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Estimation of the Physico-Chemical Properties of Water in the Churu Tehsil, of Arid Region of Rajasthan (India)

Abstract

Ground water is the main source of drinking water in the Churu. Drinking water contamination by fluoride, chloride, nitrate, arsenic etc. play important role in public health. The main health risks from fluoride are bone and teeth diseases. Nitrate can undergo endogenous reduction to nitrite and nitrosation of nitrites can form N-nitroso compounds which are potent carcinogens. Nitrites can lead among infants to the disease called blue baby syndrome. There is strong relation between nitrate concentration and diarrhea and also to some other diseases. The objective of this study is to understand the present contamination level of chloride, fluoride, and nitrate, alkalinity, hardness and TDS of ground water in Churu tehsil. For these, total 21 samples were collected from different part of the study region. It was found that water constituents were not as per the permissible ranges of WHO.

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Introduction

The provision of safe supply of drinking water is a high priority issue to a government for safeguarding the health of human beings. The production and supply of adequate and safe drinking water is the most important factor contributing to a decrease in morbidity and mortality in developing country like India. As we know water is a very good solvent, hence some toxic and hazardous substances dissolve in it and produce water pollution problem posing many parameters of interest for water quality assessment. In Rajasthan 71% of the irrigation and 90% of the drinking water supply sources are underground water (Rathore, 2005).

Churu district is the part of great Indian Thar desert and lies in arid zone of western Rajasthan. The region is situated between 73^{o} 5' to 75^{o} 5′ E longitude and 27^{o} 5' to 29^{o} 0′ N latitude. It is bordered by Sri Ganganagar in the north; Nagaur, Sikar and Jhunjhunu in south; Bikaner in the west and Haryana in the east (Figure 1). The physiography of whole district is characterized by shifting and stable sand dunes, which give it a desolate and barren look. Being situated in a shallow depression, the climatic conditions are very extreme here and very hot summer and very cool winter prevail. The rainfall in the district is scanty and irregular. Annual rainfall is very low, which range around 225 to 500 mm (Singh *et al.* 2009).

In absence of surface water resources, people of the area primarily depend upon underground water to meet out their drinking and agricultural requirements. The underground water in the study area is characterized by medium to high salinity. More than 57% water is of sodium chloride type and distributed throughout the district. The district is notorious for having high fluoride and nitrate concentration in underground water, which makes it unsuitable for drinking purpose. The dry climatic condition with high evaporation and insignificant recharge might have accelerated the strengthening of fluoride and nitrate concentrations in the underground water of this area.

There are many factors contributing to nitrate contamination to water sources in the region. An increase of nitrates in water is often associated with use of agricultural chemical by farmers such as fertilizer, pesticides or poor sanitary activities. It was found that the crop of family legumineaceae is the main reason of nitrate hazard in the Churu. The crop of this family takes atmospheric nitrogen and fixed it in the soil as nitrate and more nitrates are formed than the plants need. Such excess nitrates are available for leaching and ground water get contaminated with high concentration of nitrate. Nitrate is the ultimate oxidation state of nitrogen

and is the source of pollution in ground water. Nitrates undergo reduction and nitrosation of nitrite can form N- nitroso compound that is a potent carcinogen. The use of High nitrate contaminated drinking water is a well known risk factor for infant methemoglobinemia (Mirvish, 1985). Gastric cancer, birth defects and hypertrophy of the thyroid are other health effects on humans that are potentially influenced by elevated levels of nitrate in drinking water (Kugali *et al*, 2013). The increased nitrate level in drinking water may also adversely affect the central nervous system.

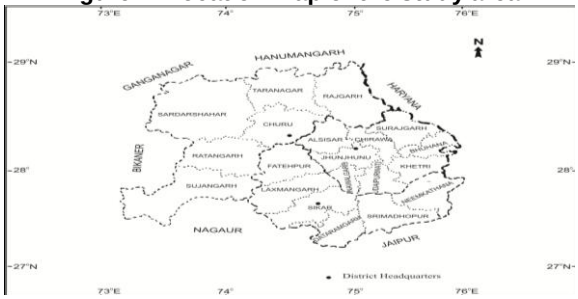
The health problems arising as a result of fluoride contamination is more widespread. According to a report of national geophysical Research institute of Hyderabad about 177 districts of India are fluoride affected. The country has increasing incidences of fluorosis, both dental and Skeletal with some 66 million people being at risk (Sinha and Mustaria 2004). In India, Rajasthan has maximum area affected by excess concentration of fluoride in ground water (Murlidharan *et al.* 2002). About 22 districts of Rajasthan have greater amount of fluoride than the permissible limits (Sinha *et al.* 1970). The reason of origin of these hazardous elements is attributed to geological reason. According to recommendation of WHO drinking water should not contain more than 1.5 mg/l fluoride. People who drink water containing fluoride in excess of this level over many years could get bone disease, including pain and tenderness of the bones. In moderate forms of dental fluorosis, brown staining or pitting of permanent teeth may appear.

