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Analysis of Drinking Water Quality Using Physicochemical Parameters of Timba Mahudi Village of Sajjangarh Block of Banswara District, Rajasthan

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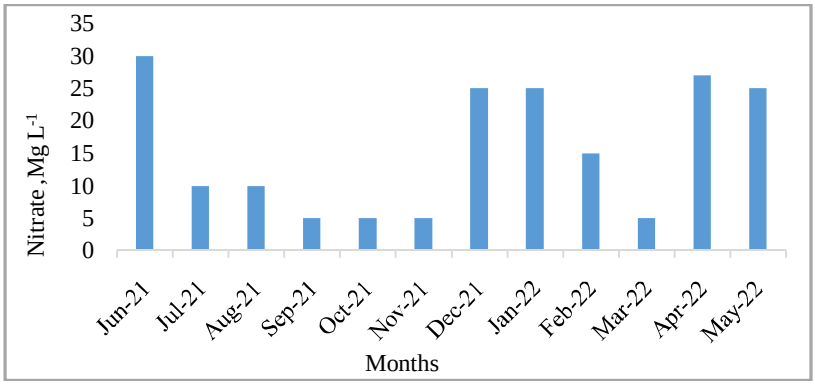
ABSTRACT

It is the study of the Physico-chemical Parameters of drinking water in the Timba-Mahudi village of Sajjangarh Block of Banswara District, Rajasthan. Groundwater samples were collected from the sampling points in strict accordance with BIS (IS10500:2012) recommendations. In this location drinking water was analyzed for a period of one year from Pre the monsoon period, and the monsoon period, and post-monsoon period. These results demonstrated that drinking water collected from Timba-Mahudi village of Sajjangarh block of Banswara district was unsuitable for human health. Physicochemical analysis shows that fluoride concentration for most of the assessment period exceeds the permissible limits of BIS (IS 10500:2012) and statistical analysis by the use of WQI calculated for selected parameters shows that groundwater is not suitable for drinking purposes. The present research aims to provide information about potable water's physicochemical characteristics and effects to discuss its utility for human consumption.

Graphical Abstract:



Nitrate in drinking water of Timba-Mahudi village of Sajjangargh Tehsil.

Keywords: Groundwater, Physico-chemical analysis, Chloride, Nitrate, Fluoride, TDS, Sajjangarh Block of Banswara.

INTRODUCTION

Water is one of the most valuable and important natural resources. All living things, the majority of ecological systems, human health, food production, and economic development depend on it [1]. Water is responsible for human beings' economic, social, ecological, and health activities, so the assessment, monitoring, planning, development, and Integrated Water Resources Managementis very essential [2]. Rajasthan is a state with low to extremely low rainfall, intense summers with very high temperatures, high diurnal variation of temperatures and low humidity and a high rate of evaporation [3]. Groundwater is a finite resource that is primarily used for human consumption and agricultural needs worldwide because it is less contaminated than surface water, affordable, and simple to use. Groundwater quality can be described by some physical and chemical parameters. Physico-chemical and biological parameters should be checked from time to time to using groundwater as drinking water because the human population is vulnerable to various water-borne diseases due to the use of contaminated drinking water. The availability of good quality drinking water is useful in improving the quality of life and preventing water-borne diseases. The quality of drinking water is determined by physical and chemical parameters such as color, temperature, pH, turbidity, total dissolved solids, total hardness, total alkalinity, acidity, chloride, fluoride, sulfate, magnesium, calcium, iron and biological parameters BOD, COD, DO, etc. can be described [4].

Various organizations like WHO, BIS 12500:2012, APHA etc [5-8]. have prescribed drinking water quality parameters according to physicochemical parameters to compare with the value of actual water samples. it is assessed the suitability of groundwater for portability and other consumption purposes by the selection of seven different Physico-Chemical parameters to calculate the Water Quality Index (WQI) [9], and also assessed the groundwater quality index of Ganeshwar and Chala villages of Neemkathana block in Sikar District of Rajasthan state [10]. Lal *et al* stated about many benefits of alkaline water for drinking purposes [11]. Water pollution has increased as a result of various man-made activities such as excessive pesticide and fertilizer use, improper drainage systems, sewerage line leakage, domestic waste, excessive construction work, and so on. In this literature review, some water analysis reports from India and various regional constituents are reviewed along with their human health impacts along with their physicochemical regimes.

