



## Studies on ground water pollution due to iron content and water quality in and around, Jagdalpur, Bastar district, Chattisgarh, India

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### ABSTRACT

The paper presents studies regarding the pollution of the groundwater in Jagdalpur. The water quality parameters viz pH, electrical conductivity(EC), Turbidity, Total dissolved salt (TDS), Sodium(Na), potassium(K), calcium(Ca), chloride(Cl), sulphate( $SO_4^{2-}$ ), Carbonate( $CO_3$ ), Bicarbonate ( $HCO_3$ ), fluoride (F), Total hardness(TH), dissolved oxygen(DO), iron(Fe) were analysed. The result shows that the ground water from some sampling sites is within permissible limit according WHO.

**Keywords:** Ground water, Quality of water, Jagdalpur, WHO

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### INTRODUCTION

Water is vital for the existence for all life forms and is essential for all activities of human beings (Dhar et al,1986).The effect of water pollution on human health is of serious nature (Rawat and Arora,1986).Drinking water plays an important role in the bodily intake of true element by human. Even though some trace elements are essential to man, at elevated levels essential as well as non essential element can cause morphological abnormalities reduce growth increase mortality and mutagenic effects [2-4] Ground water is about 20% of the world resources of fresh water and used in large amount for industry, irrigation and domestic activity.

In this present study, water samples were collected from hand pumps of different areas in and around Jagdalpur, Bastar district. The various physical and chemical parameters were determined and the results were compared with the values of various water quality standards such as World Health Organisation (WHO). Bureau of Indian Standard (BIS).The main aim of the study was to report on the assessment of the physico-chemical parameters and the trace elements present in the drinking water sources earmarked for this study. It is hoped that the results would add to the existing data.

### EXPERIMENTAL SECTION

#### Study Area

The Jagdalpur is head quarters of Bastar district and 25 km away from Bastar district. The Jagdalpur is located between longitude 82°01'36"E, latitude 19°04'53"N and elevation 552m (1.811ft).It is connected NH 43 from state capital Raipur and Vizianagram. Jagdalpur is famous for age old wooden handicraft. The area is 8755.79 km<sup>2</sup>.The maximum people are tribal and depend on ground water for drinking purpose. Average temperature of this place varies from 40°C to 29 °C in summer.

A total 20 samples from different places which were minimum one kilometre between one and other location was maintained in order to carry out a broad study on the quality of water in this area. The sample was collected in

polythene bottles which were cleaned with acid water, followed by rinsing twice with distilled water. The analysis of water was done using procedure of standard methods.

pH for Elico pH meter. TDS and Conductivity by Eutech-Cyberscan meter. Na, K, Ca by Elico flame photometer. Cl<sup>-</sup> by Argentometric, Ca<sup>+2</sup>/Mg<sup>+2</sup> and Total hardness by Titrametric method, Turbidity-Turbidity meter 135 systronics, F<sup>-</sup>ISE (Thermo scientific 4 stars Orion), BOD-Merck BOD meter, COD-Spectroquanta Merck COD meter. TA-Titrametric method, SO<sub>4</sub><sup>2-</sup>- Titrametric Method and Fe (Merck Spectroquanta).

S.No.	Sampling places	S.No.	Sampling places	S.No.	Sampling places
1	Budhaghat colony	8	Airport	15	Nakapara
2	Iamenejungle	9	Railway colony	16	Ghatkpudar
3	Naktisemara	10	Pratapganjapara	17	Shantinagar
4	Power house	11	Gangamunda	18	Rajendraward
5	Kusamgal	12	Hatkachora	19	Laminischool
6	Nayapara	13	Negiguda	20	Dharmapura no.3
7	Adawal	14	Deoda		

