aspur is higher than in Sagwara block. Graph also depict that chloride concentration rises during pre-monsoon season in both blocks.

The maximum value could be due to the fact that septic tank effluents or seepage from channels running through some parts of the study area, or garbage and solid waste dumps where bore wells are located, organic waste of animal origin, and home wastes may all be appropriate grounds for increasing chloride concentrations, as advised by WHO (2008). According to Zinjad (2013), minerals and chlorination may be reason for the increased value of chloride. Human excretions, in particular urine, contain the same amount of chloride that is found in food and water.

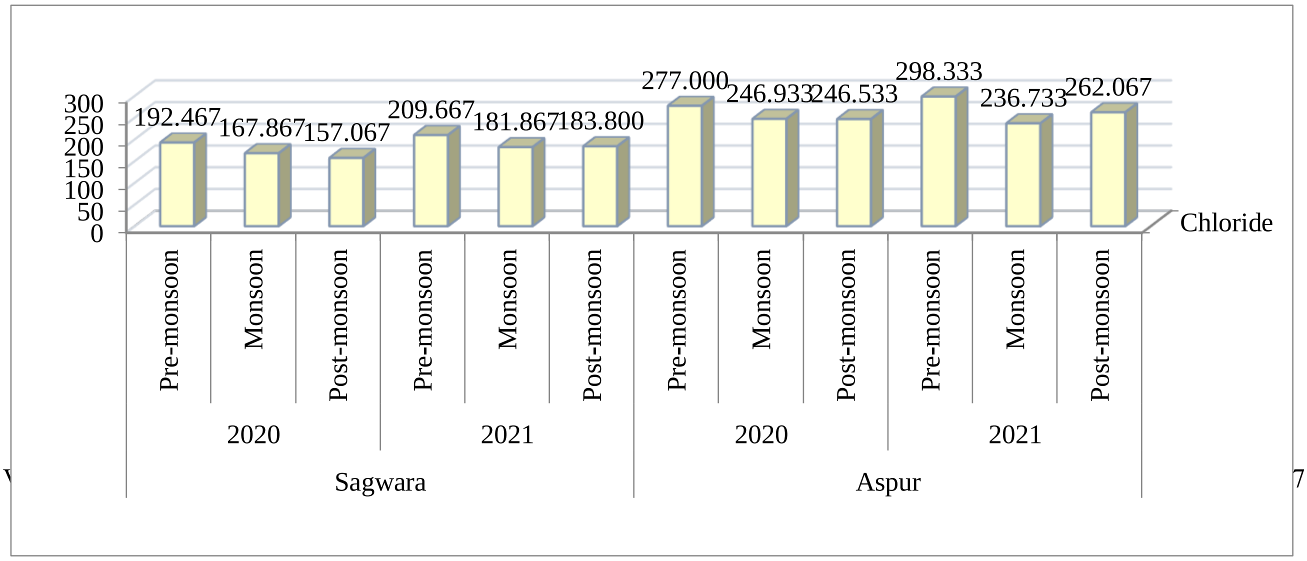

Fig. 6: The Mean Value of Chloride in Groundwater of Aspur and Sagwara Blocks During Different Seasons of Year 2020 and 2021

FLUORIDE

The ionised state of the fluorine atom is fluoride, which is extensively present in nature. Although fluorine is a highly plentiful element, the natural world does not contain it in its elemental form due to its high level of reactivity. Fluorine is the most electronegative and reactive element naturally occurring in different types of rock. The most common fluoride containing minerals are fluorspar, cryolite, fluorite, and fluorapatite. Fluoride is a chemical element which is present most frequently in groundwater as well, and it is one of the most important toxicological environmental hazards on earth. All living beings require fluoride as an essential ion for their health. It helps in dental enamel development and the proper mineralization of bones.

In the current study, groundwater samples from the Aspur block and Sagwara block were tested to assess fluoride concentrations.

