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Equitable Groundwater Assessment: In-Depth Analysis of Ground Water Quality in Muslim-Dominated Regions of Kishangarh Block (Alwar, Rajasthan, India)

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Abstract: -The present study was conducted to evaluate the groundwater quality of selected locations in Minority (Special Reference to Muslim villages) areas of Kishangarh block of Alwar District for drinking and irrigation purposes. A total of 15 groundwater samples were collected in Pre Mansoon Session for a period from March 2020 to June 2020.The groundwater samples were analyzed for physicochemical properties, major cations (Ca^{2+}, Mg^{2+}, K^{+}) and anions (Cl^{-}, NO_3^{-}, F^{-}, SO_4^{2-}) in the laboratory using the standard procedures of the American Public Health Association(APHA). This work aimed to understand the status of groundwater quality and the spatial distribution of parameters to recognize the quality of water. The average variation of cations is Ca^{2+} (40.57mg/l) > Mg^{2+} (22.89mg/l) > K^{+}(6.84mg/l) and variation of anions are Cl^{-} (124.45 mg/l) > SO_4^{2-}(33.78 mg/l) > NO_3^{-}(6.02 mg/l) > F^{-}(0.43 mg/l) in ground water of sampling locations.

Keywords: Groundwater, Physicochemical properties, Pollution, Water quality

Introduction: -Water is one of the essential components for the sustenance of life on earth and is the foundation for health, hygiene, progress and prosperity[1]. Groundwater is one of the primary water sources which are a key driver of the domestic, industrial, and agricultural sectors in this block. Over the past few decades, water demand has been increasing continuously due to increasing water and energy balance by all these sectors and continuous increases in population, leading to water shortage and quality degradation. Water is essential for human survival. Its quality must be maintained to prevent any potential health problems. Pollution and contamination are likely causes of the water quality decline[2]. Groundwater is an important source of drinking water in rural areas as the greater part of individuals depend on it for their needs. So, groundwater quality plays an important role in deciding the health of the rural population[3].

Review of Literature: However, a survey of literature reveals that there is not any systematic study on Ground Water Quality Parameters of Minority (Special Reference to Muslim villages) areas of Kishangarh block of Alwar District for drinking and irrigation purposes. Hence present work is being undertake for the studies of water quality parameters of ground water in a parts of Kishangarh block (Alwar). Mangal et al[4] have studied the interpretation of Ground Water Quality Parameters with correlation matrix of different sampling sites of Jaipur (Rajasthan). The Groundwater Quality Index Using Geographic Information System in Parts of Rural Ajmer and Bhilwara (Rajasthan, India) have studied by Swatantra et al[5]. Groundwater contamination can also

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occur through several anthropogenic factors, such as industrialization and excessive use of insecticides and pesticides[6].

Suitability of groundwater for domestic and irrigation purposes is determined by its groundwater geochemistry because each groundwater system has a unique chemical composition

The hydro chemical study exposes the water quality by measuring the concentration of parameters and comparing them with the drinking water and irrigation standards. Groundwater samples have been collected and analyzed for physiochemical characteristics in order to understand the hydrochemistry of the water.[7]

Material & Methods:

Study Area: - Rajasthan, indeed the largest state in India by land area, faces significant challenges when it comes to water resources due to its arid and semi-arid geographical conditions. Kishangarh Bas, located in Alwar district of Rajasthan, India, is an area with significant geological and hydrological interest, particularly when it comes to groundwater research. Groundwater sampling and analysis in this area can provide valuable insights into the region's water quality, availability, and sustainability practices.