## RESULTS AND DISCUSSION

Table.1

Parameter/Sample No.	1	2	3	4	5	6	7	8	9	10
Colour	cl	sy	cl	sy	cl	cl	cl	cl	cl	cl
Temp(C°)	26	24	24	25	25	26	26	24	25	25
pH	6.89	7.58	7.08	7.94	7.10	7.27	7.11	7.73	7.55	7.94
Turbidity (NTU)	1.3	106	nil	1.0	1.2	25.9	nil	nil	49.2	9.5
Conductivity (µS/cm)	870	998	580	1472	1106	1377	145	1771	1466	1651
TDS (ppm)	438	492	288	735	545	688	72	871	737	824
Ph alkalinity (ppm)	0	16	0	24	0	0	0	30	8	32
Total alkalinity (ppm)	168	218	144	232	196	194	44	244	292	224
Ca asCaCO <sub>3</sub> (ppm)	27	9	9	8	8	7	3	4	9	4
Mg asCaCO <sub>3</sub> (ppm)	181	249	133	308	198	201	85	412	343	290
Total hardness (ppm)	208	258	142	316	206	208	88	416	352	294
Na (ppm)	7.9	2.0	1.4	12.4	23.3	34.4	1.5	20.6	4.3	23.7
K (ppm)	1.2	2.0	2.0	2.3	1.7	2.8	0.4	0.7	0.7	3.6
Ca (ppm)	26.9	25.6	12.2	36.5	40.5	52.0	1.6	47.9	37.5	47.9
COD (ppm)	low	low	low	low	low	low	low	low	low	low
BOD <sub>5</sub> (ppm)	50	48	65	low	70	54	10	48	20	00
DO (ppm)	5.55	4.16	6.05	5.55	5.15	5.05	4.36	4.16	3.57	2.77
SO <sub>4</sub> <sup>2-</sup> (ppm)	48	121	101	125	151	98	101	120	111	90
Cl (ppm)	40	19	14	37	47	58	8	62	16	49
F (ppm)	0.44	0.10	0.12	nil	nil	0.56	nil	0.26	nil	nil
Fe (ppm)	0.42	0.42	4.13	2.12	0.25	2.92	0.12	0.32	1.5	0.89

Table 2.

Parameter/Sample No.	11	12	13	14	15	16	17	18	19	20
Colour	cl	cl	sy	cl	y	cl	cl	cl	sy	cl
Temp(C°)	25	26	25	24	25	25	26	27	26	27
pH	7.86	7.53	6.33	7.42	6.65	7.42	6.82	7.05	7.10	7.04
Turbidity (NTU)	35.7	6.1	84.2	440	160	nil	210	3.05	395	nil
Conductivity (µS/cm)	1306	2280	538	891	1383	350	1073	1155	600	450
TDS (ppm)	656	1150	270	448	679	185	560	610	280	200
Ph alkalinity (ppm)	28	16	0	32	8	16	0	8	32	0
Total alkalinity (ppm)	168	304	48	196	218	280	210	196	144	290
Ca asCaCO <sub>3</sub> (ppm)	3	8	4	9	16	4	21	18	41	18
Mg asCaCO <sub>3</sub> (ppm)	295	352	182	323	127	281	279	382	314	262
Total hardness (ppm)	298	360	186	332	143	285	300	400	355	280
Na (ppm)	10.2	27.2	9.0	2.4	11.3	2.4	32.0	12.2	11.2	4.2
K (ppm)	1.1	1.0	1.2	0.9	1.0	0.9	3.5	1.4	3.2	0.8
Ca (ppm)	34.0	55.8	13.0	19.6	40.5	9.2	50.1	38.2	22.2	25.0
COD (ppm)	low	low	low	low	low	low	low	low	low	low
BOD <sub>5</sub> (ppm)	35	42	75	48	51	44	47	low	78	35
DO (ppm)	2.87	3.27	6.74	4.86	4.96	5.15	2.84	3.51	3.42	4.15
SO <sub>4</sub> <sup>2-</sup> (ppm)	101	77	64	105	125	98	125	66	106	50
Cl (ppm)	42	68	82	59	75	86	91	106	125	150
F (ppm)	0.15	0.62	0.08	0.05	1.78	0.28	1.42	0.07	0.48	0.38
Fe (ppm)	0.45	0.48	0.28	0.15	6.22	0.04	3.52	0.24	2.48	0.13

