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Comparative Physico-Chemical Analysis of Ground Water Quality in Aspur and Sagwara blocks of Dungarpur District, Rajasthan, India

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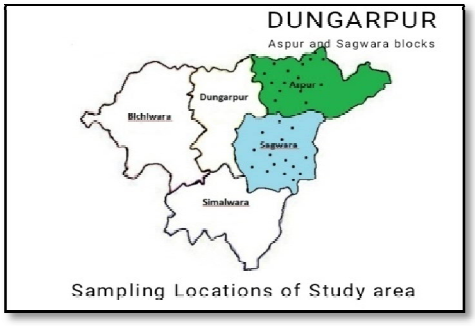
ABSTRACT

The quality of water sources depends on their physicochemical and microbial characteristics. In present days the Physico-chemical properties of water have been deteriorated due to various anthropogenic activities. This study aimed to assess the quality of groundwater in several sections of Rajasthan's Dungarpur district in order to determine its suitability for drinking and other applications. Therefore ground water samples were collected from hand pump and bore well and water quality parameters (Physico-chemical parameter) such as colour, taste, pH, TDS, Total hardness, Total alkalinity, chloride, fluoride, nitrate and phosphate were analyzed using standard procedures of APHA, and the physicochemical properties of all selected groundwater sample of study area were compared with drinking water standard proposed by BIS and WHO. The results of investigation revealed that all the selected parameters were found to be high in both Aspur and Sagwara blocks except pH and alkalinity. The findings also revealed that the concentration of almost all selected parameters were comparatively high in Aspur block. The correlation analysis also conducted to determine correlation coefficient (r) among the selected chemical parameters. The highest correlation found between total hardness and fluoride (r=0.845681575) in Sagwara block while in Aspur block it was found between chloride and nitrate (r=0.980543989).

Graphical Abstract:



Sampling locaitonof study area

Keywords: Nitrate, Physico-Chemical parameters, pH, TDS, Correlation Coefficient (r).

INTRODUCTION

Water is an essential natural resource for the survival of all living organisms on the planet, because it contains minerals that are vital to human nutrition [1]. Water covers around 71% of the Earth's surface. Approximately 97 % of the planet's water is found as marine water in seas and oceans, a very small amount is found as fresh water in the form of surface water and ground water. In comparison to surface water, underground water is thought to be cleaner and pollution-free. Therefore, almost 95 % of India's rural and urban population relies on ground water for household consumption [2]. However, continued discharge of industrial effluents, home sewage, and solid waste dumps pollutes ground water and causes health problems [3]. Therefore, ground water quality conservation and management must always be a priority [4, 5].

There are several people who have made significant contributions to the subject of hydrobiology in India and overseas [6-14].

The ground water in Aspur and Sagwara blocks also has a significant level of contamination, which has a serious and negative influence on the health of the study area's inhabitants. Every year, a considerable number of people are afflicted by diseases spread by contaminated water. Our most important goal these days is to safeguard water (Blue Gold) and its purity for mankind.

The current study was done to explore the impact of ground water quality of Aspur and Sagwara blacks of Dungarpur district, Rajasthan. Therefore, various Physico-chemical parameters were analysed to know the extent of groundwater contamination.

MATERIALS AND METHODS

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. It is located between 23.20’ and 24.01’N latitude and 73.22’ and 74.23’E longitude. The water level varies generally from 5 to 15 m. below the ground level. The district has semi-arid dry climate with a very hot season which receives an average annual rainfall of 761. 7mm. It is bounded on north by Udaipur district and east by Banswara district, in its south and west has common border with Gujarat state. It has five blocks Aspur, Bichiwara, Dungarpur, Sagwara and Simalwara. Out of these two blocks Aspur and Sagwara of Dungarpur district were selected for present investigation, which lies in the eastern part of Dungarpur district.

