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Evaluation of Quality of Water Consumed by the Villager's of nearby Karera and Narwar Block of Shivpuri District of Madhya Pradesh, India

KEYWORDS

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ABSTRACT *Physico-chemical properties of underground drinking water were studied after reports of presence of fluoride in ground water of some parts of Karera and Narwar Block of Shivpuri district of Madhya Pradesh. Water samples were collected from the various places of Karera and Narwar Block of Shivpuri district. The physico-chemical properties such as color, pH, TDS (total dissolved solid), salinity, electrical conductivity, acidity, alkalinity, chloride, iron, total hardness, calcium and magnesium hardness and fluoride concentration were studied and analyzed. Microbiological analysis was done using MPN test and Standard plate count. Bacteria present in samples were isolated on selective media and were biochemically characterized. The results obtained were compared with acceptable limits of the drinking water set by CPHEEO and BIS. Most of the water samples were not found suitable for drinking. Results indicate that three out of eight water samples had fluoride content above acceptable limit and all samples accept one had coli forms present. Moreover, these samples were found to contain Escharichia coli, Pseudomonas species and Enterobacter species that may pose serious health hazards in immuno-compromised persons and children. One sample was contaminated with Salmonella typhi, consumption of such water may result in typhoid outbreak. So, water from these sources can't be used for drinking purpose without special treatment.*

Introduction:

Majority of people in India depends upon fresh water supplies from bore wells, dug wells, ponds, springs and the like. The lack of clean water is the direct cause of millions of deaths every year in poorer countries. Hence it is very important to access the ground water quality not only for present use but also from the viewpoint of a potential source of water for future consumption. In recent years, considerable attention has been focused on the study of ground water to ensure safe drinking water for human consumption. Ground water is renewable natural resource, which is replenished annually by the precipitation.

This study was conducted after reports of presence of fluoride in ground water in some places of Shivpuri districts of Madhya Pradesh (Mishra et al.,2011 and GOI survey report 2009). Fluorine is a naturally occurring element in minerals, geochemical deposits and in natural water systems and enters into food chains through drinking water. The area selected for this study was ground water of Karera and Narwar of Shivpuri which is fluoride effected. It is located at 25^0.47'N, 780.15'E and 25.33'N, 77.51'E. The average rainfall of Shivpuri district is about 875 mm most of which is concentrated in monsoon from late June to early October. In the present study the quality of drinking water was assessed in terms of physico-chemical and microbial parameters.

Material and methods:

The present investigation deals with the quantitative and microbial analysis of groundwater of nearby area of Karera and Narwar block of Shivpuri. Thus ground water samples were collected in the month of January 2013 from 24 underground bore wells and hand pumps at various locations of Karera and Narwar village of Shivpuri Madhya Pradesh. The location was chosen as study area because recently presence of Fluoride is reported in some of the towns of the district. The samples were collected in sterilized bottles and were stored at 4^0C till further investigations. The physico-chemical parameter such as color, pH, electrical conductivity, alkalinity, acidity, TDS, total hardness, Ca & Mg hardness, chloride, total iron, fluoride concentration were analyzed according to standard methods of APHA (2000). Microbiological analysis was done as per guidelines of ISO (1988 a, b; 1990 a, b) and WHO (1985). MPN (Minimum portable number) test for Presumptive coliform count and standard plate count technique for total bacterial population was performed on all water samples collected. MPN test was done as described by Arora and Arora (2008) by adding measured amount of water samples as 50ml, 10ml, 1ml, 0.1ml volumes into 50ml,10ml double strength medium and 5ml single strength in the screw capped inoculation bottles and tubes. These were incubated at 37°C for 48 hours, the presumptive coliform count per 100ml was determined from the bottles showing acid and gas using the probability table. After the presumptive test, Confirmed E. coli count was determined by preparing some subcultures from all the bottles. The media used were Macconkey agar and Eosin Methylene Blue agar; the sub-cultures were incubated at 37°C and 44°C and examined after 24hours. Besides this each sample was inoculated on Salmonella-Shigella (SS agar) agar plates. Total plate count was done by pipetting 1ml of each water samples into four sterile dishes and 1ml of water to 9 ml of diluents in sterile test tubes, then 1ml of 1/10 dilution was added to each of the four petri-dishes, also 1/100 dilution was added to two petri dishes followed by addition of 20ml of molten sterile yeast extract agar, these were mixed gently in a clockwise and anti- clockwise directions. Two of the plates inoculated with undiluted sample, while the other two were inoculated with 1/10 dilution and 1/100 were incubated at 37°C for about 24hours, the remaining plates having undiluted and 1/10 dilution were incubated at 25°C for 72 hours (Baker and Breach, 1980). The isolates were identified by morphological and biochemical tests viz. colo-