Sample Collection: The totals 15 groundwater samples (Table -1) from identified bore well, hand pumps and pond, which are functionally active and extensively used by the local population living there, for drinking and other household purposes, were collected during March 2020 to June 2020 using Glass bottles of 2000 ml capacity from selected locations in Minority (Special Reference to Muslim villages) areas of Kishangarh (Alwar, Rajasthan). The collected Ground water samples were then analyzed for the physical parameters (pH, EC & TDS) and for the chemical analysis of groundwater samples involving major cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}), major anions (F^{-}, NO_3^{-}, SO_4^{2-}, Cl^{-}), and other parameters like Arsenic (As), Zinc (Zn), Iron (Fe), Biochemical Oxygen Demand (BOD), and Chemical Oxygen Demand (COD), various analytical methods are used. All reagents utilized were of analytical grade, and solutions were prepared using distilled water to maintain the integrity and precision of the analysis. Each Physicochemical Parameters often requires a specific analytical method (Table-2) for accurate measurement of ground water samples.

Table-1: Ground Water Sampling Location of Kishangarh Block (Alwar, Rajasthan)

S.no	Sampling Location	Ground Water Source	Sample Code
1	Kolgoan (Govt. hospital) South side	Bore well Water	S1
2	Kolgoan (Madarsa) North side	Hand pump Water	S2
3	Kolgoan (Govt. Tank no 4) North-East side	Bore well water	S3
4	Khanpur Mewan(PNB Bank)North side	Hand Pump water	S4
5	Khanpur Mewan South Side	Pond water	S5
6	Khanpur Mewan(Govt. Hospital) East side	Bore well water	S6

7	Ghasoli(Govt School)North side	Hand Pump water	S7
8	Ghasoli(Panchayat Office) West Side	Hand Pump water	S8
9	Ghasoli(Private School) East Side	Bore well water	S9
10	Moosakhera(Govt Hospital) North side	Borewell water	S10
11	Moosakhera(Govt tank) North side	Borewell water	S11
12	Moosakhera(Atal seva kendar) North side	Borewell water	S12
13	Khora Peepli (Govt school) East side	Borewell water	S13
14	Khora Peepli (Dispensery) South side	Borewell water	S14
15	Khora Peepli (Pond) West side	Borewell water	S15

Table-2 -Analytical methods for ground water physicochemical parameters analysis

S.no.	Physicochemical Parameters	Analytical Methods
1	pH, EC & TDS	Digital Portable Water Analyzer
2	F^-	Ion Selective Method
3	NO_3^- & SO_4^{2-}	UV Spectrophotometric
4	Ca^{2+} & Mg^{2+}	Complex metrically Method
5	Cl^- & TH	Volumetrically Method
6	Na^+ & K^+	Flame Photometric Method
7	As, Zn & Fe	Absorption Spectrophotometer
8	BOD	Dilution Method
9	COD	Titrimetric Method

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Result & Discussions: - Groundwater samples from 15 sampling locations (Table -1) of Kishangarh block (Alwar, Rajasthan) collected from March 2020 to June 2020 and evaluated for different physicochemical parameters. The results of the groundwater analysis for sampling locations (Table -1) S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14 & S15, were evaluated for chemical characteristics of groundwater (Table -3 & 4).

Table 3: Physicochemical Ground Water Quality Parameters of Sampling Locations of Kishangarh Block (Alwar, Rajasthan)

Table 4: Statistical Data of Physicochemical Ground Water Quality Parameters of Sampling Locations of Kishangarh Block (Alwar,Rajasthan)

Parameters	Average	Minimum	Maximum	Median	Standard Deviation	Standard Drinking Water :Specification as per IS-10500: 2012	
						Desirable limit	Permissible limit
pH	7.018	5.3	8.2	7.3	0.785168	6.5-8.5	---
EC(uS/cm)	1383.867	810	1745	1356	229.7228	300 us/cm	----
TDS (Mg/L)	804.8667	345	1154	859	228.3837	500 Mg/L	2000 Mg/L
Ca (Mg/L)	40.576	3	73.6	36.8	18.12643	75 Mg/L	200 Mg/L
Mg (Mg/L)	22.89133	11.66	35.9	21.87	8.312112	30 Mg/L	100 Mg/L
K (Mg/L)	6.846667	0	25.2	6.1	5.425978	----	----
Cl- (Mg/L)	124.4557	56.52	214	134.7	58.21658	250 Mg/L	1000 Mg/L
SO_4^{2-} (Mg/L)	33.288	8.1	89	16.2	30.33732	200 Mg/L	400 Mg/L
NO_3^-(Mg/L)	6.026667	1.4	13.5	4.6	4.259522	45 Mg/L	No relaxation
F- (Mg/L)	0.438667	0.13	0.9	0.4	0.26243	1.1 Mg/L	1.5 Mg/L
BOD (Mg/L)	8.88	1	106	1.5	26.88487	---	---
COD (Mg/L)	4.826667	2	8	5	1.686699	---	---
TH (Mg/L)	188.2667	14	320	156	79.17654	300 Mg/L	600 Mg/L
% Na	38.45333	23	59	33.4	12.6662	---	---
Fe (Mg/L)	0.215333	0.02	1.1	0.12	0.285379	0.3 Mg/L	1 Mg/L