Total alkalinity is the measure of capacity of water to neutralize the acids. It provides guidance in applying doses of chemicals in water and waste water processes specially in coagulations, softening and operational control of anaerobic digestion.

Hardness in ground water in the area is due to availability of limestone, sedimentary rock and calcium bearing minerals in soil. Hardness can also occur locally in groundwater from excessive application of lime to the soil in agricultural areas. Excessive hardness in drinking water results in urinary concentrations, stomach disorder, stone in kidney and bladder.

Chlorides are widely distributed in nature as salts of sodium chloride, potassium chloride, and calcium chloride. A normal adult human body contains approximately 81.7 g chloride. Excessive intake of drinking-water containing sodium chloride at concentrations above 2.5 g/l has been reported to produce hypertension (Fadeeva, 1971). This effect is believed to be related to the sodium ion concentration.

Figure -1 Location map of the study area



Material And Methods

Total 21 groundwater samples were collected from tube wells, open wells, and hand pumps of different locations of study area. The collected samples were analyzed for estimation of physical and chemical properties like pH, Total Alkalinity, total hardness, Ca, TDS, Chloride, Nitrate and Fluoride. Samples were collected in clean bottles of 1 liter capacity. Physical parameters like, pH, TDS were measured using digital meters immediately after sampling. The total hardness, alkalinity, nitrate, nitrite, chloride, fluoride were analyzed using standard titrimetric methods - APHA 1998.

Results and Discussion

Present study is an overview of drinking water parameters in Churu and surrounding area. The most of the water samples in study area are brackish to saline in nature and pH values ranged from 7.1 to 8.4, which is more than the WHO (1984) permissible limits.

Alkalinity and pH in the groundwater of study area are caused by bicarbonate and carbonates. The values of alkalinity in all the samples range from 180 to 700 mg/l in the area.

The hardness of ground water ranged from 200 to 1480 mg $Caco_3$/l with an average of 761.42 mg $Caco_3$/l in the study area, whereas WHO permissible limit for hardness of ground water for safe life is 500mg/l. The analysis reveals the increase in the concentration is mainly due to mineralization of ground water. The range of calcium in the groundwater of study area varied from 120 to 700 mg/l.

The amount of TDS in groundwater depends on the solubility of minerals in different geological regions of the area. Water containing TDS concentrations below 1000 mg/l is usually acceptable for consumption. In the present study TDS was found to vary from 920 to 4620 mg/l.

Chloride concentration range was from 200 to 2550 mg/l in the study area, which is higher in the most of samples than desirable level determined by ICMR (200 mg/l). Except three, all the study sites had chloride contents far above the permissible limit of WHO. Chloride concentration was maximum in Balrasar and minimum in Gajsar (figure 2).

High concentration of nitrate has been reported in ground water of Churu. Data analysis reveals that nitrate concentration in collected water samples lie in the range from 30 to 280 mg/l, with an average of 81.19 mg/l (Table 1). WHO proposed permissible limit for nitrate is 45 mg/l but about 19% of samples collected in study area have high values of nitrate. Churu (GPF) and Balrasar had maximum nitrate contents far above the WHO permissible limit (Figure 3).

Fluoride content ranges from 0.5 to 4.3 mg/l in the Churu tehsil with an average of 1.66 mg/l (Table 1). The study indicates that most of the water samples contain high concentration of fluoride than that of the standard set by WHO and ICMR (1.5 mg/l). Churu T/W 31 had the maximum fluoride contamination followed by Churu GPF site. Ten study sites had

fluoride contamination above WHO permissible limit (Figure 4) and rest had the concentration within range. The analysis of data indicates that high concentration of fluoride is associated with salinity. Regular intake of fluoride contaminated water may cause bone diseases.

The results of data analysis showed that there is a significant association between chloride, fluoride and nitrate contaminated drinking water and diseases related to bone, teeth and digestion.

