Evaluation of Fluoride and different Physico-Chemical Parameters in the Kelwa Village, Rajasamand District Rajasthan

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ABSTRACT

We investigatedthe quality of groundwater in the Kelwa region of the Rajsamand district in the Southern part of Rajasthan. The fluoride content of the groundwater in Kelwa was determined and techniques to reduce the fluoride content were employed to improve the groundwater quality. we analyzed a variety of Physico-Chemical water quality dataincluding TDS, pH, Total Alkalinity, Chloride, Sulphate, Calcium, Magnesium and Fluoride. By APHA, all of these criteria were examined using industry-recognized techniques. Physico-Chemical parameters were gathered from 10 Distinct Sites, including $Ca,^{2+}$ $Mg,^{2+}$ $Cl,^{-}$ $SO_4,^{2-}$ $F,^{-}$ $NO_3,^{2-}$ Total Hardness and Alkalinity. Only 5% of the study's water samples fell into the category of relatively bad quality, while 95% were judged to be of acceptable quality.

The methods utilized were analysis of pH, determination of pH, Chloride Estimation and Determination ofSulphate, Fluoride and Nitrate Estimation along with others.

Groundwater samples from Kelwa and a nearby village were taken and their chemical properties and overall water quality were examined Twenty samples in total were taken from various water sources in 10 distinct Kelwa settlements. The findings of this study are consistent with those of other studies that show that when Fluoride levels in drinking water rise so does the prevalence of Dental Fluorosis. Individuals in the current study displayed Dental Fluorosis symptoms in 40% to 64.99% of cases. Dental Fluorosis was more common in some water sources than others.

Keywords: Groundwater, Parameters, Water Quality, Dental Fluorosis

Introduction

On a world with water, humans can survive only because of water as it is a vital resource given by nature. The same applies for plants and animals. The most prevalent physical material and clear liquid on earth is water. Water serves as the basis for all life. Humans cannot exist for very long without water since water is directly or indirectly involved in every phase of life. Every cell and organ system in the human body depends heavily on water to function correctly.Every function of the human body is supported by water. In villages and many cities of developing countries, there is a scarce reach to clean and sufficient water required for drinking.[1]Groundwater is a dependable and limited water resource in rural regions. Water at the surface along with groundwater are the most typical water sources utilized for agricultural and other uses. Ground water is linked with surface water. The surface water lies on the earth's surface while the groundwater is present below the surface of the earth in rocks and porous soils. It exists as streams, rivers, lakes, ponds and oceans.A significant natural source of drinking water is groundwater. Although groundwater's chemical and biological composition is suitable for the majority of applications, human activity has altered the water's quality.[2] The most prevalent dissolved mineral substances found in groundwater include $Na,^{2+}$ $K,^{2+}$ $Mg,^{2+}$ $Ca,^{2+}$ $HCO_{3,}^{-}$ $Cl,^{-}$ F^{-} and $SO_{4.}^{2-}$Numerous elements, including dissolved minerals and organic molecules found in groundwater at varied quantities,affect the appropriateness of groundwater for diverse uses.Less than 20 to several thousand parts per million (ppm) of fluoride may be found in soil and phosphate deposits with a greater amount of fluoride. Fluoride, in the form of fluorspar, alkali, silicate andigneous etc. Contributes to the creation of soil and rocks.One of the 23 countries where fluoride contamination of the water system causes health issues is India. Fluorosis affects 62 million people worldwide, including 6 million children, in 18 states in India.[3]Indian villages have Fluoride poisoning of groundwater from a significant source of water suitable for drinking. The concentration of fluoride in groundwater is excessive and this is because groundwater is mostly caused by industrial effluents, a lack of precipitation, inadequate recharge and agricultural uses.It is advised by the World Health Organization (WHO) that the concentration of fluoride in water that is used for drinking should not be more than 1.0 or 1.5 ppm. If consumed within the allowed limits (1.0 mg/L), fluoride is also advantageous for health of humans and aids in reducing dental cavities.