The concentration of fluoride varied from 1.10 mg/l to 4.57 mg/l in the Aspur block, and the data after statistical analysis showed that the value of fluoride with a mean ± S.D. at 3.269 ± 0.889 was determined. The settlements surrounded by granitic gneissic complexes have higher fluoride concentrations than those in other rock formations. On the other hand, the fluoride value ranged between 0.76 mg/l and 4.65 mg/l in the Sagwara block with a mean ± S.D. at 2.971 ± 0.965. The results of the investigation showed that the levels of fluoride in the groundwater in both blocks exceeded the maximum limit allowed for fluoride in drinking water. Furthermore, it was discovered that the groundwater fluoride value of the Aspur block was higher than that of the Sagwara block.

Choubisa (2018) reported that in all 33 districts of Rajasthan, drinking groundwater sources are contaminated with fluoride, and the majority of them have fluoride levels over the permissible limits of 1-1.5 ppm.

Table 6: ANOVA Test Applied for Fluoride Parameter of Two Blocks.

Blocks	N	Minimum	Maximum	Mean	Standard Deviation	Mean Difference	't' Value	'p' Value	Result
Sagwara	90	0.76	4.65	2.971	0.965	0.298	2.153	0.033	S
Aspur	90	1.10	4.57	3.269	0.889				

The test results mentioned above demonstrate a significant difference between the fluoride values of both the blocks (t= 2.153 and p = 0.033, which is <0.05).

Fluoride is a toxic substance that occurs naturally and is usually present in drinking water. According to Shailaja and Johnson (2007), fluoride enters groundwater through infiltration through naturally occurring minerals like fluorspar, cryolite, and fluorapatite. According to Murray (1973) and Chaturvedi *et al.* (1990), the mean value of fluoride concentration in the groundwater of Aspur and Sagwara blocks lies within the category of dental fluorosis. But many places in both the blocks have fluoride concentrations of more than 3-4 mg/l, where cases of both dental and skeletal fluorosis were observed.