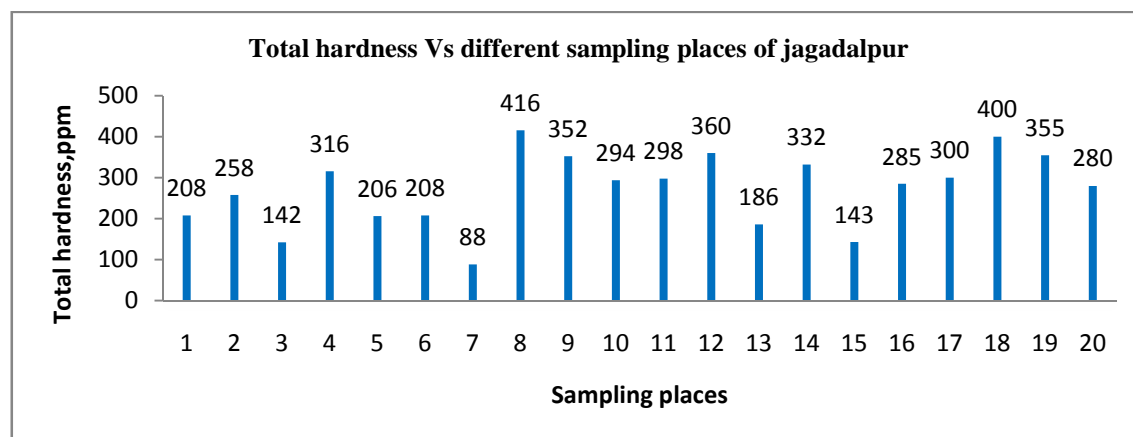
cl-colourless. sy-Slightly yellowish. y-yellowish. All values are expressed as ppm. BOD measurement at 20°C for 5 days.

The various physical and chemical parameters determined for the water samples were given in table 1. From the analyzed results it was found that the quality of water considerably varies from location to location. As far as the physical parameters are concerned most of the samples were appeared as colourless remaining sample no. 2, 4, 13, 19 are slightly yellow and the sample no. 15 is yellowish.

pH varies from 6.65 to 7.94. This shows that all samples are existed within the minimum and maximum tolerable limits of WHO. The water samples were found to be slightly basic.

The turbidity level of samples no. 2, 6, 9, 10, 11, 12, 13, 14, 15, 17, 19 are higher than the permissible limits as standard value of WHO is 5 (NTU). Turbidity varies from 0 to 440 mg/l (mean is 76.41 mg/l). It may be due to presence of muddy particle in water.

Total dissolved solids (TDS) are the concentration of all dissolved minerals in water indicates the general nature of salinity of water. The values of total dissolved solids (TDS) determined for these samples showed that most of samples no. 4, 5, 6, 8, 9, 10, 11, 12, 15, 17, 18 are crossed the minimum tolerance limits of 500 ppm of WHO. TDS values varies from 75 to 934 ppm of collected samples of study area. The higher value of total dissolved solids is attributed to application of agricultural fertilizer contributing the higher concentration in the ground water. High values of TDS in ground water are not harmful to human beings but high concentration of these may affect persons, who are suffering from kidney and heart diseases. Water containing high solid may cause laxative or constipation effects.