MATERIALS AND METHODS

Groundwater Temperature and pH were recorded at the time of sample collection, by using a Thermometer and Pocket digital pH Meter. While other Parameters Such as TDS, Total Hardness, Chlorides, Total Alkalinity, Nitrate, Fluoride, and Calcium were estimated in the Laboratory By using Standard Methods as Prescribed by BIS (IS10500:2012).

Table 1. Parameters and Methods of Determination

Parameters	Methods of determination
Turbidity	Spectrophotometric Method
pH	pH Meter
Total Hardness (mg/l)	EDTA Method
Ca (mg/l)	Titration Method
Mg (mg/l)	Titration Method
TDS (mg/l)	Potentiometric Method
F^- (mg/l)	UV Spectrophotometric Method
NO_3^- (mg/l)	Spectrophotometer

The weighted arithmetic index method is adopted to calculate the selected site's water quality index. The suitable parameters for groundwater were used and compared with the BIS (IS10500:2012) recommended to calculate a WQI.

Study area: The study area comprises the Banswara district of Rajasthan state. Banswara district is one of the Thirty-three district of Rajasthan state and its administrative headquarter is located in Banswara. Banswara district falls within South Rajasthan in India. Its area is spread over a total geographical area of 5037 sq. km. It is also known as "The City of Hundred Islands". In our present research paper, Physico-chemical analysis was carried out for the Timba-Mahudi village of Sajjangarh Block. It lies at an altitude of 260 meters above sea level, its average temperature is 26°C and the average annual rainfall is 934 mm.

Water sampling: In the present investigation, different water samples were collected in polythene bottles which were cleaned with acid water, followed by rinsing twice with distilled water. The water sample was immediately brought into the laboratory for the estimation of various physiochemical parameters. The water samples are chemically analyzed. The analysis of water was done using the procedure of standard methods.

RESULTS AND DISCUSSION

The Monthly Variation in Physicochemical Parameters is presented in table 2.

Table 2. Physico-Chemical parameters of drinking water of Timba-Mahudi village of Sajjangarh Block

Parameter / Month	Temp. °C	pH	TDS mg L^{-1}	Turbidity mg L^{-1}	Total Alkalinity mg L^{-1}	Total Hardness mg L^{-1}	Cl^- mg L^{-1}	F^- mg L^{-1}	NO_3^- mg L^{-1}	Ca^{++} mg L^{-1}	Mg^{++} mg L^{-1}
Jun-21	25	8.1	729	0.0	270	280	80	0.9	30	56	34
Jul-21	25	6.6	529	0.0	270	240	50	1.6	10	56	35
Aug-21	24	6.7	524	0.0	250	240	60	1.6	10	56	35
Sep-21	23.4	6.5	394	0.0	200	160	40	1.6	5	32	19
Oct-21	21	6.5	509	0.0	240	200	40	1.6	5	100	100
Nov-21	20.5	6.5	509	0.0	240	200	40	1.6	5	100	100
Dec-21	19.5	6.9	500	0.0	240	220	60	1.2	25	110	110
Jan-22	20.5	7.0	500	0.0	240	220	60	1.25	25	110	110
Feb-22	22	7.4	580	0.0	240	230	60	1.2	15	48	27
Mar-22	24	6.5	509	0.0	240	200	40	1.6	5	100	100
Apr-22	26.5	7.4	659	0.0	270	290	70	1.0	27	150	140
May-22	27	7.1	540	0.0	210	240	60	0.9	25	120	120

Temperature of water: The temperature in the current study ranges from 19.5°C to 27°C. The maximum temperature (27°C) was recorded in May (summer) and the minimum (22.5°C) in December (winter). In a similar study discovered that water temperature was high during the summer due to low water levels, high temperature, and a clear atmosphere [**12, 13**]. Water temperature has a significant impact on the chemical, biochemical, and biological properties of water.