FLUORIDE SOURCES

The most crucial source of fresh water for human life is groundwater. Unchecked human activity in industry and agriculture has caused dangerous chemical levels in ground water to surpass safe limits and fluoride pollution has become a major concern that has spread throughout the globe. The Majority of rocks containing fluoride-bearing minerals are to blame for fluoride contamination in ground water.[4] The soil's ability to leach fluoride into groundwater is another factor. However, water quality factors including pH, ionic strength and hardness are the main drivers of mineral solubility in groundwater.[5] After achieving equilibrium, the water becomes oversaturated with fluoride if the fluoride concentration is more than 5 mg/L. The precipitation of Calcite further raises the Fluoride levels. Certain water aquifers' properties such as chemical, physical and the topographical have an effect on the natural concentration with porosity, soil and acidity.[6]

The solubility of fluorite in ground water decides the maximum concentration of fluoride in it.[7] When exposed to water bodies, rocks formed by magma have large concentrations of fluoride-bearing minerals. This significantly contribute to the level of fluoride in ground water.[8]

Andhra Pradesh, Rajasthan, Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, Gujarat, Maharashtra, Tamil Nadu and Karnataka are just a few of the states of India. They have made a thorough acknowledgment of the existence of fluoride in their groundwater.[9] It was initially found in the Indian State of Andhra Pradesh in 1937. Drinking water from subterranean sources that contains high amounts of fluoride contaminants causes fluorosis, which affects 62 million people globally, including 6 million children.[10]

MATERIALS AND METHODS

We have used materials and methods of varied nature in order to optimize the improvement of water quality in the Kelwa district of Rajsamand. Sampling process has been utilized to collect water samples. They have then been analyzed and tested to check the water quality. Then the methods have been

employed by the author to make the water potable to a great extent. The water sampling and storage procedure was accurate and appropriate. The author collected samples from various villages in the Rajsamand district'sKelwa region. The material used to collect water samples was standard screw capped polyethylene storage containers. From each location a water sample of over 1 liter was taken and the samples were then labelled too. We employed the pH analysis using a pH meter. Hydrogen electrode served as a reference point for measuring pH. Similarly, Chloride Estimation, Mohr Titrimetric Estimation was used and a glass beaker with 65 ml of sample solution was taken.
Other apparatus used included burette, it's stand, pipette, conical flask etc. and reagents like Potassium Chromate Indicator, Silver Nitrate Solution, Sodium Chloride and Distilled Water. Apart from this, Sulphate Estimation was carried out too using titration. Fluoride Estimation was done using spectrophotometry using apparatus like beaker etc. Total Hardness and TDS were determined too. Alkalinity was Estimated too. Defluoridation was used to remove the Fluoride content from water which is very necessary. We employed two different techniques for the same namely:

Defluoridation of water by activated carbon prepared from lemon peels: This method was found to be better than the chemical treatments. We used various operating parameters like pH, adsorbent dosage etc. and the amount of eliminated fluoride was noted down.

Defluoridation of water by using the modified Nalagonda Technique.
This technique involved the fast mixing of bleaching powder, calcium oxide and alum (aluminium sulphate) build up. Alum is to be applied as a 10% solution to a 40 L bucket that is attached to a tap. For disinfection, bleaching powder was added to the sample water at a rate of 3 mg/L. After applying the Nalgonda approach, it was possible to detect the decreased level in water samples taken from various locations.
The dental and skeletal fluorosis survey in Kelwa village. Many techniques like the physical treatment, membrane filtration procedure, ion exchange process and distillation. Chemical treatment and contact precipitation was also applied for removal Fluoride in the groundwater.

RESULTS

This unit and work used the physico-chemical techniques to determine the parameters. The following table depicts the samefindings.