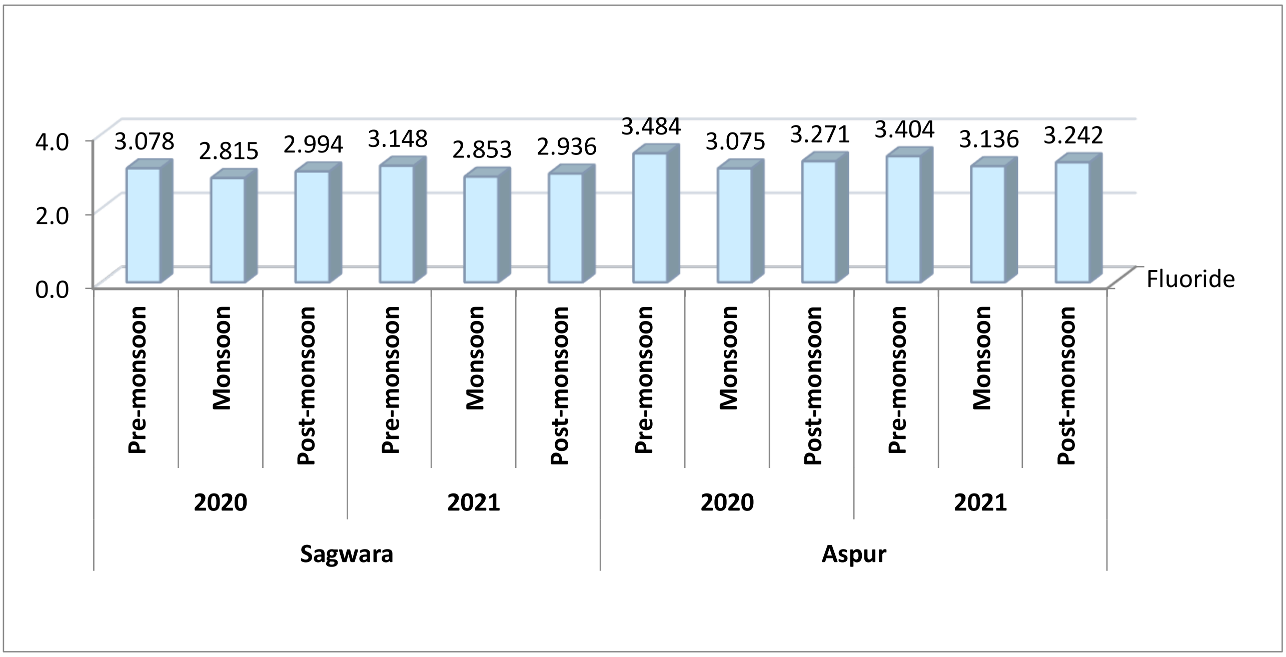

Fig. 7: The Mean Value of Fluoride in Groundwater of Aspur and Sagwara Blocks During Different Seasons of Year 2020 and 2021

The graphical representation of the statistical analysis shows the mean value of fluoride in different locations in the Aspur and Sagwara blocks during different seasons of the years 2020 and 2021. The bars of the graph clearly show that the Aspur block has a comparatively higher fluoride concentration than the Sagwara block. By the graphical representation, it is also observed that the fluoride concentration is found higher in the study area during the pre-monsoon season than during the monsoon and post-monsoon seasons in both the investigated years.

The significant variation in the means of the different blocks could be caused by a variety of factors, but the majority of the fluorides in groundwater are naturally occurring and come from the weathering and deposition of atmospheric particles, the breakdown of rocks and soils, and other sources. Most fluorides are sparingly soluble and are only present in trace amounts in groundwater. Sharma (2014) also observed similar results, she found high fluoride content (ranged between 1.0 and 18.8 mg/l) at almost sampling sites of Jodhpur District. According to her high fluoride level in groundwater is due to weathering of primary silicate and associated accessory minerals. Mohan and Kumar (2022) also found high fluoride in Agra city of Uttar Pradesh. Additionally, Kumar *et al.* (2018) reported a high fluoride level (1.73 mg/l to 4.92 mg/l) in the Rajauli sub-division of Bihar. They claim that the higher fluoride in the studied area may be caused by the local geological formation, rock weathering and fluoride-bearing mineral leaching.

NITRATE

Nitrate is a naturally occurring substance found in soil and it is also found in food and water in small concentrations. Water is a solvent for almost all inorganic nitrates, so it is found in groundwater also. Nitrates in groundwater come from a wide variety of sources. The main sources include septic tank wastewater, chemical and organic fertilisers, organic matter decay, and atmospheric nitrogen that soil microbes convert to nitrate. Only when dissolved in water do nitrates penetrate the soil. The movement of nitrates toward groundwater is facilitated by rain, irrigation, and liquid septic tank waste.

According to the Indian drinking water quality guidelines of BIS, the permissible limit for nitrate is 45 mg/l. Higher concentrations than the maximum permissible limit may cause methemoglobinemia stomach cancer, and birth abnormalities. Pitchaiah (1995), Mirvish (1985).

In the current investigation, the nitrate levels in groundwater samples from the Aspur block ranged from 45 mg/l to 131 mg/l with a mean ± standard deviation of 70.444 ± 19.151, while in the study area of the Sagwara block, it ranged from 40 mg/l to 72 mg/l with a mean ± standard deviation of 55.967 ± 7.221.

The test findings presented above demonstrate a highly significant difference between the nitrate values of both the blocks ($t = 6.711$ and $p = 0.00$). The results showed that the mean concentration of nitrate in the Aspur block (70.444 mg/l) was higher than in the Sagwara block (55.967 mg/l).

Table 7: ANOVA Test Applied for Nitrate Parameter of Two Blocks

Blocks	N	Minimum	Maximum	Mean	Standard Deviation	Mean difference	't' value	p value	Result
Sagwara	90	40	72	55.967	7.221	14.478	6.711	0.000	HS
Aspur	90	45	131	70.444	19.151				

According to Sridhar and Sunandamma (2018) the nitrate that is present on the surface is leached into the groundwater by percolating water, which causes the contamination. High nitrate consumption may affect central nervous.