Figure 1. Temperature of drinking water of Timba-Mahudi village of Sajjangargh Tehsil.

pH of water: The pH of water is a measure of the concentration of hydrogen ions. Water with a pH of 6.5 to 8.5 is generally regarded as safe to drink. Acid water is corrosive, especially if the pH is less than 6. Alkaline water is less corrosive than acidic water. pH in this study ranges from 6.5 to 8.1, and all of the water samples analyzed have concentrations within the WHO's safe limit of 6.5 to 8.5. This indicated that the measured pH values of the drinking water samples were within the BIS (IS10500:2012) permissible range, posing no risk to consumers (Table 2).

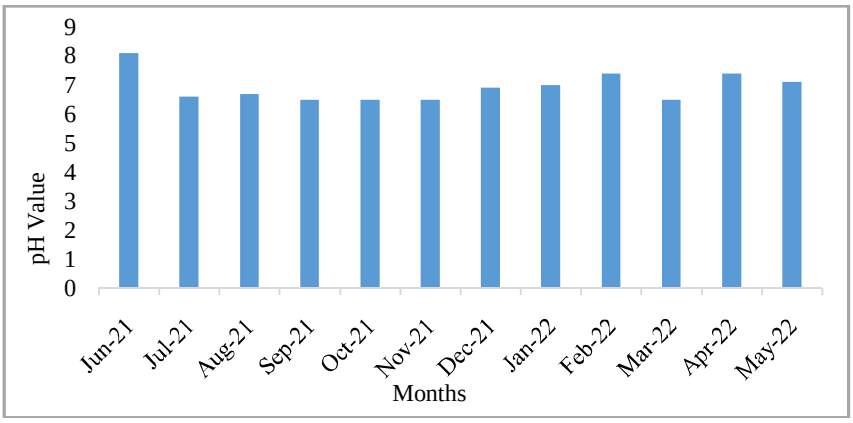


Figure 2. pH of drinking water of Timba-Mahudi village of Sajjangargh Tehsil.

TDS of water: The total dissolved solids fluctuate from 394 mg L^{-1} to 729 mg L^{-1}. The maximum value of 729 mg L^{-1} was recorded. From the results, it is clear that water samples of the studied area are within the Permissible limit of 2000 mg L^{-1}, and suitable for drinking in terms of TDS.

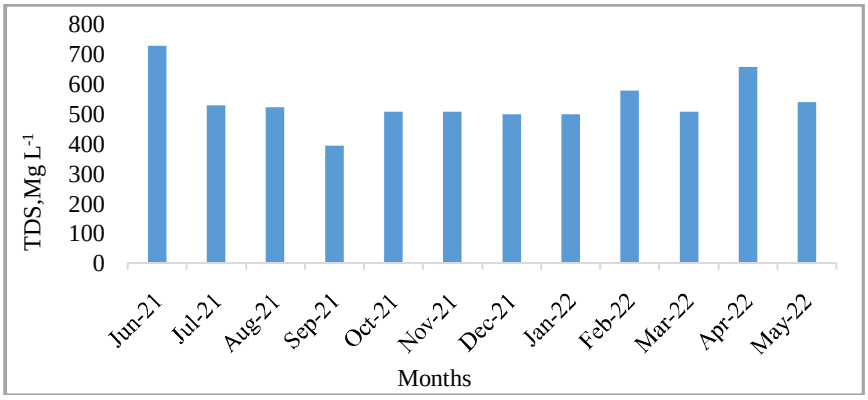


Figure 3. TDS in drinking water of Timba-Mahudi village of Sajjangargh Tehsil.

Chloride in water: The values of chlorides range from 40 mg L^{-1} to 80 mg L^{-1}. The maximum value (80 mg L^{-1}) was recorded. While the permissible limit of chloride prescribed by BIS for drinking water is 250 mg L^{-1}.

