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Assessment of Drinking Water Quality: A Case Study of Chandauli District, Uttar Pradesh, India

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Abstract

Water represents the basic elements supporting life and the natural environment, a primary component for industry, a consumer item for humans and animals, and a vector for domestic and industrial pollution. Much of ill health that affects humanity, especially in the developing countries can be traced to lack of safe and wholesome water supply. There cannot be state of positive health and well-being without water. The study was aimed to examine the various samples of drinking water and the quality of groundwater as it relates to public health. Seven groundwater samples were taken from different source of drinking water of S_1, S_2, S_3, S_4, S_5, S_6, S_7, S_8, S_9 and S_{10} were analyzed for pH, Electrical Conductivity (EC), Total Dissolve Solid (TDS), Total Hardness, Acidity, Alkalinity and Chloride. The results were compared with BIS standards. The usefulness of these parameters in predicting ground water quality characteristics were discussed. The results of the experiment are concluded as the pH, $EC_{25}{}^{0}dSm^{-1}$, Chloride (mg/l), Alkalinity (mg/l), Acidity (mg/l) was found within the permissible limits at all sites of experiment. The Total Hardness (mg/l) at all sites and TDS (mg/l) of S_1 (Chandauli), S_2 (Mughalsarai), S_4 (Niyamtabad) was found under desirable limit. The study reveals that after chemical analyses, the considerable variations were recorded in drinking water quality at different places and sites of Chandauli District, most of the water samples do not comply with BIS standards of water for drinking purpose.

Keywords: Drinking Water Quality, Conductivity, Hardness, Alkalinity, Chloride.

Introduction

Water is one of the most significant and precious gift of nature. 3/4 parts of our earth are covered by water, only approximately 1.0 % of the total water is fresh and useable for drinking, bathing, irrigation and other domestic purposes. Water is an essential natural resource and an absolute necessity for sustaining life. Water is not only the most valuable constituent of all animals, plants and other organisms but it is also pivotal for the survivability of the mankind in the biosphere. It is the lifeblood of the environment. Human beings solely depends upon the availability of fresh water for living and livelihood and in its natural state it is a 'savior of life'. One can hardly live without water even for a few days. Today, by ignoring these facts, man is indiscriminately polluting water and unknowingly providing nature a complex situation (Narsimha *et al.* 2012).

Also faucal pollution of drinking water causes water born disease which has led to the death of millions of people, (Adefemi and Awokunmi, 2010). Ground water quality depends on the quality of recharged water atmospheric precipitation inland surface water and sub-surface geochemical processes. Temporal change in the origin and constitution of the recharged water, hydrologic and human factors may cause periodic change in ground water quality. Water pollution not only affects water quality but also threats human health, economic development and social prosperty. Ground water is a source of drinking water and even today more than half of the word population depends on ground water for survival. Assessment of ground water for drinking and irrigation has become a necessary and important task for present and future ground water quality monitoring and evaluation for domestic and agricultural activities around the world. Water is prime need for human survival and industrial development. It serves as the universal solvent in the extracellular and

intracellular compartments, as 99% of all molecules in the body (NRC, 2007).

The rainfall condition all over the world is uneven, scanty and unpredictable. Since majority of human habitat have no direct access to the fresh surface water sources, groundwater becomes the only available and reliable source of drinking water for millions of rural and urban families, besides catering to the irrigation and industrial needs (Kumar and Tushaar, 2004). Free (CO_2) Carbon Dioxide in water exists in varying amounts naturally. Most ground waters will contain less than 50 ppm of Carbon Dioxide in drinking water. A large amount of Carbon Dioxide in water creates an acidic water conditions, (Gupta, 1991; Madhuri *et al.* 2004).

In view of the above stated problems concerned drinking water quality and quantity, an experiment was conducted to assess the drinking water quality of Chandauli District.

Review of Literature

This chapter reviews the literature relevant to the objective of the study i.e., status of water quality as well as information. The most common and wide spread threat associated with water is contamination, either directly or indirectly by drinking water, by human excrement. Water quality criteria of various drinking water have been studied from sources e.g. Hand Pump by a number of Researchers. A few of them has been listed.

McFeters (1990) reported that, the combined results of these problems lead to drinking water contamination, which is detrimental to human health. Over 2 billion people of the world‘s populations have suffered from disease related to drinking polluted waters. More than 250 million new cases of waterborne diseases are reported each year, resulting in more than 10 million deaths and nearly 75% of these waterborne disease cases occur in tropical areas.

Arvinda (1991) reported that, the major problem with the water is that once contaminated, it is difficult to restore its quality. The solution is non- tribal because of complex dynamics involved in the ground water flow, which requires simultaneous solution of complicated geochemical and hydrological equation. Hence there is a need for and concern over the protection and management of ground water quality.

Khan *et al.* (1993) reported that, potash alum is effective disinfectant on vibrio- cholera, in drinking water they found 40mg/lit killed vibrio, when increase in the concentration of potash alum is increased to 100 ppm, 80-90% bacteria are killed they found when potash alum was used in organic matter. Bacteria were coagulated and settle down. The action of the potash alum on bacterial protoplasm decreased their activity.