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ny morphology, Gram staining and motility, Indole, Citrate, Urease, Methyl red, Voges Prosker (VP), Hydrogen Sulphite and sugar fermentation tests. The results obtained were compared with drinking water quality guidelines by Central Public Health and Environmental Engineering Organization (CPHEEO) and standards set by the Bureau of Indian Standards (BIS).

Results and Discussion:
The physico-chemical of the underground water near the fluoride effected area of shivpuri were determined and the results obtained are presented in Table1.

The colour of all water samples were transparent.
pH measures the activity of hydrogen ions (H^+) in the water. pH indicates the alkalinity and CO_2 concentrations of the water. Results show that pH values of the samples under study varied from 7.78 to 8.33. pH of six samples was above acceptable limit of CPHEEO suggested guidelines. However pH of all the water samples lies within BIS and WHO suggested range of 6.5 to 8.5(Figure1).

Electrical conductivity is directly linked to the concentration of the ionic impurities in the water. Conductivity measurements are influenced by pH levels and the temperature. Conductance of all the samples was ranged between 257µs/cm to1133µs/cm.

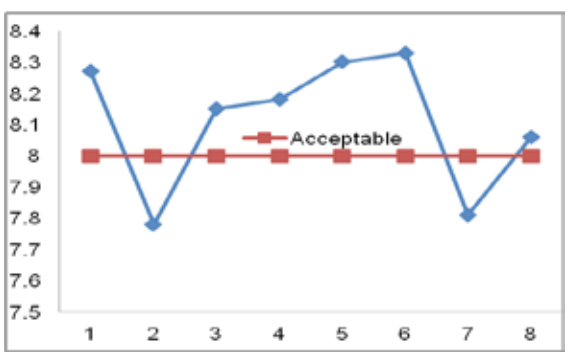

Figure 1: pH of water samples

Total dissolved solid (TDS) consists of inorganic and organic substances. Inorganic substances which include clay, silt, minerals, metals, etc. mainly in the form of carbonates, bicarbonates, chlorides, sulphates, phosphates, nitrates, calcium, magnesium and sodium can create taste, odor, hardness, corrosion & scaling problem. TDS of the different water samples ranged from 138 to 1299 mg/L(Figure 2).

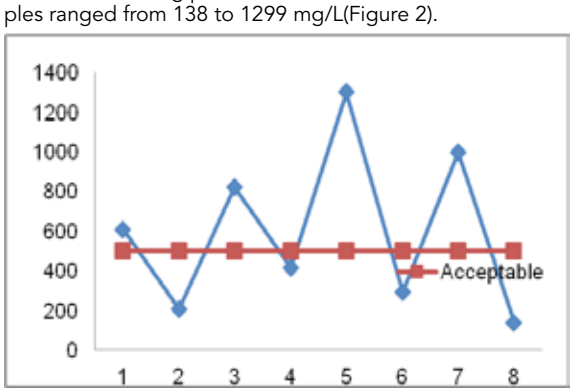

Figure 2: TDS in water samples.

Hardness of water is caused by the presence of multivalent metallic cations and is largely due to calcium (Ca) and magnesium (Mg) ions. Hardness is reported in terms of $CaCO_3$. Results showed that hardness of all the water samples was found in the range of 180 mg/L to 490 mg/L. Hence all the samples fall in the category of hard and very hard. (Figure3).