Nitrates in water: The values of nitrate range from 5 mg L^{-1} to 30 mg L^{-1} with the maximum value (30 mg L^{-1}) observed. The acceptable value of nitrate is 45 mg L^{-1}; above this concentration, water becomes harmful and causes a disease namely methamoglobinemia in infants a condition known as "blue baby."

Fluoride in water: Prescribed permissible limit of fluoride by BIS for drinking water is 1.5 mg L^{-1}. The observed value ranges from 0.9 mg L^{-1} to 1.6 mg L^{-1}, the maximum value of 1.6 mg L^{-1} was observed, as the fluoride levels around 0.5-1.0 mg L^{-1} reduce the risk of dental caries, while

significantly higher levels may cause skeletal fluorosis, depending on water intake and the fluoride content of the diet. Timba-Mahudi village of sajjangarh Block is at high risk.

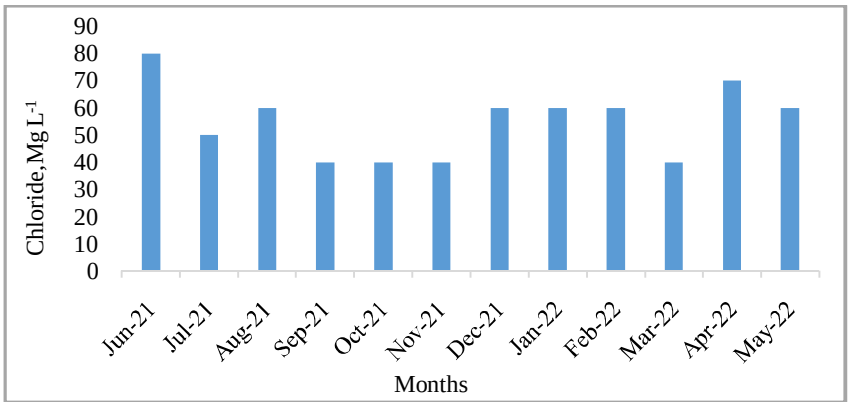


Figure 4. Chloride in drinking water of Timba-Mahudi village of Sajjangargh Tehsil.

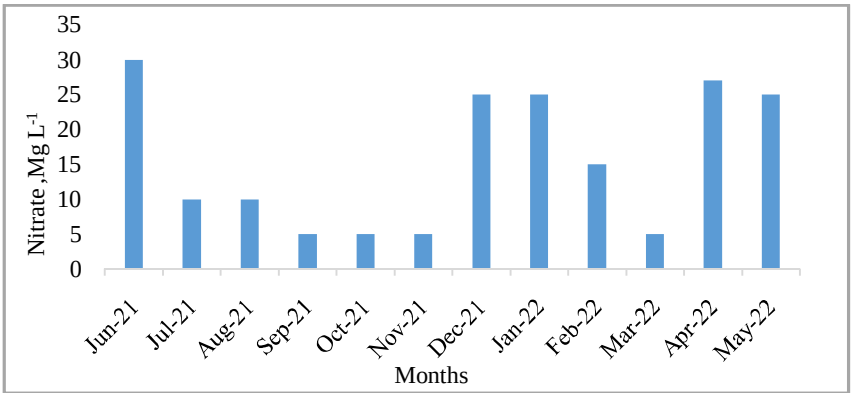


Figure 5. Nitrate in drinking water of Timba-Mahudi village of Sajjangargh Tehsil.