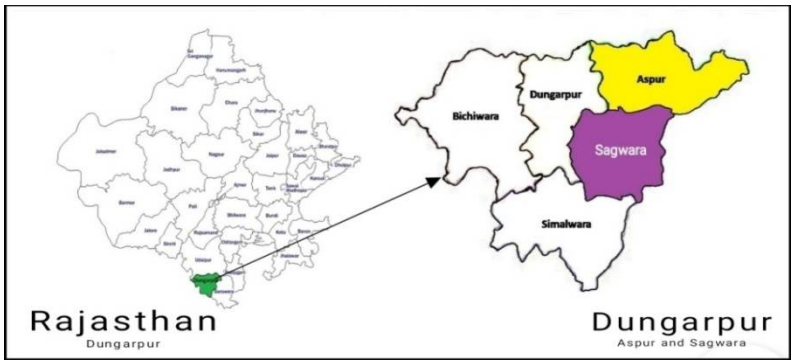


Figure 1. Different study area of Dungarpur in Rajasthan

The aim of present investigation is to determine the quality of ground water in Aspur and Sagwara blocks of Dungarpur district. Therefore, groundwater samples were collected from different villages of Aspur and Sagwara block in Dungarpur district during pre monsoon season. All samples were taken either from hand pump or tube well in fresh, acid wash sampling bottle.

As per the study aim, different Physico-chemical parameters were analysed according to standard method described by APHA [15]. The analysed physical and chemical parameters like pH, total dissolve solids, total hardness, total alkalinity, chloride, fluoride, nitrate, and sulphate were compared with standard prescribed by BIS [16] and WHO [17]. The correlation coefficient also determined to find correlation among the different Physico-chemical parameters of selected study area.

RESULTS AND DISCUSSION

The tables 1 and 2 showing result of conducted Physico-chemical test of samples collected from different villages of Aspur and Sagwara blocks. The physical parameters like colour and taste of collected samples were under desirable limit prescribed by BIS and WHO except colour of water (> 5Hz) in some villages like Khadgda, Ranoli, Limbod of Sagwara block and Gole, Punjpur, Ramghar of Aspur block.

Table 1. Showing result of samples collected from Sagwara block in Pre monsoon season (2020)

S.No.	Location	pH	Colour	Taste	TDS	TH	TA	Cl^-	F^-	NO_3^-	PO_4^{3-}
	Desirable Limit	6.5 to 8.5	<5Hz	Agreeable	500 Mg L^{-1}	300 mg L^{-1}	200 mg L^{-1}	250 mg L^{-1}	1.0 mg L^{-1}	45 mg L^{-1}	0.1 mg L^{-1}
1.	Bhilura	7.58	<5 Hz	Agreeable	1102	600	92	275	2.73	59	0.25
2.	Khadgda	7.48	14 Hz	Agreeable	812	420	80	219	1.65	62	0.22
3.	Gamda	7.10	<5 Hz	Agreeable	540	340	70	180	1.54	54	0.14
4.	Decha	7.20	<5 Hz	Agreeable	780	450	75	220	1.76	65	0.25
5.	Tamatiya	7.27	<5 Hz	Agreeable	720	450	80	170	1.60	58	0.15
6.	Ranoli	7.35	10 Hz	Agreeable	860	340	95	200	1.65	59	0.27
7.	Mandav	7.30	<5 Hz	Agreeable	766	500	100	150	2.60	60	0.20
8.	Limbod	7.41	20 Hz	Agreeable	700	500	110	120	2.60	60	0.15

Table 2. Showing result of samples collected from Aspur block in Pre monsoon season (2020)

S.No.	Location	pH	Colour	Taste	TDS	TH	TA	Cl^-	F^-	NO_3^-	PO_4^{3-}
	Desirable Limit	6.5 to 8.5	<5Hz	Agreeable	500 mg L^{-1}	300 mg L^{-1}	200 mg L^{-1}	250 mg L^{-1}	1.0 mg L^{-1}	45 mg L^{-1}	0.1 mg L^{-1}
1.	Gole	7.55	20 Hz	Agreeable	928	510	82	250	1.97	70	0.20
2.	Katisor	7.39	<5 Hz	Agreeable	1760	700	90	500	3.55	130	0.35
3.	Khalil	7.43	<5 Hz	Agreeable	754	450	87	200	2.00	62	0.22
4.	Lilwasa	7.40	<5 Hz	Agreeable	660	370	70	235	1.93	58	0.15
5.	PardaThoor	7.44	<5 Hz	Agreeable	1015	440	80	210	3.05	62	0.15
6.	Punjpur	7.34	13 Hz	Agreeable	1370	760	100	280	3.20	70	0.30
7.	Ramgarh	7.60	15 Hz	Agreeable	1276	700	80	300	1.98	73	0.28
8.	Rayaki	7.45	<5 Hz	Agreeable	1624	560	120	450	2.0	110	0.30

pH: The pH is an important parameter which determine acidic and basic nature of water. According to the BIS and WHO, pH of drinking water should be between 6.5 to 8.5, pH below 6.5 made water acidic and above 8.5 turn water into alkaline nature. In current study pH varied between 7.10 to 7.58 in Sagwara block while it ranged between 7.34 to 7.60 in Aspur block, finding of the analysis showed that the pH values of both the block were under the desirable limit of pH suggested BIS and WHO for drinking water.

