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Research Articles

“PHYSICO-CHEMICAL STUDY OF BOREWELL WATER OF REWA (M.P.)”

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ABSTRACT

Ground water samples of bore well Collected from different locations of municipal corporation Rewa, Madhaya Pradesh. The present study was undertaken to characterize the physicochemical parameter such as pH, TSS, TDS, Total Alkalinity (TA), calcium hardness (CH), Magnesium hardness (MH), Total hardness (TH), DO, chemical oxygen demand (COD), Biological Oxygen Demand(BOD) etc. Each parameter was compared with its standard permissible and excessive limits as prescribed by WHO. The study reveals that the ground water of area needs some degree of treatment before consumption it also needs to be protected from the perils of contamination.

KEYWORDS: physicochemical parameter, Total hardness, chemical oxygen demand

INTRODUCTION

Ground water is used for potential source of drinking water, irrigation purpose, domestic, and industrial water supply, Rapid urbanization and industrialization are the major cause which affects the availability and quality of ground water.[1-2] According to WHO about 80% of all the diseases in human being are caused by contaminated water[3], so water quality has acquired as much importance as water quantity[4]. India is heading

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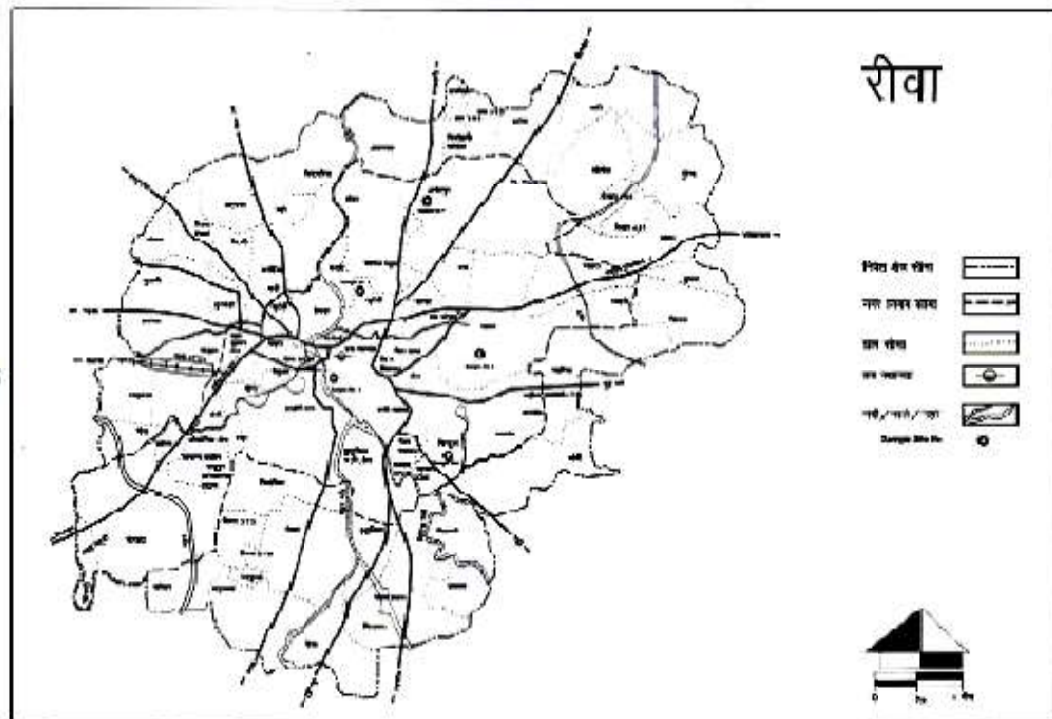
towards a freshwater crisis mainly due to improper management of water resources and environmental degradation. The fresh water crisis is already evident in many parts of India.[5] It is vital to regularly monitor the quality of ground water and to devise ways and means to protect it. The water from the sources viz, falls, lakes, hand pump, open well, and bore well are contaminated with domestic, and industrial waste and likely to cause water related diseases.[7]

In this study, physicochemical parameters are determined to draw a conclusion on the quality of water whether it is good or unfit for drinking purpose.