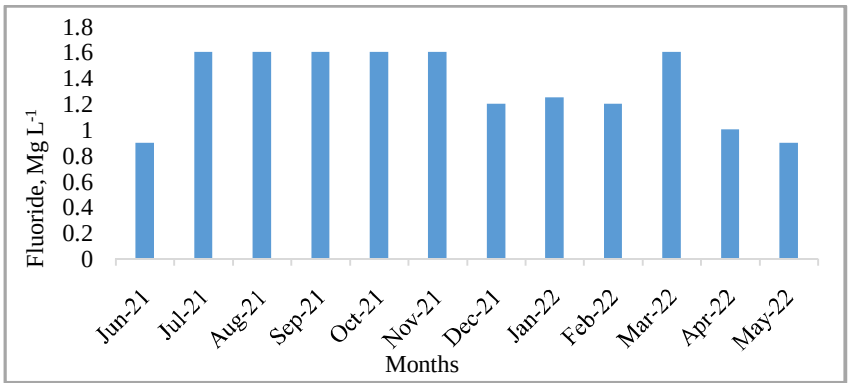


Figure 6. Fluoride ion in drinking water of Timba-Mahudi village of Sajjangargh Tehsil

Total Hardness of water: Total Hardness in groundwater is primarily caused by bicarbonates, carbonates, sulfates, and chlorides of calcium and magnesium which means Calcium and magnesium are the main ions that cause hardness. The acceptable limit of the total hardness is 200 mg L^{-1}, while the permissible limit is 600 mg L^{-1} [**1**]. The hardness of the water samples tested ranged from 160 to 290 mg L^{-1} as $CaCO_3$ as shown in table 3. Durfor *et al.*, classified drinking water as soft, moderate, hard, or very hard. Based on this classification, no water samples were found to be soft, with this regard majority of the samples fall into the hard to very hard category [**14**]. But all measured values were within the BIS (200 mg L^{-1}) and WHO (500 mg L^{-1}) acceptable limit values.

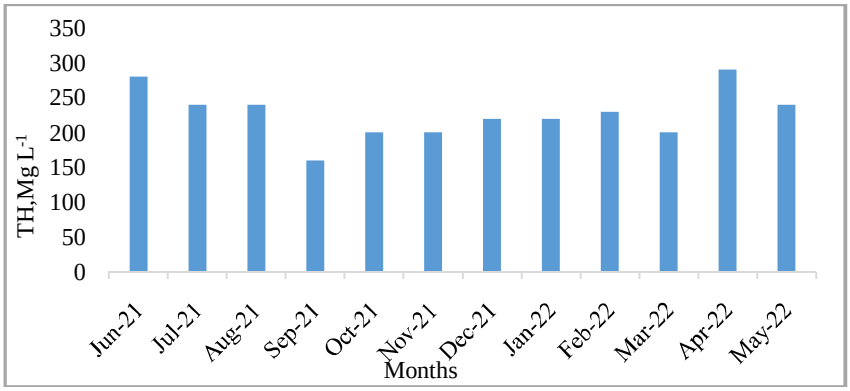


Figure 7. Total hardness in drinking water of Timba-Mahudi village of Sajjangargh Tehsil.

Table 2 .Classification of water on the basis of Total Hardness

Total Hardness (mg L^{-1})	Nature of water
0-60	Soft
61-120	Moderate
121-180	Hard
>180	Very Hard

Total Alkalinity of water: The alkalinity of water is its acid-neutralizing capacity. Groundwater alkalinity is primarily caused by carbonates and bicarbonates. The acceptable limit for alkalinity is 200 mg L^{-1}, and in the absence of another water source, alkalinity up to 600 mg L^{-1} is safe [**15**]. The results of the current study revealed that the total alkalinity of the water samples ranged from 200 to 270 mg L^{-1}. According to BIS, the desired and maximum permissible limits for alkalinity in drinking water are 200 and 600 mg L^{-1}, respectively. The value of total alkalinity content in the sampling site was found to be within the desired and maximum permissible limits of BIS in the current study.