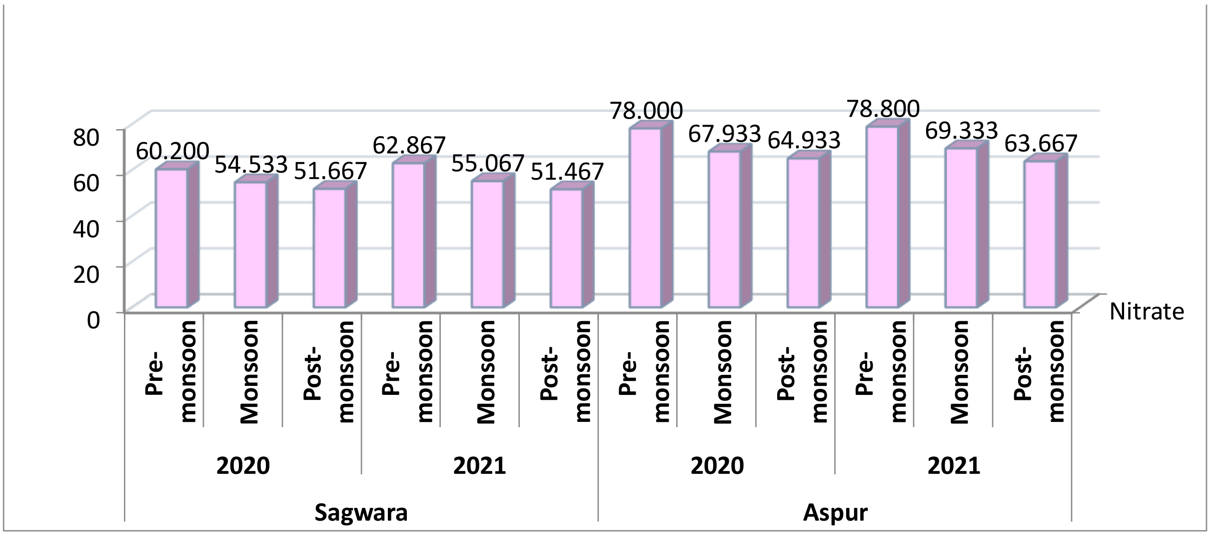

Fig. 8: The Mean Value of Nitrate in Groundwater of Aspur and Sagwara Blocks During Different Seasons of Year 2020 and 2021

The statistical analysis using the mean value of nitrate in two separate blocks within the study region is represented graphically, and it is observed that the Aspur block had a greater mean value of nitrate than the Sagwara block. The graph's bars also show that in both blocks, nitrate levels in groundwater rise during the pre-monsoon season compared to the monsoon and post-monsoon seasons.

The significant variation in mean values between two blocks could be caused by various factors, including different types of minerals, minerals with nitrate-bearing rocks, inorganic fertilisers, seepage from sewage near to the sampling sites, septic systems, manure storage or spreading operations, mining, and artificial fertilisers used for plant growth.

Conclusion

The overall results showed that all parameters were found comparatively high in Aspur block. It is also observed that the concentration of all selected parameters was higher in pre monsoon than monsoon and post monsoon season. Possibly the reason behind the high concentration of physico-chemical parameters is due to geography of the district, a typical hard rock terrain and geology of the district belongs to Pre Cambrian-Aravalli where ultrabasic rocks have been observed with asbestos, soapstone, beryl, fluorite, magnesite, chromite, phyllite and schist factor can be influenced the ground water of Dungarpur district. According to the results of present investigation, the ground water quality of Aspur block is not safe for drinking purpose as per the BIS and WHO standard. The people of the area still unaware about the complications of contaminated water on their health and they are continuously using the ground water. It is suggested to the government to take preventive measures to provide pure water to the people of the area.

References

[1]. Abdullah, M.H, and Musta, B, (1999), Phreatic Water Quality of the Turtle Island of West Malaysia: Pulau Selingan and Pulau Bakungan Kechil, *Borneo Science*, **6:**1-9.

[2]. Acheampong S.Y., Hess J.W. (1998). Hydrogeologic and hydro chemical framework of the shallow groundwater system in the Southern voltaian sedimentary basin, Ghana. *J. Hydrogeol,* 6(4), 527–537.

