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Research Article

Study Of Physiochemical Analysis Of Drinking Water Sources Of Selected Villages Of Raipur District

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ABSTRACT

Water quality is affected by natural processes and human activities in the water environment. Poor water quality in developing countries causes diarrhea, stomach flu, cholera, typhus, skin rashes, kidney disease, high blood pressure, heart disease, cancer, blood etc and therefore it is important to test the water supplied from different sources. There is a need to develop a regular water quality monitoring system to analysis the water supplied from different sources and systems specially in rural area. In this study, ten villages nearby the college campus of Raipur Institute of technology, Raipur in Chhattisgarh have been selected to test drinking water samples collected from Tubewell Water Supply (TWS) and Public Water Supply (PWS) and physiochemical analysis has been conducted from the samples collected from different locations.

Keywords – Ground water source, water quality, rural water supply, Physiochemical characterstics.

1. Introduction

Clean water is more essential for everyone's life. Two major sources of drinking water are ground water and surface water. There are many high-tech water purification systems. But for the huge majority of the population in the developing world who live in rural areas. Water must be tested and care of drinking water must be taken in rural areas. IS-10500 has set standards for drinking water with a revised edition of IS 10500:2012 as a Standard for Drinking Water Quality Control. It is very important to increase awareness about clean water and drinking water should be checked regularly. The growth of literature and data the research work based on water quality and water pollution studies has been truly enormous in the last few years. Montoyaa et al., (2023) conducted a critical review on odour measurement and prediction of sea water intrusion pattern recognition supported by unsupervised learning. Tian and Wu (2019) supported the need for rapid development of water quality assessment methods. They emphasize a better understanding of water quality either through a simple numerical figure or through a more complex interpretation of water quality characteristics. Li and Liu (2019): Deshpandey (2018) and Winter and Reddy (2019) emphasized on sensor-based technology to monitor quality of water. Long et al. (2018) investigated the effects of dry and wet seasons and land use on water quality in a karst system of Mexico and believed that water–rock interactions, hydrology, and land cover were more important factors on water quality than land use. N. Sakai et al. (2015) used atomic absorption Spectrometer to detect the presence of metals in water sample. Akter et al. (2016) used a weighted arithmetic WQI method to provide information on water quality in rural Bangladesh. These WQIs convert a large number of variables into digital numbers and are useful in understanding water quality, making them the most popular methods of water quality assessment, albeit with some weaknesses. Abtahi et al. (2015, 2016) proposed two drinking water quality indices to understand general drinking water quality conditions in rural communities. These two indexes are simple, flexible and stable without strong sensitivity to input data. Scheili et al. (2016) investigated the impacts of raw water quality, climatic factors, and human operational factors on drinking water quality in small water distribution systems in Canada, which showed that drinking water quality was mainly influenced by source water quality and source water quality. was further influenced by meteorological and climatic factors, with variability in human operational factors being the only factor that could explain the diurnal range of variability in drinking water quality. Bhattacharjee and Bhattacharyya (2010) conducted a systematic study to monitor the most important physico-chemical parameters of the Siang river water, Podgorski et al. (2020) analyzed the risk of high groundwater arsenic levels (>10 µg/L) in the regions of Bihar and West Bengal. Embrandiri et al.(2016) studied about short- and long-term effects to the natural ecosystem on the release of xenobiotics ranging from pharmaceuticals to agriculture.The present research has been to experimentally determine the physiochemical characteristics of different source of the drinking water for the identified 10 villages in the Raipur district near Raipur institute of technology, Chhattisgarh. Ahsan Shah et.al. (2023) in their article provided an overview of selected water contaminants and their effects on human health. Their review highlighted the need to ensure access to clean drinking water worldwide through a comprehensive understanding of water quality and its impacts on human health. Soni and Bhatia(2015) conducted work on drinking water quality at the household level in Jaipur city, Rajasthan. For this study, 20 samples were taken from 10 randomly selected wards; one each from the well and the water pipe. Water samples were taken from the household for physico-chemical analysis and comparison with the site was made. Meseret B. Addisie (2022) in their study considered the combination of user perceptions with measured water quality parameters determined using the Water Quality Index (WQI) tool. Data were collected using a cross-sectional household survey, and water quality samples were collected from improved and unimproved alternative sources. Nine physico-chemical and two bacteriological analyzes were performed. The result shows that the aesthetic parameters of water quality had a potential interpretation of water quality in laboratory analysis. Revathy Das et.al.(2021) assessed the quality of lake water for drinking purposes, investigation of physico-chemical parameters and bacteriological examination of surface water of Sasthamkotta, Vellayani and Pookot lakes in Kerala, Increased microbial populations in all three lakes was found which indicated unhealthy practices in the lake basins. Vinod Kothari, et.al.(2020) evaluated water quality in rural areas of five districts of Garhwal and Kumaon districts in Uttarakhand, India, based on hydro-geochemical and biological parameters. Mitharwal,et.al.(2014) highlighted the important results of physico-chemical analysis of groundwater samples from open wells, tube wells and hand pumps in urban areas of Pilani, district - Jhunjhunu of Rajasthan state. Various parameters of pH, TDS, fluorine, chloride, nitrates, sulfates, total alkalinity and total hardness are determined. Nitrate values were observed to be higher compared to ICMIR standards. The other parameters were found within the required limits.