The main objectives of the study are –

- Collection of ground water samples from bore wells of municipal corporation Rewa, Madhya Pradesh.
- Analysis of quality parameter such as pH, Total alkalinity, TSS, TDS, Hardness , Chloride etc

Statement of Problems: Ground water is an important source of water for the inhabitants of the Rewa City of Madhya Pradesh as majority of the residents depends on this source. Due to overpopulation in the City, overconsumption of water by the residents from



ground water sources is increasing causing the reduction of the quality and quantity of groundwater. The concrete cover on the ground surface is preventing the normal ground water recharge. The pollutants on soil and the leakage of sewage from the sewerage is also causing ground water pollution.

Climate

Rewa has a humid subtropical climate, with cold, misty winters, a hot summer and a humid monsoon season. Summers start in late March and go on till mid-June, the average temperature being around 30 °C (86 °F), with the peak of summer in May, when the highs regularly exceed 45 °C (104 °F). The monsoon starts in late June and ends in late September. These months see about 40 inches (1025 mm) of precipitation. The average temperature is around 25 °C (77 °F) and the humidity is quite high. Temperatures rise again up to late October when winter starts, which lasts up to early March. Winters in Rewa are cold and misty with average temperatures around 15 °C (58 °F) and little rain. The winter peaks in January when temperatures may drop close to freezing on some nights. The total annual rainfall is about 1128 mm (44 inches).

Demographics

As of 2011, Rewa had a population of about 2,354,220 out of which 1,219,980 are males and 1,134,240 are females. Rewa has an average literacy rate of 53.42%, male literacy is 63.67%, and female literacy is 42.49%. In Rewa, 14.41% of the population is under 6 years old.

Experimental

(A) Water sampling

The Water samples were collected from bore wells. The samples were collected in sterilized bottles and were analyzed just after sampling.[9] The temp of the samples were measured in the field at the time of sample collection.

(B) Analytical methods

Analysis was carried out for various water quality parameters pH meter (systronics digital model) was used to determine the hydrogen ion concentration. Electrical conductivity calculated by using conductivity meter. Total alkalinity (TA) was estimated by neutralizing with standard HCl acid. Salinity and Total dissolved solids

(TDS) were estimated using systronics water analyzer. Total hardness (TH) and calcium hardness (CH) as CaCO₃ were determined titrimetrically, using standard EDTA. The calculation of Magnesium hardness (MH) was done by subtracting the CH from TH value. The DO, BOD and COD were estimated as per standard procedures.[9]

RESULT AND DISCUSSION

For the purpose of revealing the water quality of samples covering the study area the physicochemical parameters have been listed systematically and presented in **Table: 1-11**. The parameters viz, pH and total dissolved solids show the *physical characteristics* of the ground water under the study area. The *chemical characteristics* of the groundwater under the study area are known by the parameters viz, total hardness, calcium hardness, magnesium hardness, fluoride, alkalinity and dissolved oxygen.