TDS: Another important parameter of water is TDS (Total Dissolved Solid), which is a measurement of inorganic and organic substances (mineral salts) dissolved in water as molecules, ions, or micro-granular suspended practical. According to the BIS, TDS of drinking water should be, not more than 500 mg L^{-1}. High concentration of dissolved solids raises the density of water, affects freshwater creature osmoregulation, reduces the solubility of gases like as oxygen, and reduces the utility of water for drinking, irrigation, and industrial uses [18]. TDS levels in the current study ranged from

540 mg L^{-1} to 1120 mg L^{-1} in Sagwara and 660 mg L^{-1} to 1760 mg L^{-1} in Aspur, both of which are higher than the BIS and WHO recommended limit for TDS in drinking water. TDS concentrations above a certain threshold cause the water to taste bitter, salty, or brackish. Calcium and magnesium are two minerals that frequently appear in TDS. TDS is not a significant contaminant. It's used to assess the aesthetic aspects of drinking water as well as a general indicator of the presence of a variety of chemical contaminants.

Total alkalinity: The ability of water to withstand acidification is known as alkalinity. Dissolved carbon dioxide, bicarbonates, and hydroxides are all found in significant levels in ground water, which are the primary sources of alkalinity. Alkalinity is not detrimental to humans in and of itself [19]. According to the drinking water standard of BIS and WHO, the desirable limit of alkalinity in water is 200 mg L^{-1}. The value of alkalinity in present investigation were found to be within permissible limit prescribed by BIS and WHO, it ranged between 70 mg L^{-1} to 110 mg L^{-1} in Sagwara block and 70 mg L^{-1} to 120 mg L^{-1} in Aspur block.

Total hardness: The overall calcium and magnesium ion concentration in a water sample, expressed as calcium carbonate concentration, is known as water hardness. The desirable limit for total hardness in drinking water is 200 mg L^{-1} as per the BIS while it 300 mg L^{-1} according to the WHO. The total hardness was found to be very high in all samples, it ranged from 340 mg L^{-1} to 600 mg L^{-1} in Sagwara block and 370 mg L^{-1} to 760mg L^{-1} in Aspur block which is higher than desirable limit prescribed by BIS and WHO. Hard water can contribute to dry skin and hair and such as cardiovascular problems, renal dysfunction. Many factors and geological conditions directly or indirectly affect the correlations between different pairs of parameters.

Chloride: Chloride is another parameter which affect the quality of water. According to the BIS and WHO chloride concentration up to 250 mg L^{-1} is acceptable. The value of chloride in study area ranged between 120 mg L^{-1} to 275 mg L^{-1} in Sagwara block which is under permissible limit except Bhilura village (275 mg L^{-1}), while it varied from 200 mg L^{-1} to 500 mg L^{-1} in Aspur block, which is higher than desirable limit except Khalil, Lilwasa and Pardathur. The high concentration of chloride in drinking water exhibited salty taste and laxative effect [**20**] and increases the electrical conductivity of water and reacts with metals ions to form soluble salts. If the water is being used for irrigation, it may inhibit the growth of vegetation.

Fluoride: fluoride is an ionic form of fluorine, generally it found in groundwater and affect the quality of water. Although it's optimum concentration is essential for dental and bones health but it's high concentration may causes fluorosis. The desirable limit for fluoride in drinking water is 1 mg L^{-1}. In the present investigation, the value of fluoride varied from 1.54 mg L^{-1} to 2.73 mg L^{-1} in Sagwara block while it is 1.93 mg L^{-1} to 3.55 mg L^{-1} in Aspur block, which is higher than permissible limit prescribed by BIS and WHO in both the blacks. Fluoride protects teeth from decay by demineralization and remineralisation but too much fluoride in drinking water may causes dental fluorosis and can damage bones and joints as skeletal fluorosis [21]. The impacts of high fluoride concentrations were clearly observed in the people of the study area, they are suffering from dental and skeletal fluorosis.