Parameters	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15
pH	6.8	7.5	7	6.8	7.56	5.5	6.3	5.3	7.45	8.2	7.3	7.5	7.3	7.4	7.36
EC	1456	1452	1202	1202	1745	1665	1584	1356	1356	1364	1343	1270	1318	1635	810
TDS	966	854	688	566	1154	345	456	600	895	955	872	825	859	1063	975
Ca	23	23	35	30	47	65	59	48	48	35	31.04	51.2	36.8	3	73.6
Mg	27	32.2	32.2	21	23.5	17	14	16	16	12	31.04	35.9	11.66	21.87	32.0
K	7.6	0	3.6	6.5	6.5	5.6	25.2	4.6	4.6	5.2	7.6	6.9	7.1	5.6	6.1
Cl-	56.52	89.53	74	85	189	144	214	158	148.32	174.2	78.01	127.6	141.8	124..81	62.4
SO_4^{2-}	8.4	8.7	74.6	56	48	46	87	89	15.32	19.5	8.4	9.2	8.1	16.2	12.4
NO_3^-	2.3	1.5	3.2	4.6	8.5	9.6	9.3	11.6	11.6	13.5	1.4	1.9	2.4	6.2	2.8
F^-	0.22	0.32	0.4	0.66	0.66	0.8	0.6	0.6	0.6	0.9	0.21	0.18	0.13	0.16	0.14
BOD	2.9	2.6	3.6	4.2	1.3	106	1.3	1.6	1.3	1.5	2.1	1	1.1	1.2	1.5
COD	6	4	4.2	4.2	4	6	5	8	8	5	5	2	3	3	5
TH	156	152	156	121	145	258	258	156	254	158	144	276	14	256	320
% Na	32.1	54	45	56	23	28	59	36	36	59	31.0	33.4	29.8	28.2	26.3
As	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zn	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Fe	0.12	0.12	0.02	0.05	0.12	0.12	0.09	0.5	0.5	0.02	1.1	0.1	0.11	0.15	0.11

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1. **pH**: The variation of pH values during March 2020 to June 2020 shown in graphical pattern (Figure-1). The variation of pH value of ground water samples varying between 5.3(S8) to 8.2(S10). The mean value for pH is 7.018, while the standard deviation calculated is 0.785. In sampling sites, out of 15samples (Table -3), three samples (S6, S7, S8,) have lower value than Desirable limit. The Desirable limit of pH values for drinking water is specified as 6.5 to 8.5 as per BIS: 2012(Table-4).