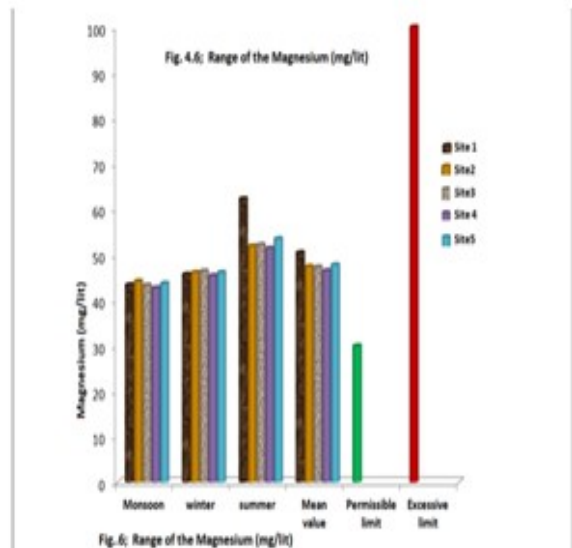
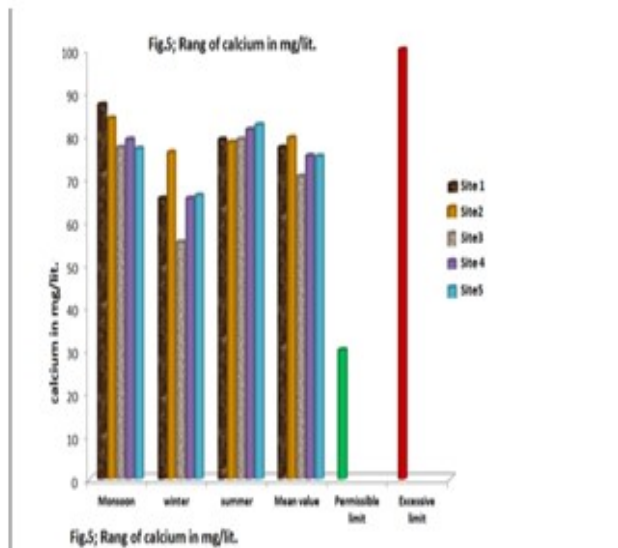
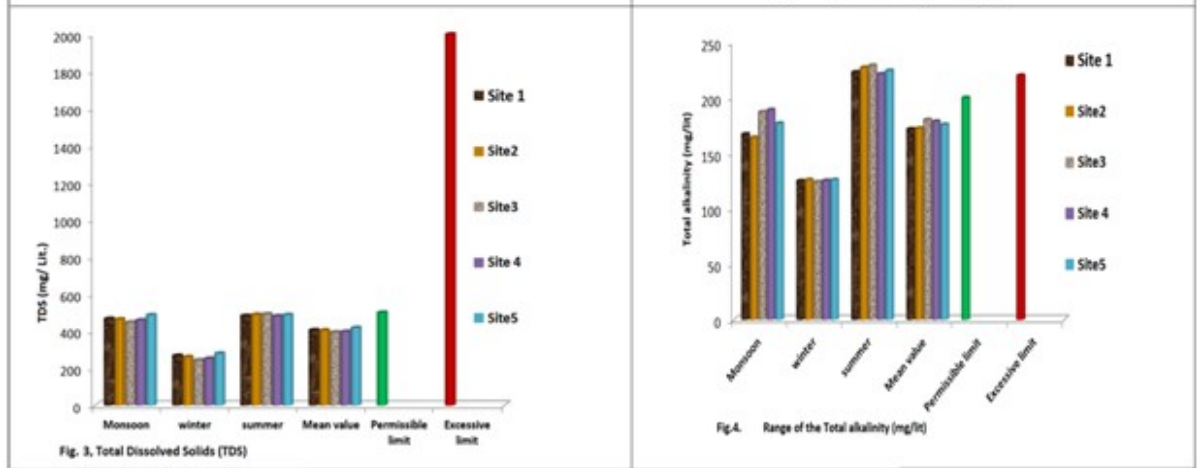
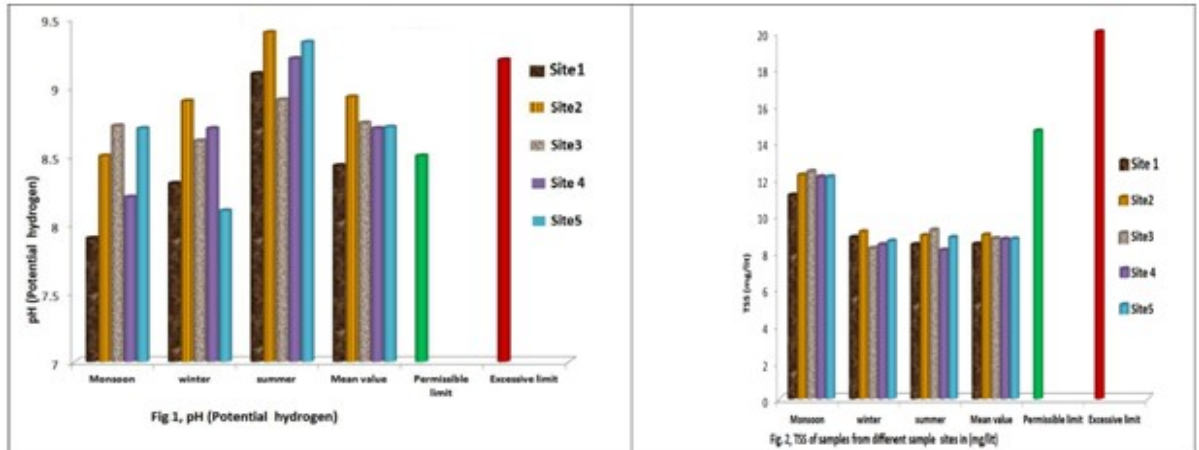
pH (potential hydrogen): pH is the hydrogen ion activity or concentration in the given water sample. pH equals to negativity log₁₀ of hydrogen ion concentration. The experimental data have been recorded as in table: 1, the pH values of different water sample, it has been observed that(Fig.1); in summer season, the pH value was 9.4 which is over from the excessive limit at the site no. 2; while lowest pH is observed 7.9 in monsoon session, at the site No. 1. Maximum Average pH value was recorded 8.93 at site No. 2, while the minimum Average pH value was recorded 8.70 at site No. 1.