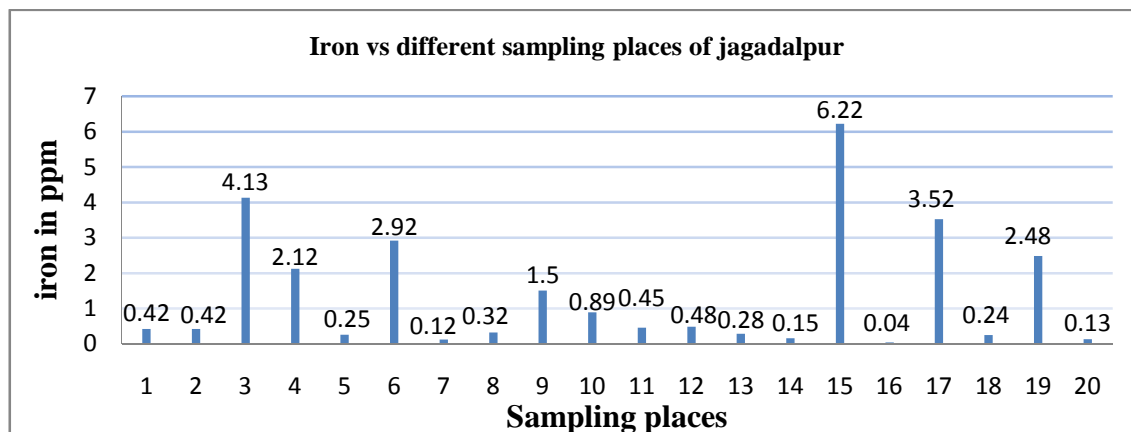


Alkalinity is the measure of the capacity of the water to neutralize a strong acid. The alkalinity in the water is generally imparted by the salts of carbonates, silicates etc together with the hydroxyl ions in free State. In the study area the sample no. 2, 4, 8, 9, 10, 12, 15, 16, 17, 20 are the exceeds the maximum permissible limits of 200 (ppm) of WHO. Total alkalinity varies from 48 to 304 mg/l (mean is 200.5 mg/l). High alkalinity in water bodies leads to sour taste and salinity.

Conductivity is measure of capacity of substance to conduct the electric current. Most of the salts in water are present in their ionic forms and capable of conducting current and conductivity is a good indicator to asses' ground water quality. Electrical conductivity is an indication of the concentration of total dissolved solids and major ions in a given water body. Electrical conductivity in a ground water varies from 350 to 2280  $\mu\text{S}/\text{cm}$ . Where permissible limit is  $<1500 \mu\text{S}/\text{cm}$  for domestic use. The sample no. 8, 10, 12 are out of tolerance limit of specified standard WHO.

Approximately 98% of world ground water is dominated by calcium and bicarbonates ions due to the weathering of limestone's in the rain catchments and ground water beds. Total hardness is considered as the major character of drinking water. Hardness is defined as the concentration of calcium and magnesium ions. Calcium and Magnesium are dissolved from most of soils and rocks. In the study area total hardness of the sample no. 4, 8, 9, 12, 14, 17, 18, 19 are exceeds the permission limits of 300 ppm of WHO and BIS. The value of total hardness in study area varies from 88 to 416 mg/l (the average value is 271.35 mg/l). The maximum permissible limit for Mg hardness and Ca hardness as per WHO is 200 ppm. The sample no. of study area 2, 4, 6, 8, 9, 10, 11, 12, 14, 16, 17, 18, 19, 20 are higher value of Mg hardness as per WHO. The value of Mg hardness varies from 85 to 412 mg/l (the mean value is 289.85)

The concentration of Na, K, and Ca are none of them exceed the minimum permissible limits of various standards. Chloride was in the range of 8 to 150 ppm (mean is 61.7 ppm) which was under permissible limit. The entire water sample was not polluted. Chlorides are relatively harmless to organisms except when converted to Cl<sub>2</sub>, ClO and ClO<sub>3</sub> which are toxic. High chloride content impacts taste and could corrosion. The sulphate varies in study area varies from 48 to 151 mg/l (mean 99.15mg/l). All the sample area the value of sulphate are within the permissible limit as per WHO standard.



As per WHO the permissible limit of iron is 0.3mg/l. But all the sample analyzed have the Fe are higher than the tolerance value while remaining sample no.5,7,8,13,14,16,18,20 are within the tolerance limits. The value of iron in study area varies from 0.04 to 6.22 mg/l (mean is 1.354 mg/l). The smells of Most of the places of water are like irony. It is due to may be periphery of Jagadalpur is covered with iron mines and dense forest. The shortage of iron causes a disease called “anaemia” and prolonged consumption of drinking water with high concentration of iron may be lead to liver disease called as haemosiderosis [2].

