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A Physico-Chemical Study of Water Quality Parameters of Drinking Water: A Case Study of Uchana Block of District Jind, Haryana, India

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Abstract*— *Actually, water is an essential natural resource for sustaining the lives of all living beings and the environment. Over the last few decades water quality has deteriorated due to the over exploitation of water. Quality of water is an essential parameter to study when the overall focus is sustainable development keeping mankind at the focal point. The present study was conducted to analyse the various parameters of underground drinking water in Uchana Block, Haryana, (India) and to analyse its fitness for the drinking purpose. In the present research work, a number of 20 water samples were collected from the different residential areas (villages) in clean polythene bottles and analyse for the different parameter like pH, electrical conductivity (EC), total dissolved solid (TDS), total hardness (TS), calcium, magnesium, total alkalinity (TA) carbonate, bicarbonate, chloride, fluoride, iron, sodium, potassium, sulphate, nitrate, and phosphate. The parameter was compared with the standard desirable prescribed limit by World health organisation (WHO), Bureau of Indian Standard (BIS) and Indian council of medical research (ICMR) standard of drinking water quality parameters. It is concluded that the water quality of the water supply system in different locations of Uchana Block is of medium quality and can be used for domestic use after suitable treatment. At the end of the study, a suitable suggestion has also been made to improve the quality of water.

Keywords*— *natural resources, groundwater, sustainability, TDS, quality parameters.

I. INTRODUCTION

As we know that water is life's matter and matrix, mother and medium. Water is the most precious gift of nature and is one of the substances essential for the sustenance of life. Water is not only a universal solvent but the most indispensable natural resource, which stimulates the economy, agriculture and industrial growth of mankind. About 70% of the body weight of all living organisms consists of water. Several fundamental rights, especially those guaranteeing the right of food, health and development cannot be attended without guaranteeing access to clean water (Gleick, 1999). The importance of water lies with the United Nations General Assembly to designate 22 March of each year as the "World Day for Water" by adopting the resolution in 1992- United Nations Conference on Environment and Development in Rio de Janeiro. Water is a wonder in nature. "No life without water" is a common saying depending upon the fact that water is one of the naturally occurring natural requirements of all life sporting activities. (Gorde & Jadhav, 2013). Only a small fraction of water, about 2.7% of earth water, is fresh and suitable for human consumption. Approximately 13% of this production is groundwater as an important source of the drinking water for many people worldwide (Bindu & Selva Mohan, 2009). Since the age of creatures on earth all civilization developed along the rivers, lakes and water resources. In the ancient era Aryavart Vedic culture developed along the Ganga, Yamuna, Saraswati, Sindhu, Chenab, Jhelum, Satluj, Brahmputra and other Himalayan rivers. Richa or Vedic Mantras were written along the Saraswati rivers.

Vedic writings speak of the value of water– "Apo Nar Eti Prokta Apo Vai Nasvnv Ta Yadsyayanm Purv Ten Narayana Smarth" (Water is the child of The Almighty God).

The groundwater has been used for drinking over a long time and its purity has made it a well-known source of potable water all over the world. In Haryana underground water is available in the form of drinking water and they are used by more than 50% of the total population of the area to meet their daily needs. In recent years borewell is also used

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in many parts of the Haryana state as a source of portable water (Chauhan & Paliwal, 2009). Heavy metal is a toxic pollutant that severely limits the beneficial use of water in domestic and industrial application (Ernest, 1991). Fluoride, nitrate, and phosphate have been identified as major anionic pollutants of the groundwater in Jind district Haryana with excessive use of nitrogen, phosphorus fertilizer and insecticide, pesticides & herbicide in agriculture. (J. P. Deshwal & B. R. Deshwal, 2018). High concentration of nitrate, phosphate and other hazardous ions in groundwater has been related with excessive use of nitrogenous fertilizer in agriculture and high amount of organic waste generated by the human population (Kataria, 2004).

II. REVIEW OF LITERATURE

It is a well-known fact that contaminated drinking water creates a major health threat to human beings worldwide. In recent years due to pollution and climatic changes the conditions of river, canal, tubewell, handpump and natural wells which provide water may not be suitable for drinking purposes. Surface and drinking water sources have been polluted to different extents. Main pollutants present in drinking water sources are heavy metal, organic substances, ammonia, nitrogen, phenol, pesticide and pathogens.