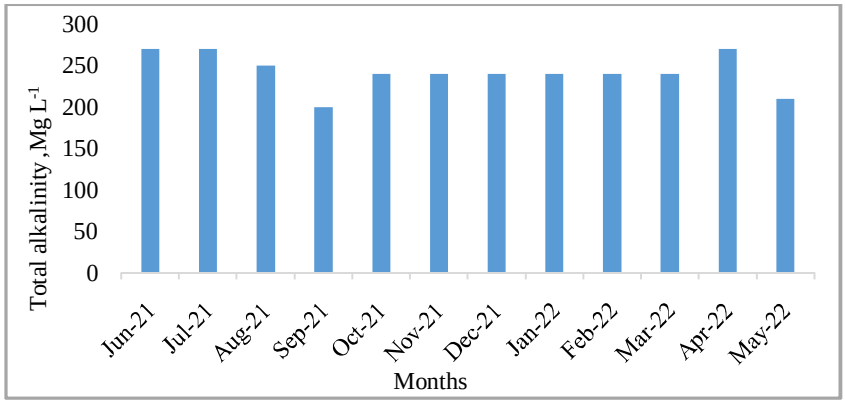


Figure 8. Total hardness in drinking water of Timba-Mahudi village of Sajjangargh Tehsil.

Calcium in water: In this study, the measured value of calcium ions in the water sample ranged from 32 mg L^{-1} to 150 mg L^{-1}. It is observed that the maximum value (150 mg L^{-1}) was recorded in the month of April -22. According to BIS (Indian drinking water standards), the desired and maximum permissible limits for Calcium in drinking water are 75 and 200 mg L^{-1}, respectively. In the current study, the value of calcium ions in the sampling site was found to be within the maximum permissible limits of BIS.

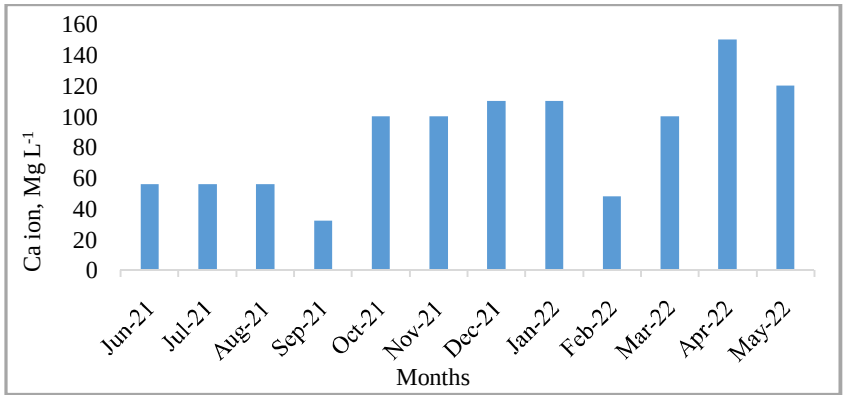


Figure 9. Ca $^{+2}$ ion in drinking water of Timba-Mahudi village of Sajjangargh Tehsil.

Magnesium in water: According to BIS (IS10500:2012), the desired and maximum permissible limits for Magnesium in drinking water are 30 and 100 mg L^{-1}, respectively. In this study, the measured value of magnesium ions in the drinking water sample ranged from 19 mg L^{-1} to 140 mg L^{-1}. The maximum value (140 mg L^{-1}) was observed in April-22 and the minimum (19 mg L^{-1}) in September-21 (winter).

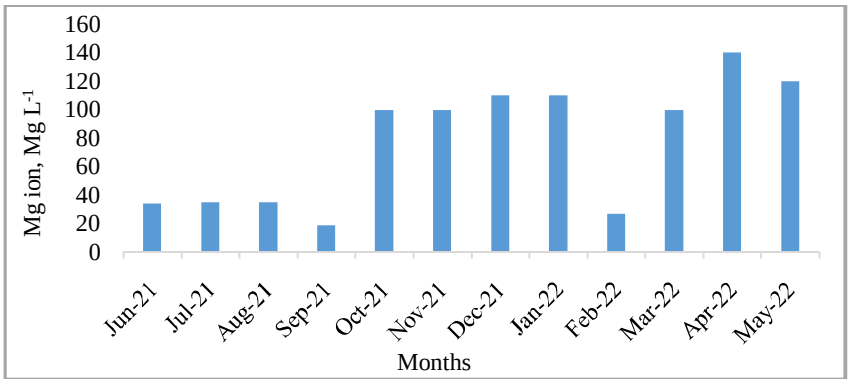


Figure 10. Mg $^{+2}$ ion in drinking water of Timba-Mahudi village of Sajjangargh Tehsil.