Brik *et al.* (1995) reported that, the current situation of drinking water treatment in Estonia, the sample of water were analysed for lactose positive coliforms, enterococci, lecithin’s positive staphylococci, pseudomonas and enter virus these chlorine resistant strains of micro-organisms were determined as indicator of sanitary risk and for surveillance of drinking water quality to evaluate water treatment process.

Singanan and Rao (1995) reported that, therefore a systematic statistical study of correlation and regression coefficient of the quality parameters not only help to assess the overall water quality but also quantity relative concentration of various pollutant in water and provide necessary for implementation of rapid water quality managements programmed.

WHO (1996) reported that, the chemical parameters must be taken into consideration in the assessment of water quality, such as source protection, treatment efficiency and reliability and protection of the distribution network.

Mato (2002) reported that, the parameters of concern in this study were total hardness, chloride and nitrates levels in the drinking water. Water hardness is the traditional measure of the capacity of water to react with soap, hard water requiring considerably more soap to produce lather. The hardness of softness of water varies from place to place and reflects the nature of the geological properties of the area, with which water have been in contact. In general, surface waters, although, this is not always the case.

Khayum *et al.* (2011) reported that, assessment of drinking water quality was carried out at Bangalore city and samples were collected from different parts of Bangalore west zone ward wise namely Rajarajeshwari nagar, Vijayanagar, Rajajinagar, Nagarbhavi. The Results showed that 26% of the samples exceeded with permissible limits for BOD. (Vijayanagar (5.6mg/L), Agrahara Dasarahalli, Manjunatha Nagar (5.0mg/L), Mahalakshmi Layout (6.8mg/L), JyotiNagar (4.8mg/L), Kamashipalya (12.0mg/L), Mysore Road (3.0mg/L)). Highest variation of COD values recorded in the study. About 60% of the total samples showed total dissolved solids levels above the desirable limit of 500mg/L. About 60% of the samples showed above desirable limit of drinking water standard values for TDS.

Shivaraju (2011) reported that, the physico-chemical and bacteriological analysis was carried out for the assessment of drinking water quality in the Mysore city. All the water samples were collected from overhead tanks, which are located in different areas of city and as collected water samples were analyzed for the physico-chemical and bacteriological characteristics. In the present study results obtained are reported and importance of drinking water quality parameters obtained are discussed by compared with permissible limits set by bureau of Indian standards. As per physico-chemical parameters are concerned, few drinking water samples supplied in the city crossed their permissible limits.

Pavendan *et al.* (2011) reported that, a study was undertaken to investigate the quality of drinking water samples in and around Tiruchirappalli district. Pollution of water bodies is one of the areas of major concern to environmentalists. Water quality is an index of health and well-being of a society. Industrialization, urbanization, and modern agriculture practices have direct impact on the water resources. These factors influence the water resources quantitatively and qualitatively. Examination of the physico-chemical profiles of the bore well, open well and corporation water samples of Tiruchirappalli District, Tamil Nadu, India showed that the open wells were highly polluted with very high levels of total dissolved solids, total alkalinity and total hardness, and the bore wells with fluoride content higher than the permissible limit of the World Health Organization. The deep aquifers had higher fluoride levels than the open well aquifers.

Rout and Sharma (2011) reported that, a total of 26 water samples were collected from deep aquifer based tube well from different parts of Ambala

Cantonment area. In order to assess the ground water quality, the water samples were analyzed for different physico-chemical properties, e.g., p^H, electrical conductivity (EC), total dissolved solid (TDS), total hardness (TH), total alkalinity (TA), chloride, fluoride and sulphate concentrations. The results were compared with the standards prescribed by World Health Organization (WHO) and Bureau of Indian Standard (BIS). The correlation matrix was also calculated for different parameters of drinking water. From the p^H values it is clear that the ground water of the study area is alkaline in nature and the total hardness varies in between 116.6-129.4 mg/l, which indicates that water in the deep aquifer is moderately hard.

Patil *et al.* (2012) reported that, the natural water contaminates due to weathering of rocks and leaching of soils, mining processing etc. It is necessary that the quality of drinking water should be checked at regular time interval, because due to use of contaminated drinking water, human population suffers from varied of water borne diseases. The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life. It is necessary to know details about different physico-chemical parameters such as color, temperature, acidity, hardness, pH, sulphate, chloride, DO, BOD, COD, alkalinity used for testing of water quality. Heavy metals such as Pb, Cr, Fe, Hg etc. are of special concern because they produce water or chronic poisoning in aquatic animals. Some water analysis reports with physic-chemical parameters have been given for the exploring parameter study.

Andrews *et al.* (2012) reported that, the quality of drinking water is a powerful environmental determinant of health. Assessment of water quality of drinking water supplies has always been paramount in the field of environmental quality management. Assurance of drinking water safety is a foundation for the prevention and control of water borne diseases. The suitability of drinking water has many requisite potable conditions.