The concentrations of fluoride ion in study area are within tolerance limit except sample no.15 is slightly higher than the specified value of WHO which is 1.5 ppm. The fluoride ion concentrations of these samples were very low and all these facts showed a good sign for the usage of this water for drinking and cooking purposes. High fluoride value may cause fluorosis which characterized by mottling teeth enamel, nervous and skeletal disorder.

Dissolved oxygen of water samples collected lies in the range from 2.84 mg/l to 5.55 mg/l. Samples no.10, 11,12,17,19 have slightly low values for dissolved oxygen and lower the permissible limit propose by WHO. Lower value may be affecting the fish life in aquatic system.

Biochemical oxygen demand (BOD<sub>5</sub>) is a chemical procedure for determining is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in water sample at certain temperature over a specified time period. It indicates organic quality of water. The biochemical oxygen demand (BOD) at 20°C for 5 days in study area varies from 0 to 78 mg/l (average is 41 mg/l).

**Table 3. Statistical evaluation for different parameters in hand pump waters in and around Jagadalpur Bastar district.**

S.No	Parameter	Range	BIS	WHO	Mean	Standard Deviation	Coefficient of Variation%
1	Temp	24-27	28-30	28-30	25	0.8825	3.47
2	EC	350-2280	1500	1500	1073	535.44	50.00
3	pH	6.33-7.94	6.5-8.5	6.5-8.5	7.27	0.44	6.00
4	Turbidity	0-440	5	5	76.41	130.87	172.00
5	TDS	72-1150	500	500	540.39	265.28	49.00
6	Total Hardness	88-416	300	300	271.35	89.85	34.00
7	Ca as CaCo <sub>3</sub>	3-41	200	200	11.5	9.62	84.00
8	Mg as CaCo <sub>3</sub>	85-412	200	200	289.85	88.74	31.00
9	Total Alkalinity	48-304	200	200	200.5	70.30	35.00
10	Na	1.5-32	-	-	12.68	10.56	84.00
11	K	0.4-3.6	-	-	1.62	0.98	61.00
12	Ca	1.6-52.0	75	75	31.81	15.55	49.00
13	Fe	0.04-6.22	0.3	0.3	1.354	1.69	125.00
14	F	0-1.78	1.5	1.5	0.33	0.47	143.00
15	BOD	0-75	-	-	41	24.06	59.00
16	DO	2.77-5.55	-	-	4.55	1.20	27.00
17	So <sub>4</sub> <sup>2-</sup>	48-151	200	200	99.15	26.93	28.00
18	Cl	8-150	250	250	61.7	37.57	61.00

Table 2 and the above discussion show that some of the parameters have the concentration level greater than the permissible limit. The observed coefficient of variation for the parameters shows that the variation in the Turbidity (172 %), Iron (125 %), and TDS (49%) is of moderately high range. From this it is concluded that various parameter concentrations are varying highly in different locations.

### CONCLUSION

The ground water samples collected from the various places in and around Jagdalpur were analyzed for various physicochemical parameters such as pH, EC, turbidity, TDS, total hardness, Ca hardness as  $\text{CaCO}_3$ , Mg hardness as  $\text{CaCO}_3$ , total alkalinity, phenolphthalein alkalinity,  $\text{Cl}^-$ ,  $\text{F}^-$ ,  $\text{SO}_4^{2-}$ , Fe, COD, BOD, DO. The level of those low concentration of these ions does not have any considerable impact for this water to use for drinking and cooking purposes. According to this study, the Iron, turbidity, total Hardness, TDS value are higher than the tolerance value of the most of the places. So the hand pump attached study area should with filter based on activated alumina adsorption might be solution for filtering drinking water. Otherwise water should be filter by iron remover resin. In general this water may be boiling, cooled, filtered and used for drinking purpose.

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