Jay Shri et al. (2002) in their study which was carried out on the water quality assessment of Purna river Buldhana, District Maharashtra, and Jha & Tignath (2009) have also studied the assessment and impact of surface water environment in and around Jabalpur city, Madhya Pradesh. Studies on groundwater quality were done in Hyderabad (Shrinivas et al. 2010). Physico- chemical property of drinking water in the town area of Godda District, Bihar reported by (Jha & Verma, 2000). Recently Sharma et al. (2004) have studied the industrial wastewater and ground water and pollution problem in groundwater. The information on the quality of groundwater valuable knowledge regarding their possible effect on physical property of the soil and its productivity (Sharma & Minhas, 2004). Singh & Chandel (2006) have analysed the waste water which is used for agriculture purposes. Thus, the review of literature highlights the fact that no study has been undertaken in the study area in regards to physico-chemical characteristics of water yet. So, the objective of this study is to investigate and analyse the quality of drinking water (underground water) in rural areas of Uchana block of district Jind in the State of Haryana.

III. STUDY AREA & SAMPLING

In the present study, a number of 20 water samples were collected in pre–Monsoon April- May 2018. Samples were collected in pretreated and labelled plastic bottles 1.5 litre and were immediately preserved and analysed following the standard protocols given in APHA (APHA1992) Each sample bottle has been washed with 2% nitric acid and then rinsed three times with the distilled water. The sampling places are referred to as stations (U1-U20).

Table-1: Sampling Site, Source, Code and Depth of Water Samples

S. No.	Site	Source	Code	Depth
1	Alipura	Handpump	U-1	35 feet
2	Baroda	Handpump	U-2	40 feet
3	Buliyawali kheri	Handpump	U-3	32 feet
4	Bhagwanpura	Handpump	U-4	35 feet
5	Bhongran	Handpump	U-5	30 feet
6	Bhonsla	Well	U-6	40 feet
7	Budain	Well	U-7	30 feet
8	Chhatar	Well	U-8	38 feet
9	Daroli Khera	Submersible	U-9	100 feet
10	Darond Khera	Handpump	U-10	55 feet
11	Dhankhari	Submersible	U-11	100 feet
12	Dohana Khera	Handpump	U-12	35 feet
13	Durjan Pura	Handpump	U-13	30 feet
14	Ganda Khera	Submersible	U-14	55 feet
15	Ghaso Kalan	Handpump	U-15	30 feet
16	Ghaso Khurd	Handpump	U-16	35 feet
17	Ghoghriya	Handpump	U-17	40 feet
18	Jheel Morpatti	Submersible	U-18	80 feet
19	Kabarchha	Submersible	U-19	50 feet
20	Kahsoon	Submersible	U-20	60 feet

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IV. MATERIALS AND METHODS

A total of 20 samples were collected from the hand pump, tube well, natural water resource wells, from villages, temples, schools, water works, bus stands and other places. These samples we analyse for the various physicochemical parameters and some heavy metals. A portable water analyser kit with a multi 340 set was used to measure the four water quality parameters on site, these were pH, water temperature (WT), dissolved oxygen (DO), electrical conductivity (EC). Chemicals used in analysis were Qualigens extra R grade acid Indicator are of the super pure grade and double distilled water used for preparation of solutions.

Atomic absorption spectrophotometer (model 3100) Perkin Elemer USA was used for determining heavy metal, hydrogen ions concentration (pH), total dissolved solid (TDS) and conductivity measured using pH, TDS, conductivity meter respectively. Total alkalinity (TA), estimated titrimetrically using sulphuric acid. Total hardness (TH) and calcium iron (Ca2+) were analysed using standard Disodium ethylene diamine tetra acetate salt (Na2EDTA) salt. Magnesium (Mg2+) was determined by taking the difference between total hardness and calcium (Ca2+) values. Chloride was estimated by standard silver nitrate (AgNO3), while sulphate (SO4/ 2-) was analysed with the help of a spectrophotometer. In the present study minimum, maximum, average and standard deviation have been calculated for each pair of water quality parameters by using Excel spreadsheet for experimental data. The standard formula used in calculation for statistical parameters are as follows (BIS 2012) details of the method are summarised in Table- 2.