Nitrate: Nitrate concentration also determines the quality of water. Desirable concentration of nitrate in drinking water is 45 mg L^{-1} as suggested by drinking water standard of BIS. In the current study, the nitrate values varied from 54 mg L^{-1} to 65 mg L^{-1} in Sagwara block and it is 58 mg L^{-1} to 130 mg L^{-1} in Aspur block which is higher than permissible limit prescribed by BIS and WHO, in the both blocks. Nitrate cause decreased oxygen level and can turn haemoglobin into met-haemoglobin and cause more serious health effects like weakness, fatigue, dizziness and excess heart rate.

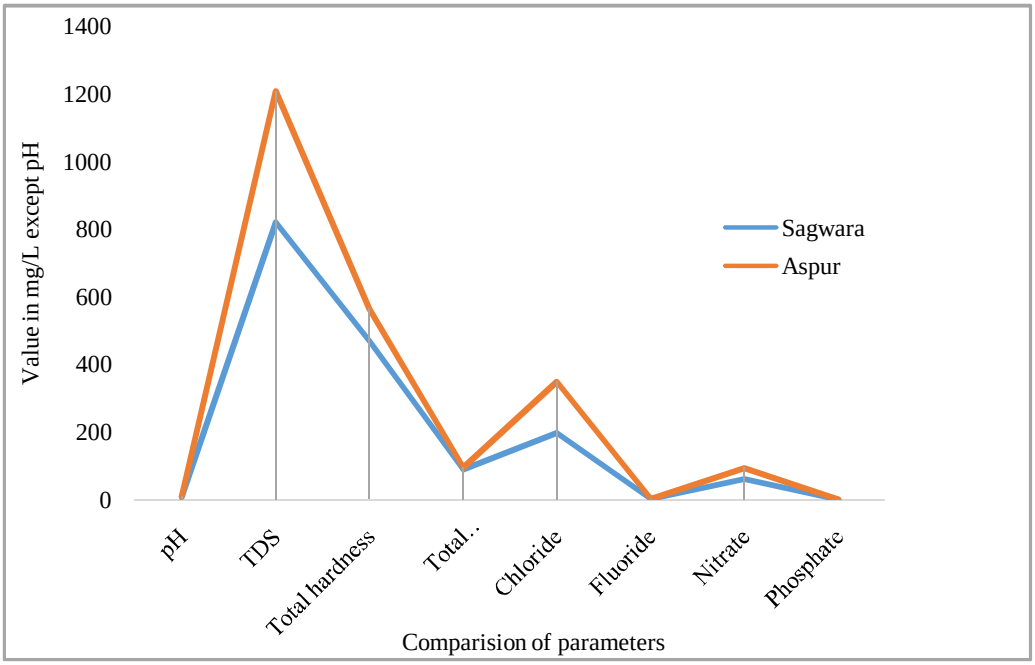


Figure 2. Graph showing comparison of Physico-chemical parameters of ground water in Sagwara and Aspur blocks.

Phosphate: In the current study, the phosphate concentration varied from 0.14 mg L^{-1} to 0.27 mg L^{-1} in Sagwara block and it is 0.15 mg L^{-1} to 0.35 mg L^{-1} in Aspur block which is higher than the desirable limit 0.1 mg L^{-1} as proposed by WHO.

Graphical representation depict that all the selected Physico-chemical parameter's concentration was comparatively high in Aspur block than Sagwara block. The correlation analysis also conducted to determine correlation coefficient (r) among the selected chemical parameters. Correlation analysis is a valuable statistical technique for evaluating how closely changes in one parameter are related to changes in another. Here table 3 and table 4 showing correlation among the selected Physico-chemical parameters in study areas.