[3]. Ahmed S., Kayes I., Shahriar S.A., Kabir M., Salam M.A., Mukul S. (2020). Soil salinity and nutrients pattern along a distance gradient in coastal region. *Global J Environ Sci Manage,* 6, 59–72.

[4]. APHA, AWWA, WEF (2017). Standard Methods for Examination of Water and Wastewater (23rd edition). American Public Health Association Washington D. C.

[5]. Atekwanaa, E. A., Atekwanaa, E. A., Roweb, R. S., Werkema D. D., Legalld, F. D. (2004). The relationship of total dissolved solids measurements to bulk electrical conductivity in an aquifer contaminated with hydrocarbon. *Journal of Applied Geophysics.* **56:** 281 – 294.
[6]. Atxotegi, A., M.Z. Iqbal and A.C. Czarnetzki, (2003). A preliminary assessment of nitrate degradation in simulated soil environments. *Environmental geology.* **45:** 161-170. DOI:10.1007/s00254-003-0876-0.
[7]. Bhuiyan M.A.H., Bodrud-Doza M., Islam A.R.M.T., Rakib M.A., Rahman M.S., Ramanathan A.L. (2016). Assessment of groundwater quality of Lakshimpur district of Bangladesh using water quality indices, geostatistical methods, and multivariate analysis. *Environ Earth Sci,* 75, 1020, https://doi.org/10.1007/s12665-016-5823-y [8]. BIS, (1991). Indian standard specification for drinking water. IS: 10500, Indian Standard Institute.
[9]. Chandra, K., Gopi, K.C., Rao, D.V., Valarmathi, K. (2017). Current Status of Freshwater Faunal Diversity in India. Director, Zoological Survey of India, M-Block, New Alipore, Kolkata-700053 ISBN: 978-81-8171-462-6
[10]. Chandra, S.J., Thergaonkar, V.P. and Sharma, R. (1981). Water quality and dental fluorosis, India. *Journal of Public. Health.***115(25):**47-51.
[11]. Chaturvedi, A.K., Yadva, K.P., Yadava, K.C., Pathak, K.C. and Singh, V.N. (1990). Deflouridation of water by adsorption on fly ash. Water, *Air, Soil Pollution.* **49:** 51-61.
[12]. Chavan B. L. and Zambare N.S. (2014). Physico-chemical Analysis of Groundwater Samples in Solapur City, Maharashtra, India. *International Journal in civil Engineering, architecture and Design.* 2(3), 7-12.
[13]. Chavan, B. L. and Zambare, N.S. (2014), Physico-chemical Analysis of Groundwater Samples in Solapur City, Maharashtra, India. International *Journal in civil Engineering, architecture and Design.* **2 (3):** 7-12
[14]. Choubisa, S.L. (2018) Fluoride distribution in drinking groundwater in rajasthan, *Indian current science.* **114(9):** 1851-1857.
[15]. Foster S., Chilton J., Moench M., Cardy F., Schiffer M. (2000). Groundwater in rural development, *World Bank technical paper*, 463.
[16]. Islam A.R.M.T., Ahmed N., Bodrud-Doza M., Chu R. (2017a). Characterizing groundwater quality ranks for drinking purposes in Sylhet district, Bangladesh, using entropy method, spatial autocorrelation index, and geostatistics. *Environ Sci Pollut Res,* 24(34), 2635-26374. https://doi.org/10.1007/s11356-017-0254-1.
[17]. Kale, S. D. and Bandela, N.N. (2016). Study of Physico-Chemical Parameters of Waste Water Effluents from Waluj Industrial Area, Aurangabad. *Journal of Applicable Chemistry.* **5(6):** 1307-1314.
[18]. Kumar, A., Singh, V. K. and Singh, K. K. (2018). Effect of Fluorosis on Village Folks of Rajauli, Bihar. *Journal of Applicable Chemistry.* **7(6):** 1795-1804.
[19]. Largent, E.J. (1961). The Health Aspects of fluoride, University, *Press Columbus,* OH.