Table-2: Analytical Methods, BIS, ICMR & WHO Parameters for Drinking Water

			Prescribed by				
			BIS (IS 10500-91)		ICMR		WHO
Sr.No.	Parameter	Method employed	Desirable limit	Maximum permissible limit	Desirable limit	Maximum permissible limit	WHO
1	pH	Digital pH meter	6.5-8.5	No relaxation	7.0-8.5	6.5-9.2	6.5-8.5
2	TDS(mg/L)	Digital TDS meter	500	2000	500	1500-3000	1000
3	TH (mg/L)	Titrimetric (EDTA)	300	600	300	600	500
4	Ca^{+2}(mg/L)	Titrimetric (EDTA)	75	200	75	200	200
5	Mg^{+2}(mg/L)	Titrimetric (EDTA)	30	100	50	–	50
6	Cl^{-} (mg/L)	Titrimetric ($AgNo_3$)	250	1000	200	1000	200
7	Turbidity(mg/L)	Nephelometry	1	5	1	5	5
8	SO_4^{-2}(mg/L)	Spectrometric Method	200	400	200	400	400
9	NO^{3-}(mg/L)	Spectrometric Method	45	100	20	100	10
10	Po_4^{3-}mg/L)	Spectrometric Method	–	–	–	–	–
11	Na/K(mg/L)	Flame photometer	–	–	–	–	–
12	Fe^{+3}(mg/L)	Spectrometric Method	0.3	1	0.1	1	1
13	F^{-}(mg/L)	APHA-Method	1	1.5	1	1.5	1.5
14	As (mg/L)	APHA-Method	0	0.05	0	0.05	0.05
			Experimental Data				

V. RESULTS AND DISCUSSION

The respective value of all quality parameters in the water sample is listed in Table 3. All results are compared with the standard permissible limit recommended by the bureau of Indian standard (BIS), Indian council of medical research (ICMR) and World health organisation (WHO) depicted in Table 3.

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Table-3: Water Quality Parameters of Uchana Block of Jind District, Haryana

Sample	Depth	Temp.	PH	EC	TDS	TH	Ca^{++}	Mg^{++}	TA	Cl^{-}	F^{-}	Na^{+}	K^{+}	SO_4^{2-}	PO^{4-}	NO^{3-}
U-1	50	30	7.85	0.697	485	215	43	26	218	177	2.2	92	5	37	0.8	12
U-2	60	27	7.55	2.102	1282	566	118	63	387	368	1.5	213	38	88	0.5	16
U-3	98	26	7.8	1.312	853	450	90	55	349	307	1.5	280	7	128	0.9	34
U-4	70	27.5	7.67	2.502	1516	755	149	93	567	421	3.8	320	13	148	0.7	32
U-5	153	27.9	7.6	1.614	885	420	88	49	252	214	1.4	158	15	112	0.7	51
U-6	85	28.1	7.57	1.084	678	349	76	39	309	169	3.8	160	20	27	0.8	30
U-7	75	25	7.66	1.686	1079	466	95	56	410	159	1.4	118	24	114	0.5	45
U-8	115	27.6	8.29	1.844	1156	580	126	64	444	258	2.9	192	36	61	0.9	29
U-9	47	26.9	7.33	2.578	1627	498	108	55	520	339	3.9	294	4	146	2.3	26
U-10	75	25.8	7.45	3.304	2013	695	155	75	895	855	3.9	515	226	335	0	47
U-11	135	29.8	6.88	1.258	798	415	87	48	312	176	0.2	135	12	39	2.4	32
U-12	64	16.7	7.89	1.236	673	430	67	64	280	187	5.9	139	13	133	0.2	135
U-13	105	27.2	8.67	2.534	1516	740	156	85	635	335	1.8	257	64	89	0.5	50
U-14	96	25.9	7.72	0.775	525	316	72	33	198	152	2.8	137	12	88	0.6	17
U-15	86	26	7.83	1.498	1048	665	132	81	398	257	1.5	232	22	127	0.3	62
U-16	100	27.2	8.37	0.526	334	210	47	22	125	68	4.2	46	15	61	1.3	15
U-17	105	27.4	7.85	2.287	1470	825	184	89	582	419	1.4	308	46	263	2.2	70
U-18	100	26.2	7.93	1.714	1099	596	115	75	427	288	2.9	212	3	217	0	41
U-19	108	25.8	8.27	2.185	1347	592	118	72	452	385	0.9	289	28	214	1.5	45
U-20	156	29.7	8.05	0.848	572	266	62	33	236	105	1.5	85	29	69	1.5	97