Hamid *et al*. (2013) reported that, in this paper quality of drinking water supplied by Water and Sanitation Agency (WASA) is analyzed. Sampling units were tube well (direct source) and tap (indirect source) localized in different areas/towns of Lahore. For assessment, various physicochemical parameters (pH, temperature, color, odor, turbidity, conductivity, total hardness, total dissolved solids, total suspended solids, electrical conductivity, chloride, fluorides nitrates, lead and arsenic) were selected. Moreover bacteriological study was recorded by finding total coliform colonies.

Singh (2014) reported that, the water quality of Pauri District of Uttarakhand, India has been assessed during pre- and post-monsoon seasons to express the suitability of water for drinking purpose. The values of turbidity and iron exceed the permissible limit prescribed by Indian Standards for drinking purpose. Some sites were also contaminated with large number of total and fecal coliform bacteria. Piper diagram exhibit that all water samples fall in Ca-Mg-HCO_3 hydro chemical facies show the nature of carbonate hardness during both season.

Tiwari *et al.* (2014) reported that, consumer item for humans and animals, and a vector for domestic and industrial pollution. Much of ill health that Affects humanity, especially in the developing countries can be traced to lack of safe and wholesome water supply. There can be not state of positive health and well-being without water. The study was aimed at examining the various samples of drinking water and the quality of the groundwater as it relates to public health. Ten ground water samples were taken from hand pump were analyzed for pH, electrical conductivity (EC), chloride, total alkalinity, Total dissolved solids (TDS) and total hardness. The results were compared with WHO and is: 10500 standards. The Usefulness of these parameters in predicting ground water quality characteristics were discussed. Thus an attempt has been made to find the quality of ground water in around Chitrakoot region tehsil Majhagwan suitable for Drinking purposes or not.

Tripathi and Agrawal (2014) reported that, water is the most important commodity and mainly most misused one. Groundwater is the main principal source for drinking water and other activities in Moradabad, Uttar Pradesh, India. It is an indispensable source of our life. The problem of groundwater quality obtains high importance in this present-day. In order to assess drinking water quality, physicochemical characteristics of drinking water collected from 10 places of Moradabad have been made. This paper is about correlation analysis of drinking water in different places of Moradabad. This attempts to bring the significance quality of ground water at the location. Total 10 ground water samples were collected, from India Mark II (IM2) hand pumps following standard methods and procedures of sampling from the various locations to analyze, various physical and chemical parameters. The results were compared with Indian standards and WHO. This study revealed that water of the area is much polluted and quality management is urgently needed. Titrimetric measurements for total hardness, total dissolved solids, available chlorine, chromate ion, carbonate, calcium, magnesium, dissolved carbon dioxide, alkalinity, chloride, copper and zinc have been made. Conductivity and pH measurements have also been carried out. Total dissolved solids measured gravimetrically. The results were compared with the standards prescribed by World Health Organization (WHO) and Beau row of Indian standards (BIS) for drinking water.

Alam and Ullah (2014) reported that, drinking water contamination is one of the core issues in many developing countries and of the challenges confronting scientists and planners. Need of water quality assessment in different parts of the country is thus imperative to analyze state of the water consumed for different purposes especially for drinking purpose. The present study took into account water quality assessment of 32 locations inside Peshawar. Groundwater samples were collected both from tube wells as well as from household ends and subjected to physical, chemical and bacteriological analysis as well as presence of heavy metals, to check their suitability for drinking purpose. Results revealed that physical and chemical characteristics of 96.87% samples were within the permissible limits.

Ganesh *et al.* (2015) reported that, the geogenic leaching of the minerals in aquifers and excessive use of fertilizers coupled with improper sewage disposal has resulted in severe degradation of the ground water quality. The present study is focused on assessing the pH, total dissolved solids (TDS), fluoride and nitrate ion content in the groundwater of the Puttaparthi mandal, Anantapur district, Andhra Pradesh. The water samples were collected from the bore-well and

the results of the physico-chemical analysis were compared with the drinking water standards set by the World Health Organization (WHO) and the Bureau of Indian Standards (BIS). The range of physiochemical parameters observed were pH (7.47 to 8.54), TDS (317 to 1030 mg/l), fluoride ion (1.28 to 4.48 mg/l) and nitrate ion (0.27 to 212.1 mg/l) during this study.

Materials and Methods

The area of Chandauli District was selected purposely located in south-eastern part of Uttar Pradesh at The region is situated with longitudes & latitudes 25°27′N and 83°27′E an elevation of 69 m above the mean sea level. Chandauli District covers an area of 2485 Km^2. at the meeting point of the three sacred rivers of Ganges. In the ancient days, the area was known as Vats country. The southwest of the Chandauli district is having the Sonbhadra area, eastern and south-eastern areas are surrounded by the Sonbhadra region, and Purvachal Eastern region covers the northeast and north part while the Doab region is located towards the East of Chandauli. The entire division of Chandauli covers the districts of Varanasi, Ghazipur and Sonbhadra. There are 3 tehsils in the district along with development blocks which are 09 in number with a population of 2416617 people. (Source: office of the registrar general and census commissioner [web]) some areas of the western parts of the district of Chandauli were assembled together in the newly formed Varanasi

Sample Collection

The collected samples were analyzed for different physical and chemical parameters. Total 40 samples was collected systematically and analyzed for seven parameters. The samples were analyzed for pH, EC, TDS, Total Hardness, Alkalinity, Acidity and Chloride method (Keith, 1996). Broad attempt is also been made to compare the results obtained from the analysis with the Indian Standard specification as per 1S:10500:1991 to evaluate the quality of drinking water for drinking purpose.