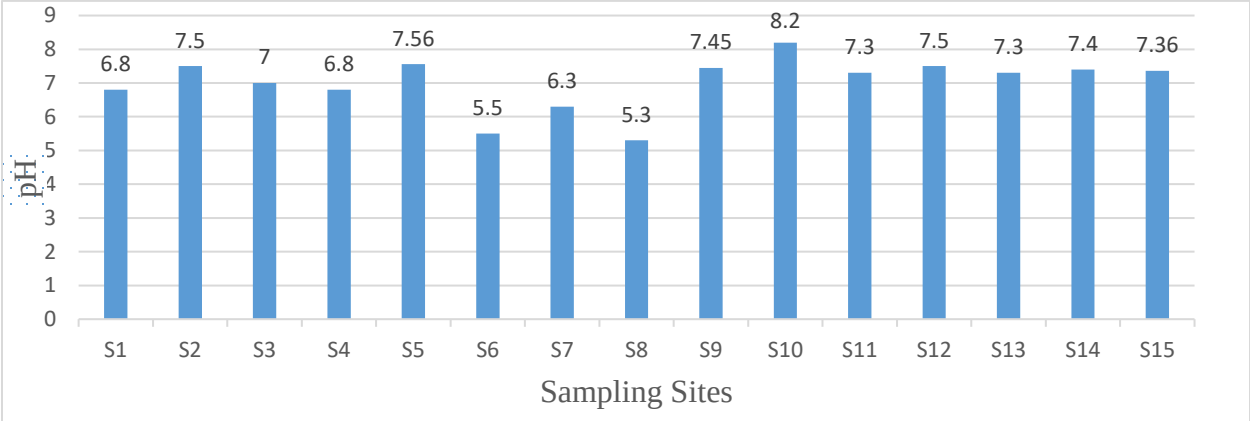

Figure 1: Variation of pH in sampling sites ground water of Kishangarh block

2. **EC**: The values of electrical conductance(Figure-2) of groundwater samples are ranged from 810(S15) to 1745µS/cm (S5) with average value 1383.86µS/cm and standard deviation calculated is 229.72 µS/cm (Table-3&4). The permissible limit of EC values for drinking water is specified as 1400 µS/cm as per WHO: 2003.In sampling sites, out of 15 samples, six samples (S1, S2, S5, S6, S7 &S14) have higher value than permissible limit.

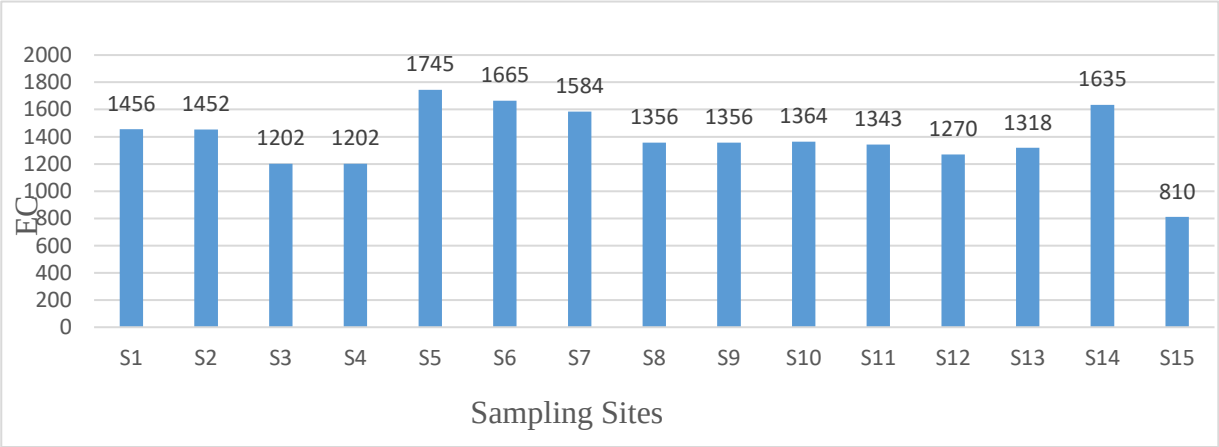

Figure 2: Variation of EC in sampling sites ground water of Kishangarh block

3. **TDS**: - The TDS of groundwater samples ranged from 345 (S6) to 1154 mg/L (S5) mg/L (Table -3) with an average value 804.86 mg/L and standard deviation is 228.38 mg/L (Table -4). The Desirable limit & Permissible limit of TDS values for drinking water is

specified as 300mg/L and 2000mg/L as per BIS: 2012 The variation of TDS values during March 2020 to June 2020 shown in graphical pattern (Figure-3).