4.2 DATA (EXPERIMENTAL)

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S. No.	Sample ID	Water sample using from	Habitation	Parameters						
				Alkalinity mg/L	Chloridemg/L	Nitratemg/L	TDSmg/L	TH Mg/L	Fluoride mg/L	pH mg/L
1	KS-1	Handpump	Aakhriya	400	570	71	1749	1100	0.65	7.22
2	KS-2	Handpump	Dholimagri	320	150	02	679	210	1.4	7.60

3	KS-3	Handpump	**Khtamla**	300	290	58	1073	680	**2.8**	7.40
4	KS-4	Handpump	Bheelo ki basti	230	80	49	523	400	0.35	8.21
5	KS-5	Handpump	Umedpura	230	220	49	685	260	1.3	8.24
6	KS-6	Handpump	Naneza	310	130	12	772	400	0.58	7.90
7	KS-7	Handpump	Kacholiya	380	90	54	579	430	0.48	7.98
8	KS-8	Borewell	Aakhriya	300	380	03	1018	430	0.49	7.83
9	KS-9	Borewell	Dholimagri	280	350	02	1053	270	1.5	7.78
10	KS-10	Borewell	**Khtamla**	240	380	60	1265	720	**2.9**	7.89
11	KS-11	Borewell	Dev talai	350	500	46	1312	700	0.42	7.62
12	KS-12	Borewell	Naneza	280	140	10	773	400	0.66	7.85
13	KS-13	Borewell	Umedpura	350	440	04	1494	860	0.76	7.28
14	KS-14	Borewell	**Kacholiya**	390	430	56	1362	580	**2.95**	7.47
15	KS-15	Openwell	**Aakhriya**	270	110	60	583	360	**2.85**	7.57
16	KS-16	Openwell	Dholimagri	320	350	02	1051	330	1.5	7.74
17	KS-17	Openwell	Khtamla	150	340	51	875	400	0.88	8.85
18	KS-18	Openwell	Umedpura	260	220	10	690	340	1.2	8.17
19	KS-19	Openwell	Naneza	340	180	08	696	340	0.46	7.99
20	KS-20	Openwell	Kacholiya	360	90	26	572	390	0.49	7.98

Table 1: Parameters and Techniques used for Determination

pH in the data ranged from 7.22 to 8.85. The highest pH was measured at the village of Khatamla, at 8.5 and the lowest pH was found in the village of Aakhiya, at 7.22. Other regions revealed pH levels in water samples taken from hand pumps, tube wells and open wells that were within the Health Ministry's acceptable ranges.

The lowest value of Total Alkalinity was observed in the settlement of Kelwa and its habitations The minimal levels of total alkalinity in water samples taken from hand pumps, open wells and tube wells were the lowest that are within the Health Ministry's acceptable limits.

A hardness level of 210 to 1100 mg/L was observed. Results showed that water samples from hand pumps and tube wells had higher levels of hardness than water samples from open wells.

20 samples of water were considered and four out of them samples showed higher fluoride level in water samples which are above than maximum permissible limit prescribe by Ministry of Health. The highest fluoride found in **Khtamla,Kacholiya** and**Aakhriya**of the Kelwa Village.

Chloride levels ranged from 80 to 570 mg/L. The findings revealed that the WHO's minimum Chloride limit is present in open wells, tube wells and hand pumps. The minimum value was measured in water samples from 07 out of 20 and maximum value in water samples from 00 out of 20.

The author’s findings revealed that water samples taken from different habitations in Kelwa village's open wells, tube wells and hand pumps had the lowest levels of TDS. The average TDS level in water samples from these sources was 931 mg/L.

The results showed that water samples from tube wells and open wells had lower levels of calcium than water samples from hand pumps. Results showed that in various habitations, open wells, manual pumps and tube wells had the lowest levels of magnesium. Magnesium levels in water samples from these sources were on average 57 mg/L. Three out of twenty water tests revealed the least amount of magnesium, which was below the Ministry of Health's permitted standard.

Nitrate levels were on average 31 mg/L. Water samples from Aakhriya had the highest value measured in them, and samples from DholiMagri had the lowest value. In villages with high fluoride levels and high percentage fluorosis incidence, people were afflicted more severely. It was discovered that more than 80% of people have dental fluorosis

The original Nalgonda method resulted in a 30% reduction in fluoride. Defluoridation was accomplished by 76% by employing combination H and the modified Nalgonda approach. Compared to the traditional Nalgonda method, the salt precipitation after treatment with combination H was significantly higher.