Procedure of Water Sampling

The representative sampling sites were chosen randomly in order to cover various anthropogenic activities, including waste and plastic bottles. The gathered background information provides sufficient details on these aspects. Water samples were drawn from hand pumps during February to May 2015, at an interval of 20 days duration to know the variability. The samples were drawn in clean bottles without any air bubbles. Prior to collection, the sample bottles were rinsed thoroughly with the sample water and tightly sealed after collection and labeled in the field. The drinking water was pumped prior to the sampling, to ensure that drinking water to be sampled was representative of drinking water and to avoid contamination of Drinking Water. The samples were collected as per the Standard Methods of Water Examination, APHA/AWWA (Keith *et al.* 1996).

Geographical Location and Sampling Sites

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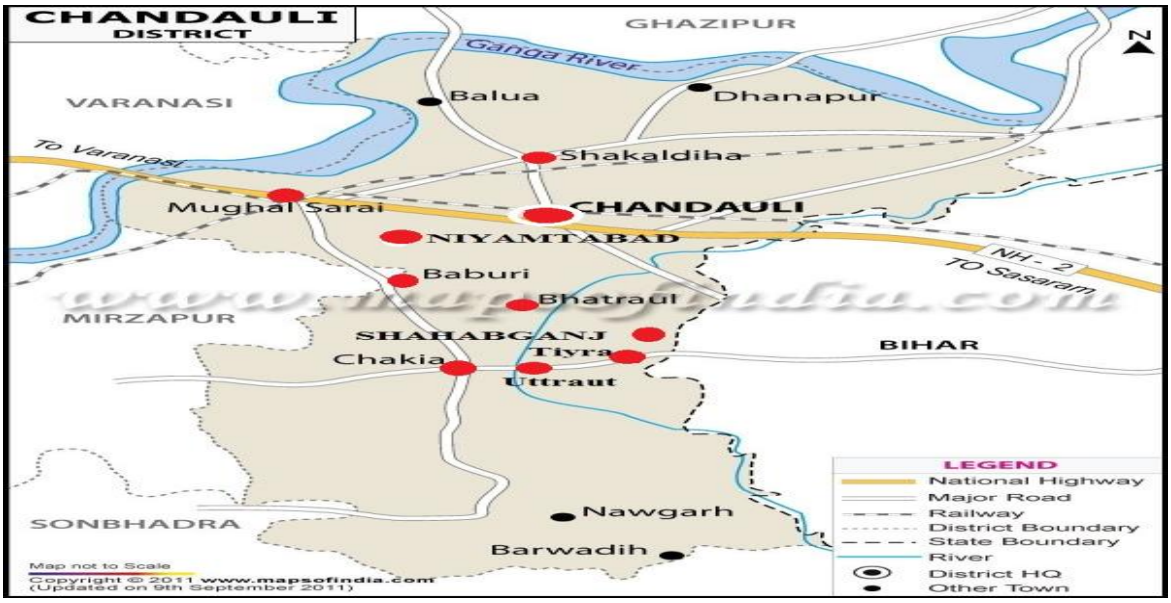

Fig.1. Map of Study Area

Sampling Sites

Drinking water samples, collected from 10 selected sites of Chandauli District, U.P. India.

Table 2.1
Distance from Chandauli District to Different Selected Sites for Study

S.N.	Location of Sample	Distance (Km.)	GPS Location
1	Chandauli	0.0	25.26^0N, 83.26^0E
2	Mughalsarai	28.0 Km.	25.27^0N, 83.12^0E
3	Sakaldiha	22.0 Km.	25.34^0N, 83.25^0E
4	Niyamtabad	28.0 Km.	25.22^0N, 83.13^0E
5	Baburi	22.0 Km.	25.17^0N, 83.18^0E
6	Chakia	18.0 Km.	25.08^0N, 83.22^0E
7	Shahabganj	12.0 Km.	25.09^0N, 83.26^0E
8	Tiyra	7.6 Km.	25.12^0N, 83.22^0E
9	Bhatraul	3.8 Km.	25.15^0N, 83.25^0E
10	Utaraut	11.0 Km.	25.12^0N, 83.26^0E

Analytical Methods

Table 2.2
Methods Used for Analysis of Physico-Chemical Parameters

S. N.	Parameter	Instrument/ Method	References
1	pH	Potentiometer/ Electrode	Jackson,1958
2	$EC_{25}{}^0$ dSm^{-1}	Electrolytic	Jackson,1958
3	TDS (mg/l)	By TDS meter	John De Zuane, 1997
4	Total Hardness (mg/l)	EDTA tritrimetric	Trivedy and goel, 1984
5	Acidity (mg/l)	Titration method	John De Zuane, 1997
6	Alkalinity (mg/l)	Titration method	Moser, 1976
7	Chloride (mg/l)	Argenometric method	A.O.A.C. (1950)

Sampling Frequency

Samples of drinking water were collected from different selected sites of Chandauli District, U.P. (India) at 20 days interval of each site.