2. Materials and Methods

The first part of the work was to select the locations for testing the water sources. In this project 10 villages nearby the college campus of Raipur institute of technology have been selected to test drinking water quality parameter. Table 1 and figure 1shows the geographical locations of sampling points.

Table-1 Physical location of sampling stations in the study area

.	Geographical Location	
Name of Village	North (Latitude)	East (Longitude)
Sonpairi- 3	21°10’15.47”	81°52’32.61”
Lakholi	21°12’08.56”	81°53’19.05”
Gujra	21°12’15.56”	81°52’33.89”
Dhamni	21°12’16.64”	81°52’33.05”
Umariya	21°12’59.19”	81°49’33.62”
Palaud	21°10’52.07”	81°49’23.34”
Parsada	21°12’0.87”	81°50’21.62”
Nawagaon	21°13’12.27”	81°48’56.19”
Chhatauna	21°13’33.03”	81°48’14.21”
Deoda	21°12’15.83”	81°52’31.55”

Figure-1 Geographic location of sampling stations in the study area

2.1 Identification of the water supply system –

Identification of the water supply system for which samples have been collected from two types of water supplies system; TWS- Water comes from groundwater through the tubewell and PWS- Public water supply has been implemented to provide safe and sufficient water to all rural families through "Jal Jeevan Mission" started by Prime Minister Narendra Modi on 15 August 2019. This is being implanted in Chhattisgarh under the "Har Ghar Jal Yojana". Under this scheme, clean water is being supplied to all homes, Anganbadis and government institutions.

2.2 Sampling information

Water samples were collected taking all necessary precautions, in plastic containers of one litre capacity and tightly closed to avoid contact with air. The integrated samples stored in 5 litre capacity plastic containers, after that the name of villages labelled on containers. Preservation and storage of samples were done following the standard procedure. The parameters like pH, temperature, turbidity and colour were measured immediately after collection. The containers kept at normal temperature at cool and dry place, away from sunlight. On the basis of the average rainfall and other climatic conditions, the water samples were collected during Dry season (November - April) . Physical parameters and Chemical parameters were selected for monitoring the drinking water quality in this work.

a). Physical parameters:

Temperature - The temperatures of water samples were determined immediately by using mercury thermometer. Colour - The colours of collected water samples were observed visually. Turbidity - Turbidity of water samples was measured with a Nephelo-Turbidimeter (Model CL-52D, ELICO, India). pH - All pH measurements were done using a digital pH meter (Model LT-120, ELICO, India). Total suspended solids - (TSS) content of water samples was obtained by (TSS = TS – TDS). Total Dissolved Solids were determined by evaporation method.

b). Chemical Parameters:

Analytical grade reagents were used all throughout and all solutions were made in double distilled water. Total hardness - Determined by using EDTA titrimetric method,m using Eriochrome Black-T (EBT) as an indicator. Dissolved oxygen - the dissolved oxygen (DO) of the collected water samples were measured by Winkler's iodometric method. Bio-chemical oxygen demand(BOD) - The BOD testing of drinking water was done through incubation. Chemical oxygen demand - The evaluation of COD values was done through open reflux method. Chloride: Chloride in drinking water was estimated by silver nitrate method.