5.1. pH

pH is used to determine the acidity or alkalinity of water and the concentration of hydrogen ions in water. The pH value of all underground water samples is found to be in the range of 6.98 to 8.67. The highest value of pH is 8.67 is observed at the place U-14 where the lowest value of 6.98 observed at the place U-11. The pH value of groundwater samples is within the limit of WHO (BIS, 2012). There is no anomalous change in pH of given samples of ground water. In long term exposure to pH behind the permissible limit affects the mucus membrane of cells.

5.2. Electrical Conductivity (EC)

Electrical conductivity, measuring the capacity of a substance to conduct the electric currents, where dissolved salt's ions are the conductors. Most of the salt is present in water in the ionic form and capable of conducting electric current. Conductivity is a good indicator to assess the groundwater quality. EC is a useful parameter of water quality measurement which indicates salinity hazards.

In these study areas EC values varied between the 0. 526 ds/m to 3.304dS/M. Sodium (Na+), calcium (Ca2+), potassium (K+) and magnesium (Mg2+) are the major positively charged ions that contribute to electrical conductivity of water. The major negative charged ions; chloride, sulphate, carbonate, bicarbonate, nitrate and phosphate have minor contributions to the conductivity, although they are biologically very important. Salinity is a measure of the amount of salt in water. Because dissolved ions increase salinity as well as conductivity, the two majorities are related. Salinity is an ecological factor, which influences the organisms that live in the water bodies and the growth of plants that will grow either in the water bodies or on the land fed by the groundwater (BIS 2012; Rani et.al.2013).

5.3. Total Dissolved Solids (TDS)

In the present study the groundwater sample showed variation of TDS between 334 and 2013 mg/L. For domestic use the maximum permissible limit of total dissolved solid is 1000 mg/L (prescribed by WHO). Maximum value of 2013 mg/L is recorded at station U-10 and minimum value of 334 observed at station U-16. Hence all the ground water samples are non-saline except water of sites U-2, U don't-4 U-7, U-8, U -9, U-10, U -15, U- 17, U-18 and U-19. An elevated level of TDS, by itself, does not indicate that water poses a health risk. The concentration of dissolved solids may cause the water to be corrosive, salty or brackish, resulting in the scale formation (BIS,2012).

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5.4. Total Hardness (TH)

Total hardness is the sum of concentration of alkaline earth metal cation such as Calcium and Magnesium ions. The present study shows that the total hardness analyses water samples were found in the range of 210 to 825mg/L. However, the WHO guideline value total hardness range is 300 to 600 mg/L, indicate that the several sample particularly U-4, U-10, U-13, U-15 and U-17 exceeded the maximum limit for drinking water. Consumption of salty water in excess is reported to have caused hypertension and increased the risk of stroke, left ventricle hypertrophy, osteoporosis, renal stone and asthma. Calcium content of water in the present study was found in the range of 43 to 184 mg/L. Similarly Mg content a varied from 22 to 93 mg/L. Calcium and magnesium are both essential minerals for the living organism recommendation has been made for the maximum and minimum level of calcium 75-200 ppm and magnesium (~50 ppm) in the drinking water. 7 samples U-1, U- 5, U-6, U-11, U -14, U-16, U-20 were within the range.

5.5. Total Alkalinity (TA)

The total alkalinity of the water samples showed variation from 125-895mg/L. Water of sampling site U-14 and U-16 recorded normal values and within the guideline of WHO (18 & 19) for the total alkalinity 200 mg /l. Total alkalinity in normal water is mainly due to bicarbonate, very high values of alkalinity of water of sampling site U-10 & U-13 were 895 & 635 ppm due to the bicarbonate and sulphate content in the reported sample.