Table.1
Results of the physico-chemical parameters of groundwater in selected areas of Churu Tehsil.

Sample No	Location (Churu tehsil)	pH	Alkalinity	Hardness		TDS	Chloride	Nitrate	Fluoride
				Total	Calcium				
1	Asloo	7.6	300	1200	700	4620	2000	30	1.9
2	Balrasar	7.6	420	1420	720	2700	2520	230	1.7
3	Churu (GPF)	7.5	240	410	170	920	250	280	3.1
4	Churu Garh	7.8	430	1070	120	2960	800	50	0.9
5	Churu Goenka School	7.4	400	630	250	1725	600	30	1.0
6	Churu Mishrawell	7.5	630	360	200	2480	700	45	2.6
7	Churu T/W-3	7.7	620	580	170	2960	900	50	1.9
8	Churu T/W-31	7.7	640	460	130	2350	750	40	4.3
9	Churu T/W-58	7.8	700	670	230	2900	1050	50	2.4
10	Churu T/W-95	7.6	500	690	290	2760	750	50	1.8
11	Dhadhar T/W-I	7.7	680	640	320	2680	1380	125	1.5
12	Dhadhar T/W-II	7.1	680	580	310	3050	1580	120	1.6
13	Dhadhria charnan	7.5	380	960	460	3090	1700	90	0.5
14	Gajsar road	7.8	300	200	110	1020	200	30	1.3
15	Ghanghu	7.1	240	1480	620	1940	620	95	1.4
16	Khansoli	8.0	450	930	450	3720	1580	55	1.2
17	Lakhau	7.7	280	1000	570	4340	1780	65	1.7
18	Pithisar	8.4	180	1260	680	1940	580	70	0.9
19	Raipuria	7.5	360	580	280	2940	900	50	1.4
20	Ratan nagar	7.8	440	310	180	1760	610	65	1.1
21	Shyopura	7.4	480	560	370	2770	780	80	0.7