3. Results and Discussion

The water samples collected from all the identified locations from the selected villages were tested with standard procedure. The test results obtained re from tube wells and public water supply sources are presented in table 2 and table 3 respectively.

Table 2 Test Value of Drinking Water from Tube Well.

Name Of Location	pH	TDS(mg/L)	TA(mg/L)	TH(mg/L)	Chloride(mg/L)	Nitrates(ppm)	Sulphate(mg/L)	Fluoride(ppm)	DO(mg/L)	BOD(ppm)	COD(mg/L)
Sonpairi-3	7.7 (√)	779 (X)	70 (√)	202 (√)	120 (√)	35 (√)	22 (√)	1.0 (√)	6.24 (√)	0.8 (√)	8 (√)
Lakholi	7.50 (√)	780 (X)	102 (√)	190 (√)	98 (√)	28 (√)	19 (√)	1.05 (√)	7.15 (√)	1.10 (√)	0 (√)
Gujra	7.90 (√)	805 (X)	85 (√)	122 (√)	138 (√)	37 (√)	15 (√)	0.90 (√)	6.98 (√)	0.90 (√)	6 (√)
Dhmani	7.85 (√)	639 (X)	130 (√)	145 (√)	160 (√)	40 (√)	27 (√)	1.08 (√)	6.88 (√)	0.95 (√)	5 (√)
Umariya	8.50 (√)	667 (X)	98 (√)	175 (√)	197 (√)	22 (√)	20 (√)	1.10 (√)	5.47 (√)	8.85 (√)	0 (√)
Palaud	7.80 (√)	639 (X)	70 (√)	203 (√)	182 (√)	39 (√)	25 (√)	1.15 (√)	6.79 (√)	1.15 (√)	8 (√)
Parsada	7.65 (√)	759 (X)	110 (√)	155 (√)	145 (√)	48 (√)	23 (√)	1.20 (√)	7.24 (√)	1.10 (√)	0 (√)
Nawagaon	7.40 (√)	619 (X)	104 (√)	131 (√)	144 (√)	50 (√)	18 (√)	0.95 (√)	7.31 (√)	0.90 (√)	5 (√)
Chhatauna	7.80 (√)	677 (X)	65 (√)	135 (√)	180 (√)	40 (√)	27 (√)	0.90 (√)	7.34 (√)	1.05 (√)	9 (√)
Deoda	8.10 (√)	676 (X)	114 (√)	164 (√)	165 (√)	42 (√)	26 (√)	1.20 (√)	6.54 (√)	1.08 (√)	10 (√)

√-sign shows that water quality match with standard value of drinking water.
X-sign shows that water quality doesn't match with standard value of drinking water.

Table3-TestValueofDrinkingWaterfromPublicWaterSupply

Name Of Location	pH	TDS(mg/L)	TA(mg/L)	TH(mg/L)	Chloride(mg/L)	Nitrates(ppm)	Sulphate(mg/L)	Fluoride(ppm)	DO(mg/L)	BOD(ppm)	COD(mg/L)
Sonpairi-3	7.80 (√)	750 (X)	180 (√)	130 (√)	180 (√)	25 (√)	20 (√)	0.9 (√)	6.35 (√)	0.9 (√)	9 (√)
Lakholi	7.60 (√)	782 (X)	145 (√)	178 (√)	150 (√)	29 (√)	24 (√)	1.01 (√)	7.22 (√)	1.09 (√)	7 (√)
Gujra	7.80 (√)	801 (X)	95 (√)	110 (√)	125 (√)	35 (√)	17 (√)	0.80 (√)	7.00 (√)	0.85 (√)	0 (√)
Dhmani	7.95 (√)	642 (X)	100 (√)	108 (√)	170 (√)	37 (√)	26 (√)	1.20 (√)	6.55 (√)	0.75 (√)	5 (√)
Umariya	8.10 (√)	655 (X)	185 (√)	102 (√)	135 (√)	18 (√)	29 (√)	1.15 (√)	6.45 (√)	0.95 (√)	8 (√)
Palaud	7.90 (√)	548 (X)	190 (√)	215 (√)	180 (√)	45 (√)	26 (√)	1.09 (√)	7.20 (√)	1.12 (√)	8 (√)
Parsada	8.10 (√)	759 (X)	178 (√)	160 (√)	165 (√)	35 (√)	24 (√)	1.18 (√)	7.15 (√)	1.16 (√)	6 (√)
Nawagaon	7.85 (√)	622 (X)	160 (√)	145 (√)	115 (√)	27 (√)	19 (√)	1.07 (√)	7.20 (√)	0.98 (√)	0 (√)
Chhatauna	7.75 (√)	666 (X)	170 (√)	148 (√)	190 (√)	50 (√)	30 (√)	1.15 (√)	6.80 (√)	1.09 (√)	10 (√)
Deoda	8.00 (√)	676 (X)	188 (√)	170 (√)	105 (√)	40 (√)	27 (√)	1.19 (√)	6.60 (√)	1.05 (√)	11 (X))