Table 2.3
(BIS) Indian Standards for Drinking Water

S. N.	Parameter	Indian Standard (BIS) (Is10500:1991)	
		Desirable Limit	Maximum Permissible Limit
1	pH	6.5	8.5
2	$EC_{25}{}^0$ dSm^{-1}	1.	-
3	TDS (mg/l)	500 mg/l	2000 mg/l
4	Total Hardness (mg/l)	300 mg/l	600 mg/l
5	Alkalinity (mg/l)	200 mg/l	600 mg/l
6	Acidity (mg/l)	-	-
7	Chloride (mg/l)	250 mg/l	1000 mg/l

Results and Discussion

pH

The result in figure1 shows the pH of the water samples collected from different sites of the Chandauli district. The pH of water samples ranges from 7.12 to 7.44. Which was found suitable for drinking purpose. The standard desirable limit of pH for Drinking Water 6.5 prescribed by BIS, 1991 & is within the permissible limit of 8.5. The maximum pH 7.44 was recorded at Tiyra sites and minimum 7.12 was found at Shahabganj. The pH of the water samples were in order of 7.12> 7.28> 7.33> 7.34.> 7.38> 7.41> 7.42> 7.43> 7.44 at Shahabganj> Bhatraul> Utaraut and Mughalsarai> Chakiya> Baburi> Sakaldiha> Chandauli> Niyamtabad> Tiyra respectively. The highest value recorded for water which could be due to the fact that water does not flow and its receives most of its minerals from the bottom sediments and thus rise to a relatively constant composition **(Ipinmoroti, 2005).**

EC

The data presented in figure 2 shows the EC_{25}^{0} dSm^{-1} of the water samples collected from different sites of the Chandauli District. The EC of water samples ranges from 0.61 to 1.48dSm^{-1}. It was found suitable for drinking purpose. The maximum EC 1.48 dSm^{-1} was recorded at Niyamtabad sites and minimum 0.61 dSm^{-1} was found at Baburi. The EC of the water samples were in order of 0.61> 0.66> 0.72> > 0.83> 0.91> 1.07> 1.09> 1.48 at Baburi and Utaraut> Bhatraul> Tiyra and Mughalsarai> Shahabganj> Sakaldiha> Chandauli> Chakiya> Niyamtabad respectively. EC values can be used to estimate the dissolved solids concentration which may affect the taste of water and suitability for various uses. Higher conductivity values indicate higher dissolved solids concentration in water. Higher concentration of acid, base and salts in water, more will be the conductivity. As the concentration of dissolved salts (usually salts of sodium, calcium and magnesium, bicarbonate, chloride, and sulfate) increases in water, electrical conductivity increases. The electrical conductivity is higher for water that has more dissolved ionic species (**Kelin *et al.* 2005).**

TDS

The result presented in figure 3 shows the TDS (mg/l) of the water samples collected from different sites of the Chandauli District. The TDS of water samples ranges from 288.50 to 821 mg/l. Which was found suitable for drinking purpose. The standard desirable limit of TDS 500 mg/l prescribed by BIS, 1991 and within the permissible limit of 2000 mg/l. The maximum TDS 821 mg/l was recorded at Niyamtabad sites and minimum 288.50 mg/l was found at Baburi. The TDS (mg/l) of the water samples were recorded in order of 288.50> 289.50> 339.75> 346.50> 415.25> 494> 498.75> 566.75> 670> 821 at Tiyra> Utaraut> Bhatraul> Baburi> Shahabganj> Sakaldiha> Chakiya> Chandauli> Mughalsarai> Niyamtabad respectively. The highest values of water in Niyamtabad sites studied in the present work was far higher than the desirable limits and some sites exceeded the excessive limit also. High content of TDS in drinking water can change the taste of water. The TDS concentration is considered a secondary drinking water standard, which means that it is not a health hazard. However, water with a high TDS concentration may indicate elevated levels of ions that do pose a health concern, such as aluminum, arsenic, copper, lead, nitrate, and others. These results are also in agreement. **(Farooq *et al.* 2008).**

Total Hardness

The results presented in figure 4 shows the Total Hardness of the water samples collected from different sites of the Chandauli district. The Total Hardness of water samples ranges from 306.25-515 mg/l. Which was found suitable for drinking purpose. The standard desirable limit of 300 mg/l prescribed by BIS, 1991 & is within the permissible limit of 600 mg/l. The maximum Total Hardness 515 mg/l was recorded at Chandauli sites and minimum 306.25 mg/l was found at Tiyra. The Total Hardness of the water samples were in order of 306.25> 348.75> 366.25> 367.50> 370.37> 424.12> 452.50> 457.50> 491.25> 515 at Tiyra> Baburi> Shahabganj > Bhatraul> Utaraut> Niyamtabad> Sakaldiha> Chakiya> Mughalsarai> Chandauli respectively. The maximum total hardness is due to presence of carbonate and non carbonate hardness. High value of hardness may be attributed to decrease in water volume and increase rate of evaporation of water. Total hardness in water is the sum of concentration of alkaline, total soluble magnesium and calcium salts present in the water expressed as its $CaCO_3$ equivalent.