Total Suspended Solids (TSS): This was the particulate matter, which was found to be suspended in the colloidal form in water body. The experimental data have been recorded as in table: 2, it is observed that Total Suspended solids value was maximum 12.4 mg/lit at the site No. 3 in the monsoon season while, the Minimum TSS, were recorded 8.1 mg/lit at the site no. 4 in summer session. Average Maximum Total Suspended Solids was recorded 9.47 mg/lit at site No. 2, while minimum Average Total Suspended Solids is recorded at site No. 1, which was 9.47 mg/lit. Overall, The TSS is permissible limit in all samples.

Total Dissolved Solids (TDS): These were the dispersed particles in slurry that could be separated by filtration, which has found to be suspended in the colloidal form in water body. These particles can't dissolve in the water. it is observed that in the monsoon

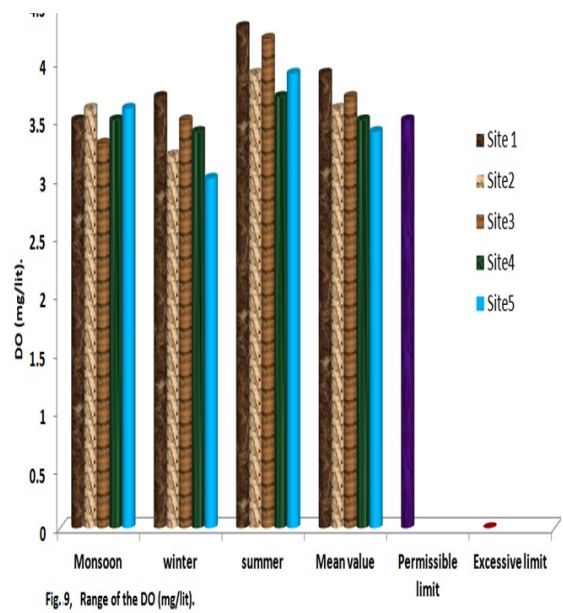
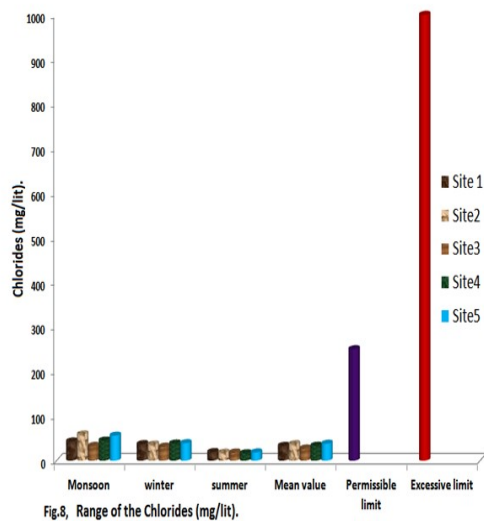
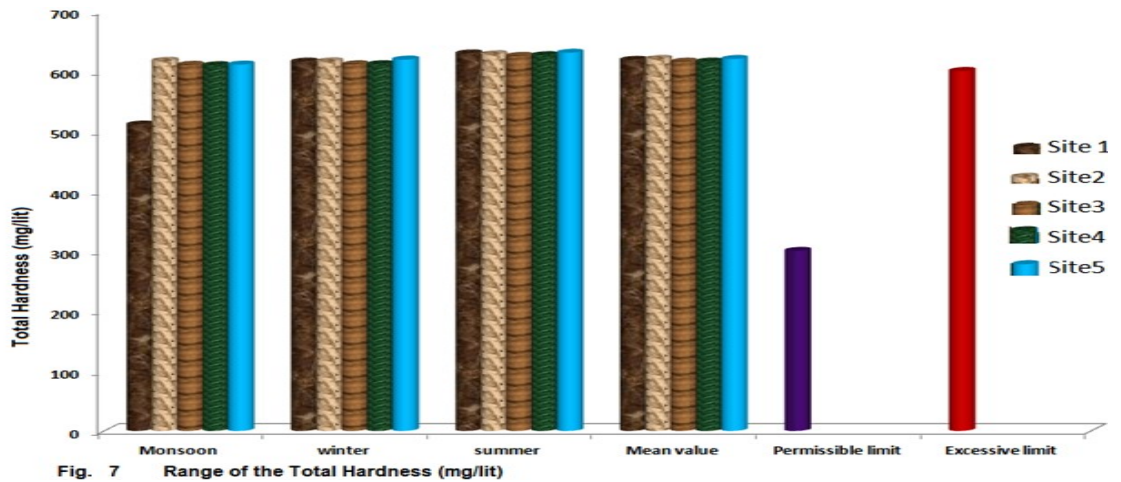
season, maximum value observed 498 mg/lit at the site no. 5 and Minimum TSS, recorded were 247 mg/lit at the site no. 3, in winter session. Maximum Average Total Suspended Solids recorded at site No. 2, was 418 mg/lit. ; Minimum Average Total dissolved solids, is recorded at site No. 3, which was 393 mg/lit. (Fig.4.3). overall, it is concluded that the TDS values are under permissible limit.

Total Alkalinity (TA): Total alkalinity is the total concentration of the bases in water expressed as part per million (ppm) or milligrams per liter (mg/lit.) of calcium carbonate (CaCO_3). These bases are usually bicarbonates (HCO_3^-) and carbonates (CO_3^{2-}), and they act as a buffer system that prevents drastic changes in pH. For example in water with low alkalinity, pH might fluctuate from 6 or lower to as high as 10 or above; while in high alkalinity waters, pH might fluctuate from about 7.5 to 8.5. it has been observed that maximum value of Total Alkalinity (TA) recorded in the summer season, 229.1 mg/lit at the site no. 3 which is excessive to the limit, while the Minimum TA, is recorded 124.2 mg/lit at the site no.3 in winter session. Maximum Average Total alkalinity is recorded 180.19 mg/lit at site No. 3, and minimum Average Total alkalinity is recorded 172.47 mg/lit. at site No. 2. (Fig.4.4). it is concluded that some sample site have observed the excessive to the given WHO limit.