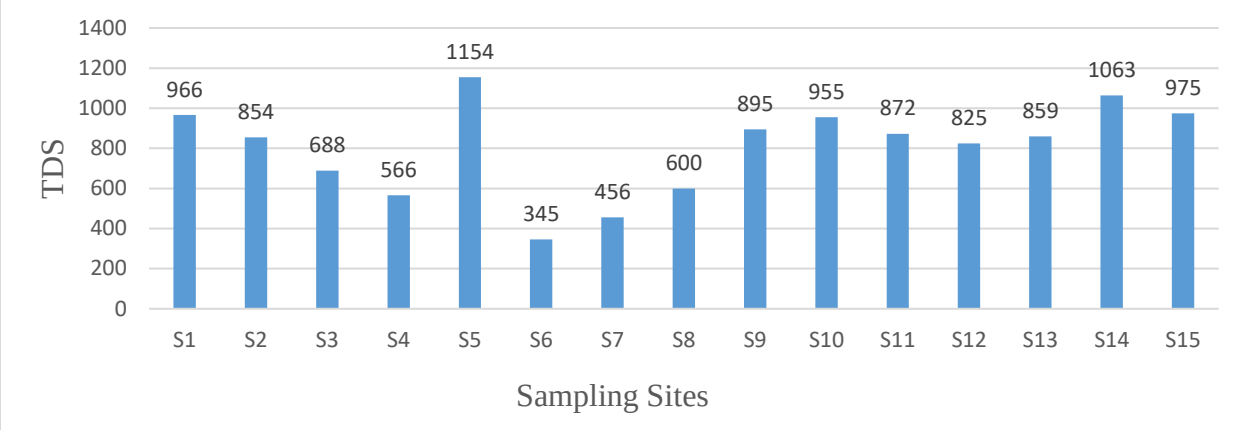

Figure 3: Variation of TDS in sampling sites ground water of Kishangarh block

4. **Calcium (Ca^{2+}) & Magnesium (Mg^{2+}):** - Calcium is important ion in apprising the hardness to the water. The calcium ion in groundwater samples ranged from 3mg/L (S14**)** to 73.6 mg/L (S15) with average of 40.57 mg/L and calculated standard deviation is 18.12 mg/L (Table -3 & 4). The limit of Ca^{2+} ion values for water is specified as 75mg/L-200 mg/L as per BIS:2012.

   Magnesium ion concentrations ranged from 11.66(S13) to 35.9(S12) mg/L with average 21.87 mg/Land calculated standard deviation value is 21.87mg/L (Table -3 & 4). The limit of Mg^{2+} ion values for water is specified as 30mg/L-100mg/L as per BIS:2012.
5. **Potassium (K^{+}):** -Potassium values ranged from 0.0 (S2) to 25.2 mg/L (S7) and the average of 6.84 mg/L and calculated standard deviation value is 6.1 mg/L (Table -3 & 4).
6. **Chloride(Cl^{-}):** The ground water samples in the present study have chloride content within a relatively narrow range, from 56.52 mg/L(S1) to 214 mg/L(S7) (Table -3). According to the Bureau of Indian Standards (BIS), the acceptable limit for chloride in drinking water ranges from 250 mg/L to 1000 mg/L (Table -4). Since all the samples in this study fall below the lower end of this range, they meet the desirable limit set by BIS for chloride content in drinking water.
7. **Nitrate (NO_3^{-})** **T**he variability in nitrate concentration in groundwater samples, ranging from 1.4mg/L(S11) to 13.5 mg/L(S10), with an average of 6.02 mg/L (Table -3.) This variation can arise from both natural sources and human activities such as fossil fuel combustion and the use of nitrate fertilizers. According to the Bureau of Indian Standards (BIS), the maximum allowable limit of nitrate in drinking water is 45 mg/L (Table -4). It's crucial to monitor nitrate levels in drinking water because exceeding this limit can lead to health issues, particularly in infants. When nitrate levels surpass 45 mg/L, it can result in a condition known as Methemoglobinemia or "blue baby syndrome" in infants, where nitrate interferes with the blood's ability to transport oxygen, causing a bluish tint to the skin. Given that the nitrate concentrations in the groundwater samples remain below the BIS

limit, ranging from 1.4mg/L to 13.5 mg/L, it suggests that the water from these samples is within safe limits for drinking in terms of nitrate content. However, continued monitoring is important to ensure that nitrate levels remain within acceptable ranges, especially considering the potential health risks associated with elevated nitrate concentrations.