Basawaraj simpi *et al*. (2011).

Alkalinity

The results presented in figure 5 shows the Alkalinity of the water samples collected from different sites of the Chandauli district. The Alkalinity of water samples ranges from 46.83 to 80.33 mg/l. Which was found suitable for drinking purpose. The standard desirable limit of 200 mg/l prescribed by BIS, and within the permissible limit is 600 mg/l. The maximum Alkalinity 80.33 mg/l was recorded at Chakiya sites and minimum 46.83 mg/l was found at Chandauli. The Alkalinity of the water samples were in order of 46.83> 49.33> 49.99> 63.66> 64.33> 70.50> 71.00> 73.66> 76.80> 80.33 at Chandauli> Mughalsarai> Sakaldiha> Utaraut> Niyamtabad> Baburi> Bhatraul> Shahabganj> Tiyra> Chakiya respectively. Alkalinity in natural waters is due to free hydroxyl ions and water with low alkalinity is more likely to be Corrosive, in the present study level of alkalinity was found slightly low. **(Frank, 1987)**

Acidity

The data presented in figure 6 shows the Acidity (mg/l) of the water samples collected from different sites of the Chandauli District. The Acidity of water samples ranges from 32 to 61.50 mg/l. Which was found suitable for drinking purpose. The maximum Acidity 61.50 mg/l was recorded at Mughalsarai sites and minimum 32 mg/l was found at Bhatraul. The Acidity of the water samples were recorded in order of 32> 35> 36> > 36.50> 37.50> 40.50> 45.50> 51> 61.50 at Bhatraul> Tiyra & Baburi> Utaraut> Chandauli> Chakiya> Shahabganj> Niyamtabad> Sakaldiha > Mughalsarai respectively. Calcium in the form of phosphates and carbonates represents a large reservoir of base in our body. In response to an acid load such as the modern diet these salts are released into the systemic circulation to bring about pH homeostasis **Frassetto L. *et al.* (2001)**

Chloride

The results presented in figure 7 shows the Chloride (mg/l) of the water samples collected from different sites of the Chandauli District. The Chloride of water samples ranges from 24.81 to 64.69 mg/l. which was found suitable for drinking purpose. The standard desirable limit of 250 mg/l prescribed by BIS, 1991 and within permissible limit of 1000 mg/l. The maximum Chloride 64.69 mg/l was recorded at Tiyra sites and minimum 24.81 mg/l was found at Chandauli. The Chloride of the water samples were recorded in order of 24.81> 33.67> 35.44> 39.88> 41.65> 50.51>54.05> 59.37> 62.03> 64.69 at

Chandauli > Mughalsarai> Sakaldiha> Chakiya> Niyamtabad> Baburi> Shahabganj> Utaraut> Bhatraul> Tiyra respectively. Chloride increases with the increasing degree of eutrophication. Similar results were reported by **Swarnalatha and Narsingrao (1998).**

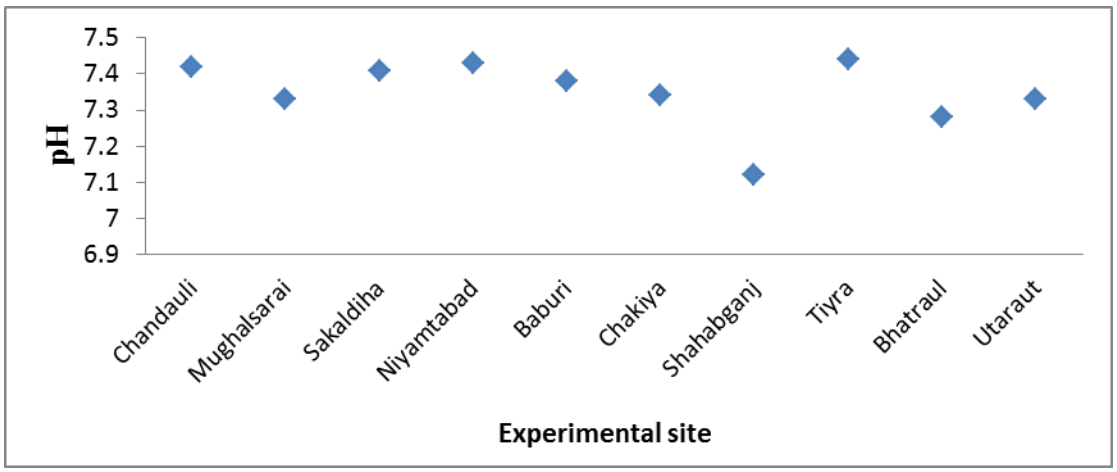

Fig. 1 pH of Drinking Water Samples Collected from Different Sites of Chandauli District