√-sign shows that water quality match with standard value of drinking water.
X-sign shows that water quality doesn't match with standard value of drinking water.

Discussion

Turbidity reflects the cloudiness caused by the substances present in water in suspension like silt, clay, organic matter and other microscopic organisms.. It ranged from 2.25 to 6.85 NTU collected from TWS and 2.85 to 6.95 collected from PWS. The lowest turbidity was found in Lakholi, Sonpairi and Deoda which shows ideal turbidity. The highest turbidity was found in the water supply of both village Palaud and Nawagaon which needs attention. The alkalinity level in the water supplied by TWS is within the standard value in all the villages and the Hardness level is higher in Palaud, Deoda, Sonpairi-3, Lakholi, and Umaria. Hardness values is higher in Deoda, Palaud, Parsada, and Lakholi village. Here in Sonpairi-3 and Umariya village the Alkalinity level is high and Hardness level is low. So Total Alkalinity is higher than the Total Hardness indicates No non carbonate hardness. The pH value is based on the concentration of hydrogen ions in water. It produces sour taste below 4.0 will shows alkaline taste for higher value above 8.5. A pH range of 6.5 – 8.3 is considered as a safer range . In the present study, the fluctuation of pH in the samples is from 7.4 to 8.2 for TWS and 7.75 to 8.1 for PWS.In the study area the chloride concentration ranged from 98.0 to 197 mg/l for TWS and 105 to 190 for PWS. Chloride imparts a salty taste to water if in excess (> 250 mg/l) and may also cause laxative effects at higher concentrations. The amount of chloride in all the villages is within the range.
In the water testing reports of all the villages, the value of TDS is the same which has the highest quantity. The amount of TDS in the public water supply of Palaud village only is 548 which come in the standard value. Higher TDS in drinking water might have been contributed from urban run-off, sewage, industrial wastewater and use of chemical fertilizers The higher TDS values can lead to kidney stones, heart disease, diabetes and other health problems. DO is ranged from 5.47 to 7.34 mg/l for TWS and 6.35 to 7.22 mg/l for PWS in the study area, where as the prescribed limit for DO is 5.0 mg/l. Low amount of Dissolved Oxygen in the water of Umariya village. So this village needs attention. All other villages are safe.BOD indicates the presence of biodegradable organic substances in water and is an important parameter used to indicate the strength of waste in drinking water. The amount of BOD in the PWS of all the villages is within the range. The low BOD value in all samples clearly shows that the water does not have biodegradable organic matter. The amount of COD in the PWS of all the villages is high. It indicates chemical organic pollution and the presence of non biodegradable matter that may arise from industrial effluents, emulsified oils etc.

Conclusion

The majority of the physiochemical parameters tested for both the type of supply system in the identified villages were in safe range except TDS and COD. The value of TDS has increased in all the villages. Low amount of Dissolved Oxygen found in the water of Umariya village. The value of Turbidity was found to be within the permissible limit in all villages. The amount of BOD in the PWS of all the villages is within the range. The amount of COD in the PWS of the entire village is high. Higher values of COD might indicate the presence of organic compounds of non biodegradable nature which is a matter of concern and needs to be further investigated. Moreover determination of microbial contamination and toxic chemicals such as chromium, arsenic and fluoride has to be further tested for better water quality results.

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