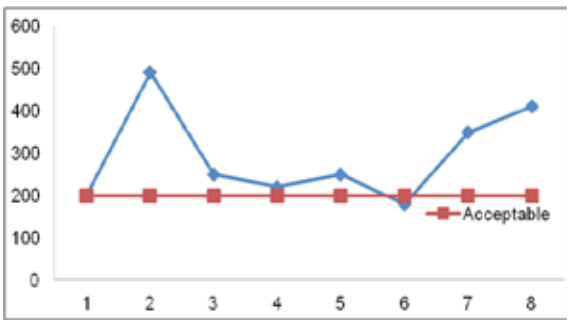

Figure 3: Total hardness in water samples

Calcium is a major constituent of various types of rock. It is one of the most common constituent presents in natural water ranging from zero to several hundred milligrams per liter. Results showed calcium ranged from 50.0 mg/L to 420.0 mg/L It indicated that all the samples have high concentration of calcium and except one sample (sample No.1) all the samples were above acceptable range of 70mg/L as suggested by CPHEEO guidelines.(Figure 4)

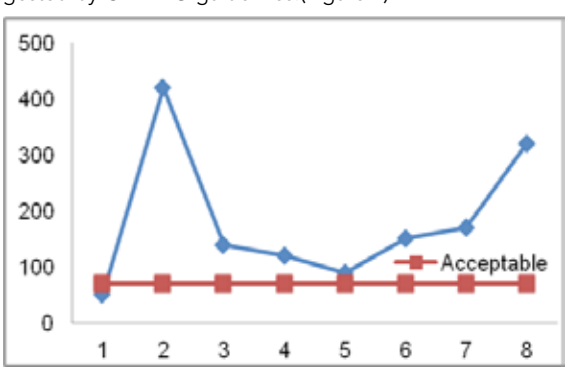

Figure 4: Calcium contents in water samples

Magnesium is often associated with calcium in all kinds of water but its concentration remains generally lower than the calcium. Magnesium content in the.

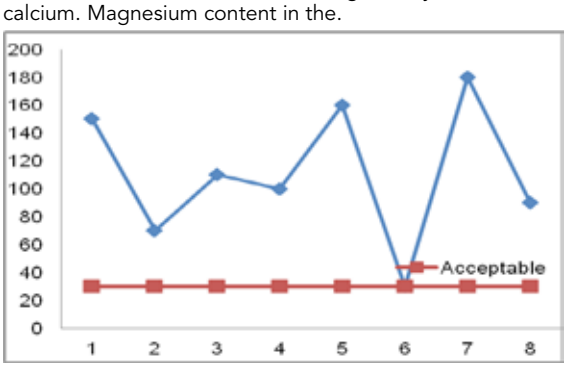

Figure 5: Mg contents in water samples.
samples under study ranged from 30.0mg/L to 180.0 mg/L. It showed that except one sample all samples were not safe for drinking (Figure 5)

Chloride is present in all natural water mostly at low concentrations. It is highly soluble in water. Chlorides are generally limited to 250mg/L to1000mg/L. Chloride ion concentration of all the samples studied varied from 47.02 to 90.10 mg/L which was well below the acceptable limit of CPHEEO. Alkalinity is the content level of carbonate (CO_3^{2-}), bicarbonate (HCO_3^-) and hydroxide (OH^-) in water. Alkalinity is the main control factor for the aggressiveness of the water. Alkalinity

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of the samples varied from 150 mg/L to 360 mg/L. Alkalinity of samples are in permissible range.