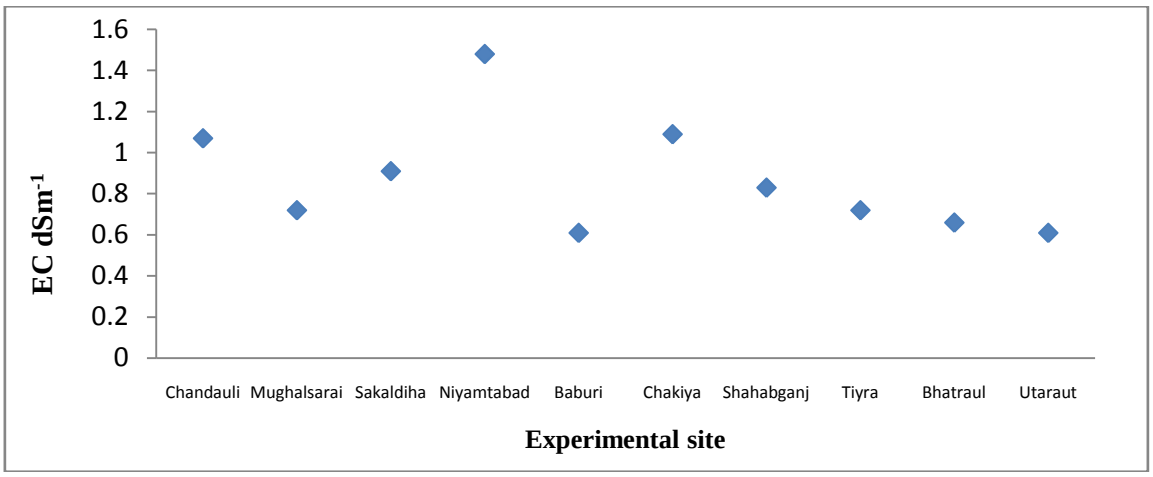

Fig. 2 EC of Drinking Water Samples Collected from Different Sites of Chandauli District

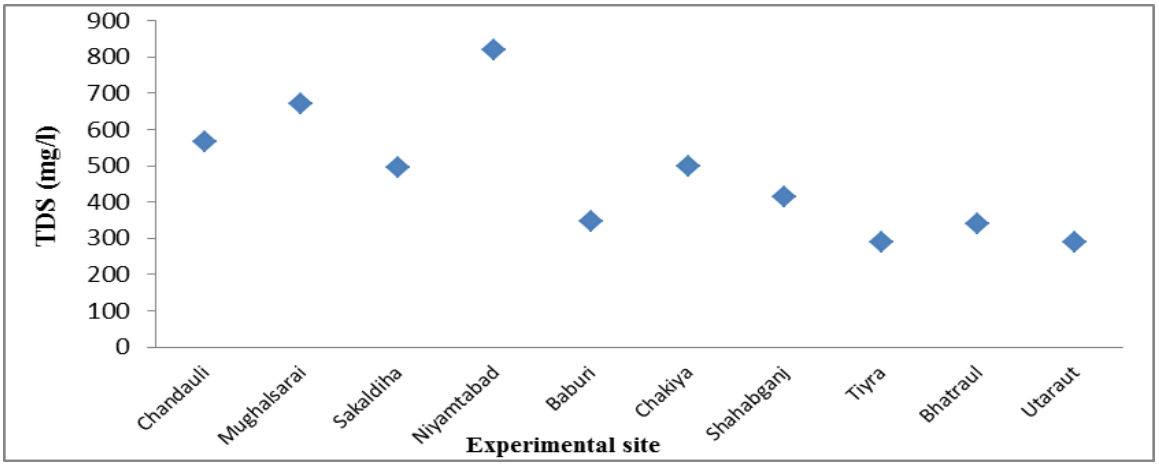

Fig. 3 TDS of Drinking Water Samples Collected from Different Sites of Chandauli District

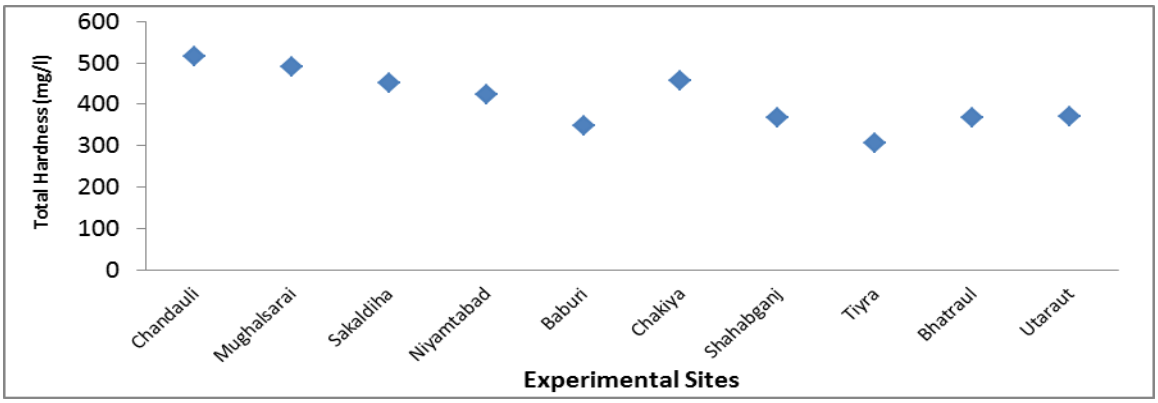

Fig. 4 Total Hardness (mg/l) of Drinking Water Samples Collected from Different Sites of Chandauli District