Calcium (Ca): Calcium is one of the most abundant substances in water as proposed by many workers. It has got a high affinity to absorb on the soil particles; therefore, the cation exchange equilibrium and presence of other cation greatly influence its

concentration in water. It is observed that Maximum value of Calcium (Ca) recorded in the summer season, 82.5 mg/lit at the site no. 5 and Minimum Calcium (Ca), is recorded 55.2 mg/lit at the site no. 2 in summer session. Maximum Average Calcium (Ca) is recorded **76.16** mg/lit at site No. 2, and minimum Average Total alkalinity is recorded **70.5** mg/lit. at site No. 3. (Fig.5). it is observed that excessive limit crossed at sample sites No. 134 and 5 in monsoon session. While in summer session all samples are crossed excessive limit.



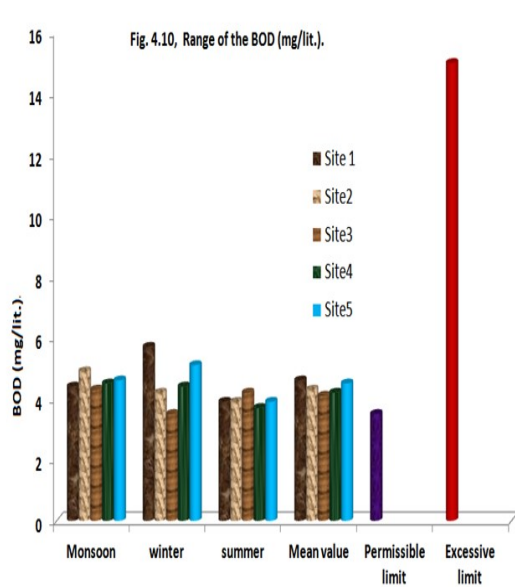


Fig. 4.10, Range of the BOD (mg/lit.).

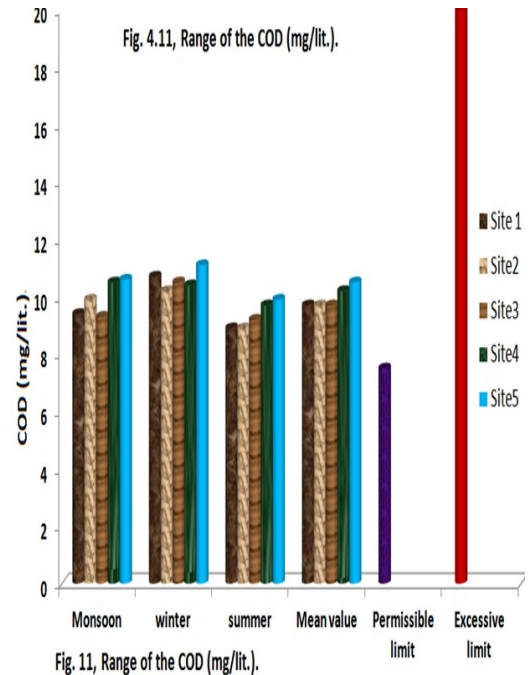


Fig. 4.11, Range of the COD (mg/lit.).

Table: 1
pH of samples from different sites

Session	Site 1	Site 2	Site 3	Site 4	Site 5
Monsoon	7.9	8.5	8.72	8.2	8.7
winter	8.3	8.9	8.61	8.7	8.1
summer	9.1	9.4	8.91	9.21	9.33
Mean value	8.43	8.93	8.74	8.7	8.71
Permissible limit	7.0-8.5				
Excessive limit	9.2				

Table: 2
Range of the TSS of samples from different sites in (mg/lit)

Session	Site 1	Site 2	Site 3	Site 4	Site 5
Monsoon	11.1	12.2	12.4	12.1	12.1
winter	8.8	9.1	8.2	8.4	8.6
summer	8.4	8.9	9.2	8.1	8.8
Mean value	9.4	10.0	9.9	9.5	9.8
Permissible limit	7.5-14.6				
Excessive limit	20				

Table: 3
Range of the Total Dissolved Solids in (mg/lit.)