DISCUSSION

In the current investigation, the pH demonstrated a gradual association with the fluoride content. The pH of groundwater is a crucial indicator of its quality and gives information for numerous computations involving geochemical equilibrium or solubility. High fluoride levels are also described when the pH of a ground water sample is high.A total of 6 water samples were determined to be naturally alkaline. Numerous other papers claimed that rocks containing fluoride tend to dissolve more fluoride when the pH is high.

The author noted that high bicarbonate ions levels (350–450 mg/L) cause fluoride to dissolve from its parent resources. Additionally, under conditions of calcium carbonate precipitation, alkaline water aids in the greater breakdown of fluoride-containing minerals, demonstrating a rise in fluoride level with increasing alkalinity. The high bicarbonate ion concentration and high fluoride content in groundwater with constant hydrogen ion concentration.

The majority of the TDS is constituted primarily of organic matter salt, carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese. Most commonly, gastrointestinal issues might result from drinking water with a higher TDS. Kidney stones and other metabolic diseases might result from prolonged usage of water with a high TDS level.

Magnesium levels in water tests from many villages were higher than allowed limits. Since magnesium is a laxative and can be dangerous if eaten for an extended period of time, high magnesium levels in water can result in a variety of gastrointestinal problems.

Diseases of the digestive system may be brought on by higher sulphate levels. Sulfate is mostly produced by rainfall, with fertilizers and surface minerals found in granites coming in second and third. Sulfate can change into sulphate and sulphate oxides depending on the redox potential of water

The total hardness of any water body is mostly caused by the presence of calcium and magnesium. Fluoride is a highly negatively charged species that prefers to mix with positively charged molecules like calcium and magnesium. When fluoride was combined with these ions, the availability of calcium and magnesium ions in water was decreased. The amount of overall hardness is eventually disturbed by a lower level of calcium and magnesium ions.

Water bodies with higher fluoride pollution were shown to have fewer free calcium ions because high positive charge calcium ions had a larger attraction to merge with fluoride ions. They also stated that the relationship between calcium concentration and fluoride concentration is inverse.

The majority of the time, fluoride occurs naturally and continuously dissolves in ground water as an additive. Some geo-physiochemical mechanisms also contribute to the natural fluoride contamination of the groundwater system. The leaching of fluoride usually begins when Fluoride parent rock and excess fluoride minerals in the earth's crust interact with each other through ground water. As a result of this chemical reaction, high fluoride concentrations in ground water bodies result. The type and structure of the existing rocks have an impact on the nature of the water. The high fluoride level of groundwater is also due to overuse of groundwater, such as excessive irrigation.

DEFLUORIDATION OF WATER BY ACTIVATED CARBON PREPARED FROM LEMON PEELS

Results made it abundantly evident how inexpensive lemon peel activated carbon was successful in removing fluoride from water. The results were very positive and shown that fluoride adsorption increased in the pH range of 4 and decreased at higher pH. Maximum fluoride elimination was attained after 120 minutes of contact. Similar maximal fluoride removal for 10 mg/L of adsorbent.

DEFLUORIDATION OF WATER BY MODIFIED NALGONDA TECHNIQUE

We discovered that, without affecting the water's quality, increases in lime and alum concentration resulted in noticeable changes in fluoride removal. According to study findings, the current Nalgonda technique significantly reduced fluoride when the proportion of alum and lime was doubled

DENTAL AND SKELETAL FLUOROSIS SURVEY

The study's observation in the endemic region (Kelwa) revealed that different age groups experienced skeletal fluorosis with varying degrees of severity and intensity. Skeletal fluorosis was more common in older adults who had been exposed to fluoride for a long time through their food and water.

CONCLUSION

The author concluded that findings of this study are consistent with those of other studies that show that when fluoride levels in drinking water rise, so does the prevalence of dental fluorosis. Individuals in the current study displayed dental fluorosis symptoms in 40% to 64.99% of cases. Dental fluorosis was more common in some water sources than others. Dental fluorosis is influenced by a number of variables, including soluble salts, dietary consumption and behaviors, in addition to water concentration and exposure time. The author observed that, people in 10 homes in the village of Kelwa showed varying degrees of dental fluorosis. The most common form of dental fluorosis in all people was that in the form of spots.

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