Table 3. Water quality parameters with values as various standards for drinking water

S.No.	Water Quality Parameters	BIS Acceptable Values	WHO Standards
1	pH	6.5-8.5	6.5-8.5
2	TDS	500 mg L^{-1}	500 - 1000
3	Total Alkalinity	200 mg L^{-1}	-
4	Total Hardness	300 mg L^{-1}	300 mg L^{-1}
5	Fluoride	1.5 mg L^{-1}	1 mg L^{-1}
6	Nitrate	45 mg L^{-1}	-
7	Calcium	75 mg L^{-1}	-
8	Magnesium	30 mg L^{-1}	-
9	Chloride	250 mg L^{-1}	250 mg L^{-1}
10	Turbidity	1 NTU	-

(Ref: - World Health Organization, Bureau of Indian Standard)

The WQI method has initially been proposed by Horton and Brown *et al.* [16, 17]. WQI was used for the first time to show the physicochemical changes that occur during the year and their impact on the quality of water [18, 19]. The WQI is calculated by using the weighted arithmetic index method [20]. This is the most used method by researchers for the calculation of the WQI. Five quality classes can be identified according to the values (Table-4) [21, 22].

Table 4. WQI Classification value

WQI	Water Class
0 – 25	Excellent quality water
26 – 50	Good quality water
51 – 75	Low quality water
76 – 100	Very low quality water
More than 100	Not-potable water

Table 5. Water Quality Index (WQI)

Months	WQI	Water Quality Class
Jun-21	88.7	Very low quality water
Jul-21	136.21	Not-potable water
Aug-21	136.84	Not-potable water
Sep-21	133.15	Not-potable water
Oct-21	141.85	Not-potable water
Nov-21	141.85	Not-potable water
Dec-21	113.15	Not-potable water
Jan-22	117.96	Not-potable water
Feb-22	107.46	Not-potable water
Mar-22	141.85	Not-potable water
Apr-22	103.5	Not-potable water
May-22	90.57	Very low quality water

Table 5 shows the results for WQI for some selected parameters, and the value ranges from 88.7 to 141.85. Nov-21 and March-22 have maximum while June-21 have minimum value. Higher end of the values makes groundwater not-potable and very low quality drinking water

APPLICATION

Assessment of drinking water quality is done during the assessment period showing that quality is not good for domestic purposes. The results of the current study will help villagers and the state government to assess the drinking water sources of the village and surroundings in the selected block. Such kind of study will help to create a better policy for the management of drinking water sources.

CONCLUSION

In this study, the collected drinking water samples of Timba-Mahudi village of Sajjangarh Block were analyzed for physicochemical parameters of pH, temperature, TDS, total alkalinity, total hardness, calcium, magnesium, nitrate, chloride, and fluoride. The result revealed that except for fluoride and magnesium, almost all the measured parameters were within the standard drinking water quality given by WHO and BIS. The concentration of F- and Magnesium in a few samples was found a little bit higher than the permissible value of BIS. However the concentration of TDS and total alkalinity in almost all samples was found a little bit higher than the standard value of BIS, but within the maximum permissible limit given by the WHO except few samples. The present investigation found that the maximum parameters were not at a level of pollution but the concentration of fluoride was found to be more than the permissible limit, which can have harmful effects on the human community. On the basis of above results from table 4 and 5 water quality index for the selected sample site have values equals or more than 100, so groundwater is not fit for purpose of drinking. On the basis of above results from table 4 and 5 WQI for the selected sample site have values equals or more than 100, so groundwater is not fit for purpose of drinking. From different water quality parameters, it is suggested that further improvement is required to treat the water at these places.

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