session	Site 1	Site2	Site3	Site4	Site5
Monsoon	467	464	447	459	498
winter	278	270	247	252	280
summer	483	489	492	481	488
Mean value	406	404.7	393	397	418
Permissible limit	500				
Excessive limit	2000				

Table: 4
Range of the Total alkalinity (mg/lit)

session	Site 1	Site2	Site3	Site4	Site5
Monsoon	177.2	164.2	187.4	189.3	177.1
winter	125.1	126.1	124.2	125.4	126.1
summer	213.1	217.2	229.1	219.4	214.5
Mean value	174.7	172.47	180.19	178.63	175.87
Permissible limit	200				
Excessive limit	220				

Table: 5
Range of the Calcium in (mg/lit)

Session	Site 1	Site2	Site3	Site4	Site5
Monsoon	77.2	74	77.2	79.1	77.1
winter	65.4	76.1	55.2	65.4	66.1
summer	79.1	78.4	79.1	81.4	82.5
Mean value	73.9	76.16	70.5	75.3	75.2
Permissible limit	75				
Excessive limit	100				

Table:6
Range of the Magnesium (mg/lit)

session	Site 1	Site2	Site3	Site4	Site5
Monsoon	23.4	24.2	23.3	22.7	23.7
winter	15.7	16.1	16.4	15.4	16.1
summer	22.3	21.9	22.2	21.4	23.5
Mean value	20.37	20.73	20.53	19.83	21.1
Permissible limit	30				
Excessive limit	100				

Table: 7
Range of the Total Hardness (mg/lit)

Session	Site 1	Site2	Site3	Site4	Site5
Monsoon	510.66	617	610.33	609.7	610.7
winter	615.7	616.1	611.2	611.4	619.1
summer	629.3	627.9	6125.2	626.4	630.5
Mean value	618.55	620.33	615.57	615.83	620.10
Permissible limit	300				
Excessive limit	600				

Magnesium (Mg): Magnesium is determined as the difference between total hardness and calcium hardness. Magnesium also occurs in all kind of natural water sample but its concentration remains generally lower than the calcium hardness. maximum Range of the Magnesium 24.2 (mg/lit) is recorded in the monsoon season at the site no. 2 and Minimum Range of the Magnesium, is recorded 15.4 mg/lit at the site no. 4 in summer session. Maximum Average Range of the Magnesium is recorded 21.1 mg/lit at site No. 5, and minimum Average Range of the Magnesium is recorded 19.83 mg/lit. at site No. 3. (Fig. 6)

Total Hardness: Hardness was originally defined as the capacity of water to precipitate soap. Calcium and magnesium precipitate soap, forming a curd which causes “bathtub ring” and dingy laundry (yellowing, graying, loss of brightness, and reduced life of washable fabrics), feels unpleasant on the skin (red, itchy, or dry skin), and tends to waste soap. maximum Range of the Total Hardness 630.5 (mg/lit) is recorded in the summer season at the site no. 5 and Minimum Range of the Total Hardness, is recorded 510.7

mg/lit at the site no. 1 in Monsoon session. Maximum Average Range of the Total Hardness is recorded 620.33 mg/lit at site No. 3, and minimum Average Range of the Total Hardness is recorded 615.57 mg/lit. at site No. 3. (Fig.7)

Table: 8
Range of the Chlorides (mg/lit).

Session	Site 1	Site2	Site 3	Site 4	Site5
Monsoon	43	59	33	45	56
winter	37	36.1	31.2	38.4	39.1
summer	19.3	17.9	18.2	16.6	18.5
Mean value	33.1	37	27.2	33.4	37.86
Permissible limit	250				
Excessive limit	1000				

Table: 9
Range of the DO (mg/lit).

Session	Site 1	Site2	Site3	Site4	Site5
Monsoon	3.5	3.6	3.3	3.5	3.6
winter	3.7	3.2	3.5	3.4	3.0
summer	4.3	3.9	4.2	3.7	3.9
Mean value	3.9	3.6	3.7	3.5	3.4
Permissible limit	3.5				
Excessive limit	-				

Table: 10
Range of the BOD (mg/lit.).