8. **Sulphate (SO_4^{2-}):** - The Sulphate ion concentration in groundwater samples ranges from 8.1 mg/L(S13) to 89mg/L(S8), with an average concentration of 33.78 mg/L and a standard deviation of 16.2 mg/L (Table -3 &4). According to the guidelines of the Bureau of Indian Standards (BIS), the permissible range of Sulphate in drinking water is between 200 mg/L to 400 mg/L (Table -4).Since all the Sulphate concentrations in the provided groundwater samples fall below the BIS range, ranging from 8.1 mg/L to 89mg/L, it indicates that the water samples meet the BIS guidelines and are free from sulfate-related concerns .Despite the presence of Sulphate in the groundwater samples, it's noted that all the water samples are free from Sulphate -related issues. High levels of Sulphate in drinking water can sometimes result in a bad taste.
9. **Fluoride (F^-):** -Fluoride is indeed important for human health, particularly for the normal mineralization of bones and the formation of dental enamel. However, excessive fluoride concentration in drinking water can lead to negative health consequences, especially when it exceeds 1.5 mg/L. Excessive fluoride intake can cause dental fluorosis, skeletal fluorosis, and other health issues. The fluoride ion concentrations in groundwater samples, ranging from 0.13 mg/L (S13) to 0.9 mg/L(S10), with a mean value of 0.4386 mg/L and a standard deviation of 0.2624 mg/L (Table -3&4).
10. **Biological Oxygen Demand (BOD)**: -The range of Biological Oxygen Demand (BOD) in the ground water samples is quite broad, spanning from 1 mg/L(S12) to 106 mg/L(S6) (Table -3&4). BOD measures the amount of dissolved oxygen that microorganisms need to decompose organic matter in water over a specific period, typically five days at 20°C.In this range, a BOD of 1 mg/L suggests relatively low organic pollution, while a BOD of 106 mg/L indicates a high level of organic pollutants. High BOD values can deplete dissolved oxygen levels in water bodies as microorganisms metabolize the organic matter.
11. **Chemical Oxygen Demand (COD**): -COD is another measure of water quality that indicates the amount of oxygen required to chemically oxidize organic and inorganic matter in water. It serves as an indicator of the level of pollution or contamination by organic substances. The Chemical Oxygen Demand (COD) in groundwater samples is from 2 mg/L(S12) to 8 mg/L (S8) (Table -3&4). In this range, the COD values are relatively low, suggesting a lower level of organic and inorganic pollutants present in the groundwater samples. However, even low levels of COD can indicate some degree of contamination, so continued monitoring and assessment of water quality are essential to ensure the safety and suitability of groundwater for various uses, including drinking water supply and ecosystem health.
12. **Total Hardness (TH)**: -Total Hardness refers to the concentration of dissolved minerals, primarily magnesium and calcium ions, in water. It's an important parameter for assessing

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water quality because it can affect the suitability of water for various purposes, including domestic, industrial, and agricultural uses. The range for Total Hardness in Ground water samples is from 14 mg/L to 320 mg/L (Table -3&4). In this range, a Total Hardness of 14 mg/L indicates relatively soft water, while a value of 320 mg/L suggests very hard water. The hardness of water can influence its taste, the effectiveness of cleaning agents, the formation of scale in pipes and appliances, and its suitability for irrigation.

13. **Sodium Percentage (Na%):** -The sodium content is often expressed as the sodium percentage for the purpose of irrigation. The sodium percentage is a measure of the sodium ion concentration relative to the total cation concentration in the ground water samples.