Table 3. Showing different pair of correlation of Sagwara block

Parameter	TDS	TH	TA	Cl^-	F^-	NO_3^-	PO_4^{3-}
TDS	--	0.621333764	0.292020812	0.724448908	0.465817175	0.350059326	0.752289907
TH	0.621333764	--	0.451152488	0.219636907	0.845681575	0.292101808	0.104975166
TA	0.292020812	0.451152488	--	0.411414376	0.761724853	0.10315115	0.053848579
Cl^-	0.724448908	0.219636907	**-0.411414376**	--	-0.070720826	0.206144074	0.695696889
F^-	0.465817175	0.845681575	0.761724853	-0.070720826	--	0.11456934	0.053175316
NO_3^-	0.350059326	0.292101808	0.10315115	0.206144074	0.11456934	--	0.559669926
PO_4^{3-}	0.752289907	0.104975166	0.053848579	0.695696889	0.053175316	0.559669926	--

In the present study the highest and positive correlation was found between total hardness and fluoride (r=0.845681575) in Sagwara block and it is found between chloride and nitrate (r=0.980543989) in Aspur block. The negative correlation was found between total alkalinity and chloride (r=-0.411414376) and with fluoride (r=-0.070720826) in Sagwara block. In other pair positive correlation found in Sagwara and Aspur block. The positive correlation coefficient in different pairs of parameters indicates that ground water of Sagwara and Aspur block are not safe for drinking purpose and domestic purpose as per standards and as reported in literally it may cause various health problems.

Table 4. Showing different pair of correlation of Aspur block

Parameter	TDS	TH	TA	Cl^-	F^-	NO_3^-	PO_4^{3-}
TDS	--	0.772673786	0.684984566	0.902218789	0.533761242	0.878733571	0.890281713
TH	0.772673786	--	0.41016237	0.539044233	0.493530278	0.489265534	0.867468471
TA	0.684984566	0.41016237	--	0.600145989	0.114288148	0.57457974	0.636997007
Cl^-	0.902218789	0.539044233	0.600145989	--	0.348144275	0.980543989	0.81524652
F^-	0.533761242	0.493530278	0.114288148	0.348144275	--	0.407781494	0.395317555
NO_3^-	0.878733571	0.489265534	0.57457974	0.980543989	0.407781494	--	0.35126078
PO_4^{3-}	0.890281713	0.867468471	0.636997007	0.81524652	0.395317555	0.791212977	--

Similar results were found around the world by researchers in their research work like A study managed to identify the quality of groundwater in the Chithar River Basin, Tamil Nadu, India, and its suitability for drinking and agricultural use [22]. An application carried out to assess the Sheba Mellouleche aquifer in Tunisia, using GIS-based susceptibility indexing system for irrigation and drinking water management planning [23]. A study conducted to evaluate the Physico-chemical characteristics of ground water in two blocks of Dungarpur district [21]. A case study of the Tefenni plain in Turkey carried out using the WQI (Water Quality Index) and multivariate analysis [24]. Physico-chemical examination of selected groundwater samples from the city of Agrain India [25]. A study conducted to analyse groundwater quality in Beed city, Maharashtra, India. [26] Evaluation of natural groundwater's physicochemical parameters in Lagos metropolis's key industrial and residential areas was carried out [27]. Physico-Chemical parameters of ground water quality assessment in Bassi Tehsil, District Jaipur, Rajasthan were reviewed [15]. Assessment of water quality for drinking purpose in Agra city, India [28]. Groundwater Physicochemical Characteristics in Selected Industrial Areas in Ogun State, Nigeria [29].

APPLICATION

In this study Groundwater quality analysis was presented as a management tool in the study area. The results raise public awareness about the type of water people are consuming in Aspur and Sagwara block.

CONCLUSION

The above results were showing that the quality of ground water in Sagwara and Aspur blocks is deteriorated and it is not up to the standard of drinking water, prescribed by BIS and WHO. It is also observed that the more contaminated groundwater found in Aspur block. Hence the water of the study area is not suitable for domestic uses. The possible reasons behind the groundwater contaminations in the study area are mining and mineral extractions activities which increases the concentration of contaminants in groundwater. The geology of the district belongs to pre-Cambrian Aravalli range, where ultrabasic rocks have been observed with asbestos, soapstone, beryl, fluorite, magnesite, chromite, phyllite, and schist, which also responsible for contamination of groundwater in the area. As noted above that the most of the population of the study area are villagers and their main source of drinking water is groundwater. The people of the area are unaware about the groundwater contamination and it's complications on their health and they are continuously using contaminated groundwater. Many cases of dental fluorosis skeletal fluorosis and other water borne diseases were observed in the people of study area. Hence it is suggested to the government and NGO to establish the water treatment plants in the district to provide clean water to the people of the study area.

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