5.6. Chloride /Fluoride

The chloride content of the sample study was found in the range of 68 to 855 mg/l. High concentration of chloride more than WHO recommended concentration 200 mg/L is considered to be risky for human consumption and causes unpleasant taste of water (Sharma et al., 2004). In the study case chloride level U-2 to U-5, U-8 to U-10, U-13, U-15, U-17 to U-19 were found higher than the permissible level. In some water sample fluoride concentrations were found higher than the permissible range 0.6-1.5 mg/L. The observed range of fluoride level in the study areas was found 0.2to 5.9 mg/L. Very high level of fluoride in the study area U- 1, U-4, U- 6, U-8, U- 9, U-10, U-12, U-13, U-14, U-16 and U-18 might be due to the presence of fluoride bearing mineral in the region. Some cases of dental or skeleton fluorosis were recorded in the area of sampling of villages and near railway stations.

5.7. Nitrate

The nitrate ion in the present study was found in the range of 12-135 mg/L. Nitrate values are commonly reported as either nitrate or nitrate- nitrogen (NO3-N). The maximum contaminant level MCL in drinking water as nitrate is 45 mg/L, where MCL NO3-N is 10 mg/L the MCL is the highest level of NO3 or NO3-N that is allowable in public drinking water supply by the U.S. Environmental Protection Agency (EPA). High levels of nitrate in water can cause methemoglobinemia or blue baby syndrome, a condition found especially in infants less than 6 months. The stomach acid of an infant is not as strong as the older children and adults, the increase in bacteria that can readily convert nitrate to nitrite. Very high value of nitrite in water samples of U-10, U-12, U-50, U-15, U-17 and U-20 all due to high value of potassium nitrate.

5.8. Iron (Fe3+)

Iron content in the present study was found within the guideline value as recommended by NDWQS and WHO. Content in normal range of 0.0 to 0.5 mg/L. Iron is one of the most abundant elements in nature ranking force by weight all kinds of water including groundwater have appreciable quantities of iron concern as health hazards but still considered as a nuisance in exceeding quantities for domestic as well as industrial uses.

5.9. Sodium/Potassium ions

The value of sodium in the drinking water sample was found in the range of 44 to 515mg/L. 10 samples are within the range given by the WHO and BIS (200 mg/ L). Sample numbers U-2, U-3, U-4, U-9, U-10, U-13, U-15, U-17, U-18, U-19 exceeded the prescribed values. Potassium values range between the 2 to 220 mg/ L. 10 samples within the range of WHO limit of 15 mg/L, except the sample study area U-2, U-6, U-7, U-8, U-10, U-13, U-15, U-17, U-19 and U-20. In healthy individuals high levels of potassium (up to 3700 mg/ day) possess no harmful effect because Potassium is rapidly excreted. Very high doses of potassium result in chest tightness, nausea, vomiting, diarrhoea, hyperkalaemia, shortness of breath and heart failure.

5.10. Sulphate

Natural water contains sulphate ions and most of these in the permissible limit and also soluble in water. Sulphate ions are produced mainly by the oxidation process of their ores. They are also present in industrial wastage. The quality of sulphate in water samples was measured by UV spectrophotometer as per IS :10500-2012, the desirable limit for sulphate is 200 mg/L and permissible limit is 400 mg/L. All sample's values are within the guided values.

5.11. Phosphate

Phosphate is an essential plant nutrient and most often controls plant growth. Normally groundwater contains only a minimum Phosphorus level because of low solubility of native Phosphorus minerals and the ability of soil to retain

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phosphate. The value of phosphorus in the drinking water sample was found 0.0 to 2.4 mg/L.

5.12. Turbidity

Suspension of particles in water interfering with passage of light is called turbidity. Turbidity is caused by the wide variety of suspended particles. Turbidity can be measured either by its effect on transmission of light, which is termed as turbidity or by its effect on scattering of light, that is termed as nephelometry. As per IS: 10500-2012, the acceptable and permissible limit is 1-5 NTU respectively. All samples are within the permissible limit.

VI. CONCLUSION

The present work is an attempt to assess the drinking water quality. Mostly analysed samples were found contaminated either due to one or more parameters. Only pH and iron value of all samples were in the permissible range. Certain parameters in all samples crossed the WHO. Arsenic is carcinogenic and is reported in one sample as high as 366 ppb (U-18). Therefore, his presence is a serious threat. In a nutshell from the results, it is suggested that the drinking water must be treated before supply.

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