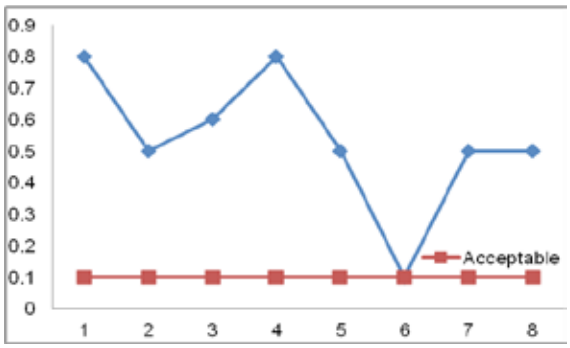

Figure 6: Fe contents in water samples.

Iron is common constituent in ground water. It is present in water either as soluble ferrous iron or insoluble ferric iron. Although iron has got little concern as a health hazard but is still considered as a nuisance in excessive quantities. Long time consumption of drinking water with a high concentration of iron can lead to liver diseases (Hemosiderosis). High concentration of iron in water is not suitable for processing of food, beverages, ice, dyeing, bleaching and many other items. Total iron content in the samples lie between 0.1mg/L to 0.8 mg/L. Thereby only one sample fall in permissible limit.(sample No.6).

Fluoride concentration was found from 0.48 mg/l to 2.50 mg/l. This shows that drinking water in this region is not safe for drinking. High fluoride (>1.5 mg/l) may

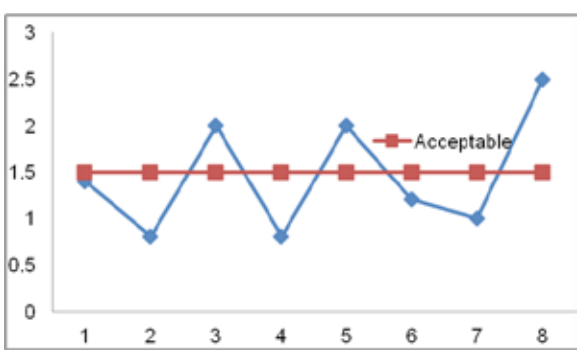

Figure7. Fluoride concentration in water samples

cause various types of fluorosis manifestations including mottling of teeth called dental fluorosis and skeletal fluorosis. Intake of high fluoride (> 3.0 mg/l) was found to results in skeletal fluorosis and other skeletal abnormalities when used for a long period. (Figure7)

Microbial Analysis:

The result of the microbial analysis of the water samples are shown in Table 3, the presumptive coliform count or MPN index/100ml of the water samples ranged from Nil to 240/100ml, it indicates that sample no 5 (Figure 8) had the highest count of 240/100ml followed by sample no 4 (130/100ml). The total plate count was also highest in sample no 5 (5.8X10^{8}cfu/ml).The bacteria isolated on different selective media identified by biochemical tests were; Escharichia coli, Pseudomonas species, Enterobacter species,Citro bacter and S.typhi (Figure 9). These water samples were highly contaminated; this may be due to the illegal dumping of domestic wastes and closeness of septic tanks. This observation is

similar to that Richmann (1997), he reported that the presence of coliforms group in water bodies may be due to contamination with Human or animal feces.

Figure 8: MPN results of Sample no 5.

Most water samples showed high concentration of Escherichia coli, these pathogens may pose a special heath risk for infants, young children and people with severely compromised immune systems (EPA, 2002). One of the samples showed presence of Salmonella typhi, causative agent of typhoid. Water contaminated with Salmonella typhi may results in outbreak of typhoid. This result indicates poor sanitary conditions around Deep water wells and the public health implication of this is obvious because feacal coliforms are associated with feacal matter, which may contain pathogens (Rees, 2003; Morinigo et al., 1992). The water can only be used for public consumption when the coliform count is zero, a count of one or more is taken as positive indication of faecal pollution and the possible risk of diseases (WHO, 1996).

Table 1: Chemical analysis ground water quality of Karera and Narwar Block of Shivpuri district of Madhya Pradesh.