Session	Site 1	Site2	Site3	Site4	Site5
Monsoon	4.4	4.9	4.3	4.5	4.6
winter	5.7	4.2	3.5	4.4	5.1
summer	3.9	3.9	4.2	3.7	3.9
Mean value	4.6	4.3	4.1	4.2	4.5
Permissible limit	3.5				
Excessive limit	15				

Table: 11
Range of the COD (mg/lit.).

Session	Site 1	Site2	Site3	Site4	Site5
Monsoon	9.4	9.9	9.3	10.5	10.6
winter	10.7	10.2	10.5	10.4	11.1
summer	8.9	8.9	9.2	9.7	9.9
Mean value	9.7	9.7	9.7	10.2	10.5
Permissible limit	7.5				
Excessive limit	20				

Chlorides: Looking towards the contamination of water body, during the present investigations efforts were made to evaluate the amount of Chlorides in the various site samples. The experimental observations have been indicated that maximum Range of the Chlorides 59.0 (mg/lit) is recorded in the Monsoon season at the site no. 2 and Minimum Range of the Chlorides , is recorded 16.6 mg/lit at the site no. 4 in summer session. Maximum Average Range of the Chlorides is recorded 37 mg/lit at site No. 1, and minimum Average Range of the Chlorides is recorded 27.2 mg/lit. at site No. 3. (Fig. 8)

Dissolved Oxygen (DO): DO is the oxygen concentration present in a given water sample. The concentration of oxygen reflects whether the process undergoing is aerobic or anaerobic. It is observed that maximum Range of the DO, 4.3 (mg/lit) is recorded in the summer season at the site no. 1 and Minimum Range of the DO , is recorded 3.0 mg/lit at the site no. 5 in winter session. Maximum Average Range of the DO is recorded 3.8 mg/lit at site No. 1, and minimum Average Range of the DO is recorded 3.4 mg/lit. at site No. 5. (Fig.9)

Biological Oxygen Demand (BOD): It has been found that, BOD plays an important role for the existence of lives. Looking towards the contamination of water body, during the present investigations efforts were made to evaluate the amount of BOD in the various water samples. maximum Range of the BOD 5.7 (mg/lit) is recorded in the winter season at the site no. 1 and Minimum Range of the BOD , is recorded 3.7 mg/lit at the site no. 4 in summer session. Maximum Average Range of the BOD is recorded 4.6 mg/lit at site

No. 1, and minimum Average Range of the BOD is recorded 4.1 mg/lit. at site No. 3. (Fig.10)

Chemical Oxygen Demand (COD): Since COD does not work independently hence its performance will depend on so many allied factors. Low value of COD comparatively in colder months may be due to lesser quantity of total solids, dissolved solids, and suspended solids in water as well as to the quantitative number of phytoplankton population. maximum Range of the COD 11.1(mg/lit) is recorded in the winter season at the site no. 5 and Minimum Range of the COD , is recorded 9.2 mg/lit at the site no. 3 in summer session. Maximum Average Range of the COD is recorded 10.5 mg/lit at site No. 5, and minimum Average Range of the COD is recorded 9.7mg/lit. at site No.2,3,4. (Fig. 11)

CONCLUSION

In the present investigation, an attempt was made to evaluate the ground water quality of municipal corporation area of Rewa city Madhya Pradesh, India. The water samples were found to be moderately hard; the hardness of water caused by the presence of Calcium and Magnesium study reveals that all the sample sites have hardness within the desirable limit prescribed by WHO. The TDS values of water samples of certain samples are higher but overall it is in the permissible range.

The water samples are slightly alkaline in nature. The values of various parameters such as TSS, TDS, TA, BOD, COD and DO shows the ground water of area needs some degree of treatment before use. The study helps us to understand the quality of the water as well as to develop suitable management practices to protect the ground water resources.

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