[20]. Mirvish, S.S. (1985). Gastric cancer and salivary nitrate and nitrit nature. **315:** 461-462.
[21]. Mishra S.P and Pandey S.N. (2008). Essential Environmental Studies, Ane Books Pvt. Ltd, New Delhi. 82-83.
[22]. Mohan, D. R. and Kumar, A. (2022). Physico-Chemical and Heavy Metal Investigation of Underground Water at Commercial Areas of Agra District (U.P.), India. *Journal of Applicable Chemistry.* **11(1):** 22-27.
[23]. Murray, J.J.（1973). A history of water fluoridation. *Br. Dent.Jour.***134:** 250-254, 299-302,347-350.
[24]. Navale, D., Nalawade, V., Ranade, P. and Barhate, V. (2018). Study of Water Pollution in Teen Talav, Ashish Talav and Wamanwadi Well in Chembur, South Mumbai Region of Mumbai Distric. *Journal of Applicable Chemistry.* **7(5):** 1336-1342.
[25]. Pandian, R.K., Sharmila Banu, M.G., Kumar, G. and SmilaK, H. (2005). Physico-chemical characteristics of drinking water in selected areas of Namakkal town (Tamil Nadu), India. *Indian Journal of Environment Protection.***10(3):** 789-792.
[26]. Parihar S.S., Kumar A., Kumar A., Gupta R.N., Pathak M., Shrivastav A. and Pandey A.C., (2012). PhysicoChemical and Microbiological Analysis of Underground Water in and Around Gwalior City, MP, India. *Research Journal of Recent Sciences,*1(6), 62-65.
[27]. Patil, V.T. and Patil, R.R., (2010). Physicochemical analysis of selected groundwater samples of Amalner Town in Jalgaon District, Maharashtra, India. *E-Journal of Chemistry.* **7(1):** 111-116.
[28]. Pitchaiah, P.S.（1995). Ground water. *Scientific Publishers Jodhpur.* PP: 304.
[29]. Raja, G. and Venkatesan, P. (2010). Assessment of ground water pollution and it's in and around Punnam area of Karur district, Tamilnadu. *E-Journal of Chemistry*. **7(2):** 473-478.
[30]. Raji B.A., Alagbe S.A. (1997). Hydrochemical facies in parts of the Nigerian basement complex. *Environ Geol,* 29(1–2), 46–49.
[31]. Rao, J.K., and Shantaram, M.V. (2003). Soil and Water Pollution due to Open Landfills, Hyderabad. *Workshop on Sustainable Landfill Management*, pp. 27-38.
[32]. Shailaja, K. and Johnson, M.E.C. (2007). Fluoride in groundwater and its impact on health. *Journal of Environmental Biology.* **28(2):** 331-332.
[33]. Sharma, D. (2014). A Physico-Chemical Analysis and Management of Ground Water Bodies from 20 Locations of Jodhpur District. *Journal of Applicable Chemistry*. **3(2):** 764-768.
[34]. Sridhar, Ch. and Sunandamma, Y. (2018). Assessment of Anionic Concentrations in Industrial Area Ground water of Vijayawada, Andhra Pradesh, India. *Journal of Applicable Chemistry.* **7(5):** 1410-1417.

[35]. Upadhyay J., Rai N. (2010). Physico-chemical parameters of ground water in Dungarpur district Rajasthan. *Journal of Current Science,* 15 (1), 105-110.
[36]. WHO (1993), Guidelines for drinking water quality, 2nd Ed., World Health Organization, Genev.
[37]. WHO (2008), Water quality interventions to prevent diarrhoea: cost and cost-effectiveness**.** *World Health Organization, Geneva.*
[38]. Yadav K.K., Gupta N., Kumar V., Arya S., Singh D. (2013). Physico-chemical analysis of selected groundwater samples of Agra city, India. *Recent Research in Science and Technology.* **4 (11):** 51-54.
[39]. Zinjad, D. G. (2013). Study of Physico-Chemical Parameters of Drinking Water in Pravara Areas around Pravara River. *Journal of Applicable Chemistry.* **2(3):** 545-548.