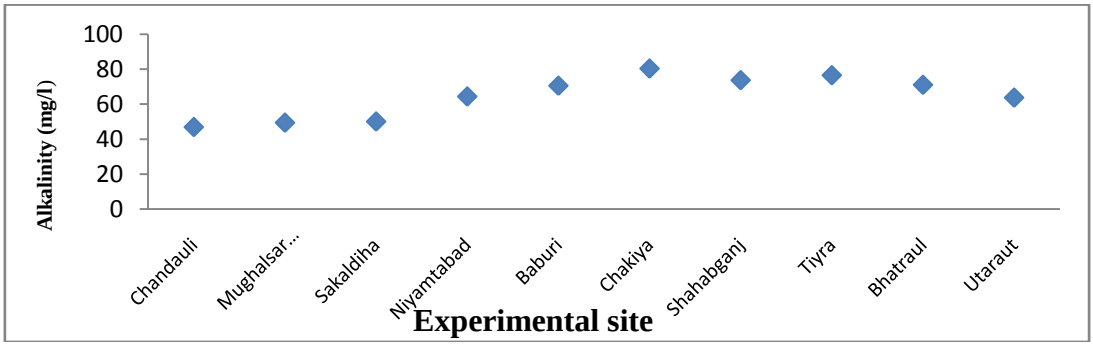

Fig. 5 Alkalinity (mg/l) of Drinking Water Samples Collected from Different Sites of Chandauli District

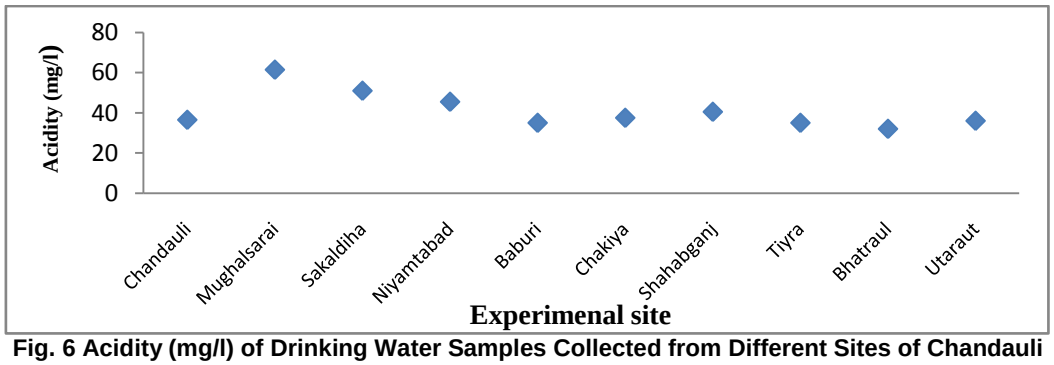

Fig. 6 Acidity (mg/l) of Drinking Water Samples Collected from Different Sites of Chandauli District

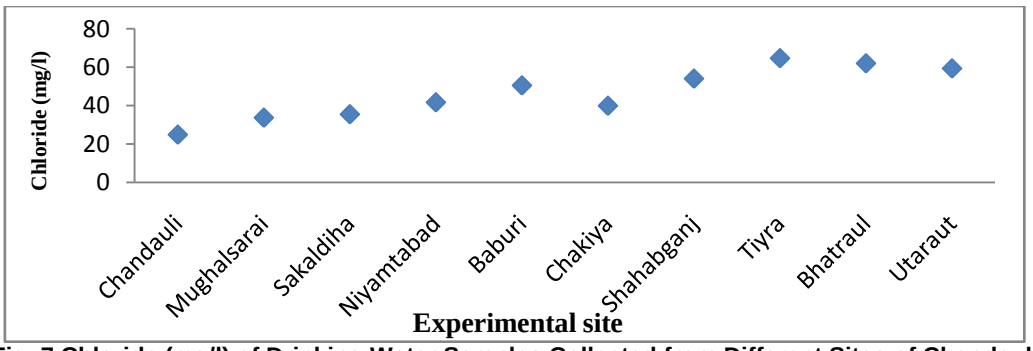

Fig. 7 Chloride (mg/l) of Drinking Water Samples Collected from Different Sites of Chandauli District

Conclusion

The results of the experiment are concluded as the pH, $EC_{25}{}^{0}dSm^{-1}$, Chloride (mg/l), Alkalinity (mg/l), Acidity (mg/l) was found within the permissible limits at all sites of experiment. The Total Hardness (mg/l) at all sites and TDS (mg/l) of S1 (Chandauli), S2 (Mughalsarai), S4 (Niyamtabad) was found under desirable limit. The study reveals that after chemical analyses, the considerable variations were recorded in drinking water quality at different places and sites of Chandauli District, most of the water samples do not comply with BIS standards for drinking purpose.

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