The sodium in irrigation water is also expressed as sodium percentage.

$$\% \text{ Na} = \frac{(Na^{+} + K^{+}) \quad \text{x } 100}{(Na^{+} + K^{+} + Ca^{2+} + Mg^{2+})}$$

Where the concentration of Sodium, potassium, calcium and magnesium are in mg/L. The range for Sodium percentage in Ground water samples is from 23% to 59%(Figure-4) Among the groundwater samples analyzed, 10 of them fall within the "Good Category" classification for groundwater. Sodium percentage categories are help to assess the suitability of ground water for different purposes, such as irrigation. These categories shown in table 5.

Table 5-Classification of Irrigational Ground water quality based on Sodium percentage (Na%)

Range of Na%	Category of Ground water	Ground Water Sample
< 20	Excellent	Nil
21-40	Good	S1, S5, S6, S8, S9, S11, S12, S13, S14 &S15
41-60	Permissible	S2,S3,S4 ,S7,S10
61-80	Doubtful	Nil
> 80	Unsuitable	Nil

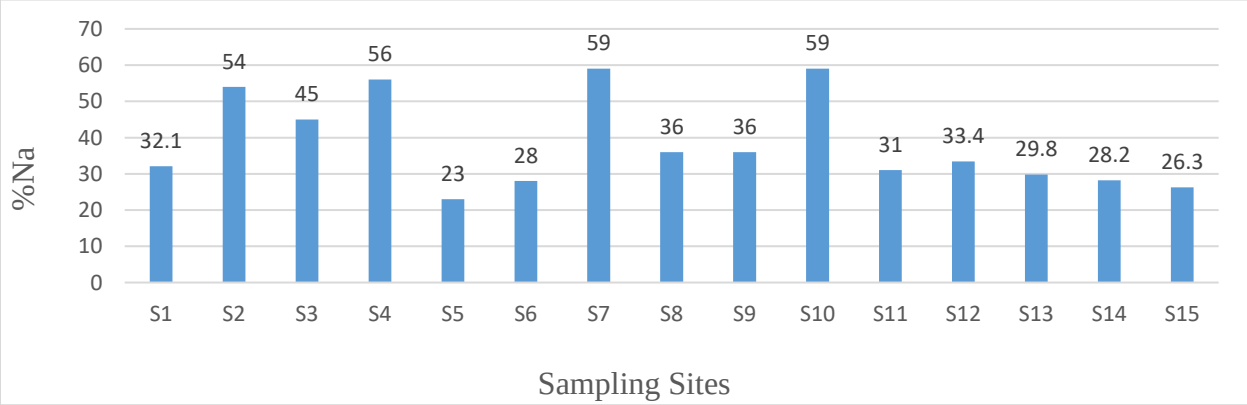

Figure 4: Variation of % Na in sampling sites ground water of Kishangarh block

14. **Coliform Organism**: -The results (Table -3) showed the absence of Coliform Organism in ground water samples. The absence of coliform organisms in groundwater samples is indeed a strong indicator of good water quality, especially concerning fecal contamination. Since coliform bacteria are commonly found in the intestines of warm-blooded animals, their presence in groundwater suggests possible contamination with fecal matter, which can harbor harmful pathogens.

15. **Heavy Metals**: -When analyzing groundwater samples for heavy metal ions and finding that Iron (Fe) is present (0.02mg/L to 1.1 mg/L) but Arsenic (As) and Zinc (Zn) are below detectable limits (BDL) (Table -3). As and Zn below detectable limits generally indicates minimal risk from these metals in the groundwater samples at the time of testing.

Conclusion: -The Physicochemical analysis of ground water samples provides valuable information about the quality of groundwater in the Kishangarh block area (Alwar, Rajasthan), which is essential for ensuring access to safe and potable drinking water for the local population. This suggests that the water from these samples is suitable for drinking in terms of all ground water quality parameters. Groundwater samples falling within the "Good Category" likely have Sodium percentages within an acceptable range for irrigation, indicating that they may not pose significant risks to soil quality or crop growth.

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