Sample No.	Color	pH	TDS mg/L	Electrical Conductivity µs/cm	Total Hardness mg/L	Ca mg/L	Mg mg/L	Alkalinitymg/L	Cl mg/L	Fe mg/L	Flouride mg/L
1	Transparent	8.27	607	480	200	50	150	350	50.05	0.8	1.40
2	Transparent	7.78	207	1746	490	420	70	290	10.01	0.5	0.80
3	Transparent	8.15	823	630	250	140	110	150	11.01	0.6	2.00
4	Transparent	8.18	416	353	220	120	100	220	4.04	0.8	0.80
5	Transparent	8.30	1299	1004	250	90	160	310	19.01	0.5	2.00
6	Transparent	8.33	293	257	180	150	30	200	4.04	0.1	1.20
7	Transparent	7.81	996	777	350	170	180	360	15.01	0.5	1.00
8	Transparent	8.06	138	1133	410	320	90	250	14.01	0.5	2.50

1.Bahgava village 2.Bayani. 3.Foolpur. 4.Chitri. 5.Hatheda 6.Chakmiyapur 7.Seehor. 8.Aeran (Narwar Block)

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Table 2: Physico-chemical drinking water quality standards.

Characteristics	BIS (1991)	WHO	Acceptable*
pH	6.5 to 8.5	6.5 to 8.5	8.0
TDS	2000	1000	500
Total hardness(mg/L)	600	500	200
Ca(mg/L)	200	100	70
Mg(mg/L)	100	--	30
Cloride(mg/L)	1000	250	200
Fe(mg/L)	1.0	0.3	0.1
Floride (mg/L)	--	--	≥1.5

***The Central Public Health and Environmental Engineering Organization (CPHEEO)**

Table: 3 Bacteriological analysis of water

Sample number	Presumtive coliform number or MPN index/100 ml	Cfu/ml	Bacteria present
1.	110 coli forms	$4.1X10^4$cfu/ml	E.coli, Enterobacter sp., Citrobacter sp.,
2.	Nil	$3.9X10^3$cfu/ml	unidentified
3.	31 coli forms	$5.6X10^7$cfu/ml	Enterobacter sp.
4.	130 coli forms	$3.7X10^8$cfu/ml	E.coli, Pseudomonas, Enterobacter sp., Citrobacter sp.,
5.	240 coli forms	$5.8X10^8$cfu/ml	E.coli, Salmonella typhi, Enterobacter sp., Citrobacter sp.
6.	09 coli forms	$3.9X10^2$cfu/ml	unidentified
7.	11 coli forms	$2.13X10^3$cfu/ml	Enterobacter sp.
8.	13 coli forms	$6.8X10^4$cfu/ml	E.coli and Citrobacter sp.

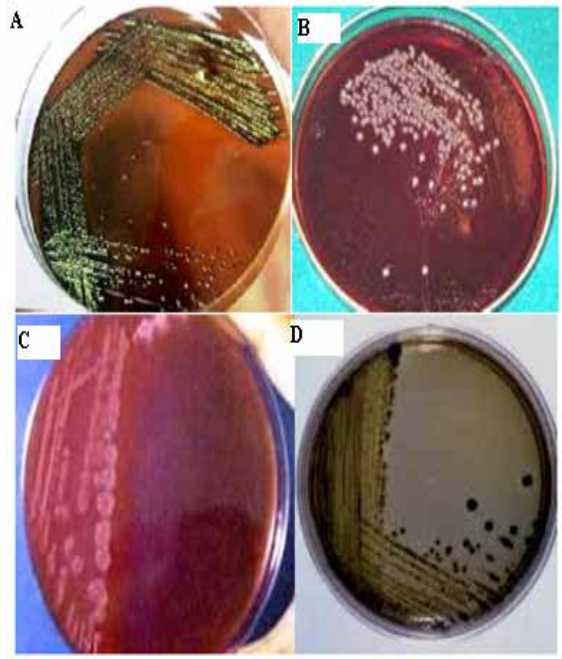

Figure 9: Growth of different Bacterial species isolated from water samples
A Growth of E.coli on EMB Agar
B Growth of Pseudomonas sp. on Mac Conkey Agar
C Growth of Citrobacter sp. on Mac Conkey Agar
D Growth of Salmonella typhi on SS Agar

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