Figure 2: Distribution of Chloride in Churu

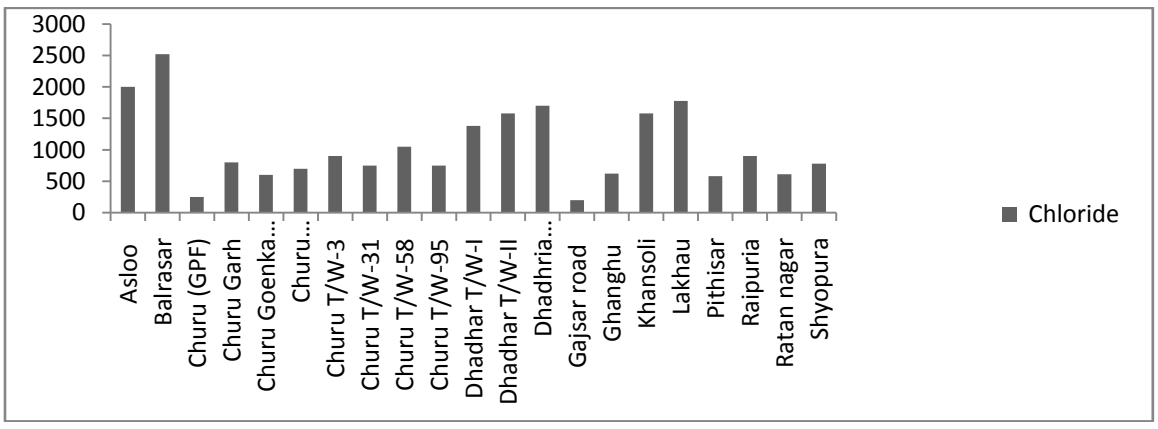


Figure 3: Distribution of Nitrate in Churu

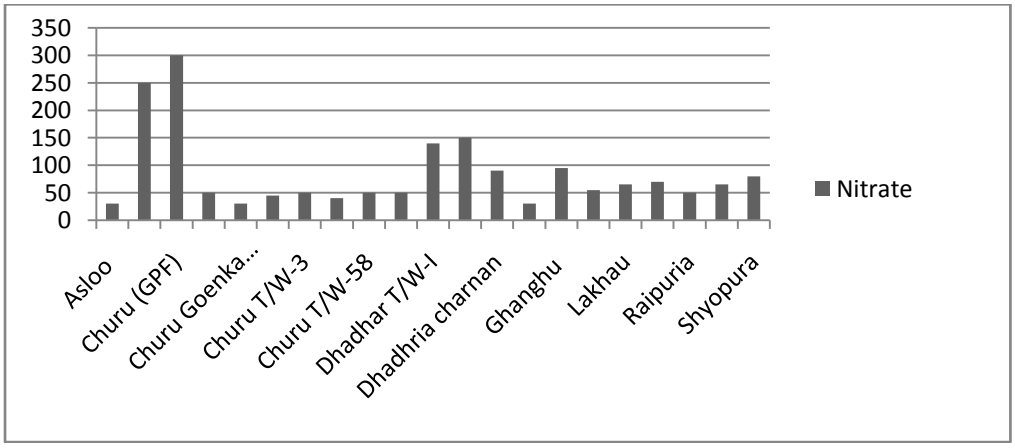
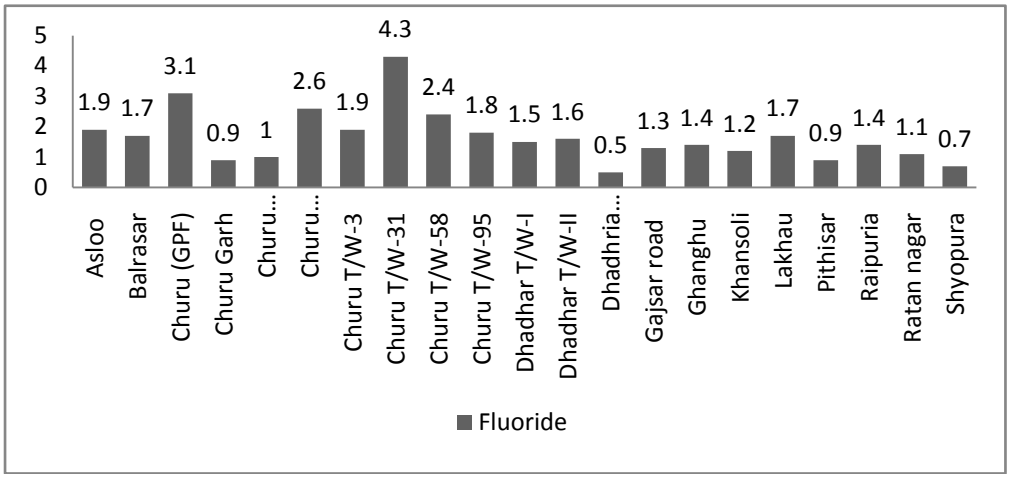


Figure 4: Distribution of Fluoride in Churu Tehsil



The quality of groundwater of Churu and surrounding area is not according to norms of Rajasthan government and WHO standards. Earlier studies conducted in the Sadulpur tehsil of the district also revealed more or less same results (Singh 2014). Higher concentration of these salts had deleterious effect on the human health (Fetter 1980). Higher concentration of nitrates had been found to be associated with cancer in Slovakia (Gulis *et al.* 2002). Knobetoch (2000) reported blue baby syndrome associated with high nitrate concentration in water. Neal *et al.* (2000) analyzed the water quality of Thames tributaries and found them to be contaminated by anthropogenic activities. Arsenic contamination has found to be lethal in amany areas of India (Chakraborti *et al.* 2004, Rahman *et al.* 2005) and Nepal (Shretha *et al.* 2003). Fortunately arsenic contamination is not very high in the region. Akhilesh *et al. (*2005) carried out study on the geochemical scenario of fluoride in the whole Rajasthan. The pH results indicate that ground water of Churu tehsil is highly brackish to saline in nature. The total hardness of ground water of this area falls in the hard category. Salinity, hardness, chloride, nitrates and fluoride properties of drinking water in the study area indicate the sign of deterioration which calls for at least primary treatment of ground water before being used for drinking. During sample collection people of area also complained about diarrhea, gastric and other digestion related problems, which may be because of consuming ground water containing high amount of nitrate contents. Consumption of high concentration of fluoride has resulted in bone deformity and joint pains. Laanthe *et al. (*2002) has suggested some bioremediation methods of nitrate but these have yet to gain fruitful results.

The purpose to persuade present research work was to know ground water quality and to find out chemical and biochemical remediation of problematic ions. The study suggests that regular evaluation of water quality is needed in Churu tehsil so that strategies can be developed to reduce excess chemical contaminations and the water can made suitable for drinking purposes.

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