

Sub-Surface water chemistry in relation to Fluoride levels in Challakere taluk of Chitradurga District, Karnataka

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Abstract

The present study deals with the fluoride levels in relation to few physico-chemical parameters in the sub-surface water samples of Challakere taluk of Chitradurga district, Karnataka during November 2019. Fluoride values varied from a minimum of 0.4 mg/l to a maximum of 1.65 mg/l. In this study, pH values varied from 6.8-8.4. The recommended turbidity values ranged between 3 to 38 NTU. The values of electrical conductivity ranged between a minimum of 850 to a maximum of 1775 $\mu\text{mhos/cm}$. Total hardness values varied from a minimum of 340 to a maximum of 897 mg/l. Calcium values ranged from a minimum of 42.5 mg/l to a maximum of 115.4 mg/l. Magnesium varied from 17 mg/l to 93.5 mg/l. The nitrate values ranged between a minimum of 0.3 mg/l to a maximum of 1.94 mg/l. The phosphate content ranged from 0.4 mg/l to 0.84 mg/l. Chloride values ranged from a minimum of 66.5 mg/l to a maximum of 586.2 mg/l. Dental fluorosis was found in the studied area.

Water is life as it is the foundation for fitness, hygiene, development and prosperity. Therefore, efficient water control is vital to civil society for betterment of pleasant of life. It is a fundamental human want and basis for the lifestyles of surroundings. "Without water there is no life. It is crucial for many elements of monetary and social development and for habitat, agriculture, strength production, production supply and it's miles a vital aspect of environment. It is of the most crucial object wished by using people / flora and other residing beings for their survival. The bacterial

movements convert vegetable rely into efficient soil. New plants which develop on this soil might be grown by means of retaining vitamins through their roots in the form of water. Thus, an ecological chain is being maintained. Water maintains ecological balance among dwelling organism and the surroundings in which they stay⁴⁸.

Water exhibits a number of physical and chemical properties that help the molecule to act as quality suited medium for the existence activities. Most of the biochemical

reactions that occur inside the metabolism and boom of the living cells entails water. Water has been a regularly occurring solvent, since many of the additives dissolve in water⁴⁴.

Groundwater is an crucial supply of water deliver throughout the arena. It is used m irrigation, industries and domestic utilization keeps to boom in which perennial, water resources are absent. The satisfactory of groundwater used for these purposes is greater vital because the case of amount. The geology of particular place has a extra have an impact on at the occurrence and high-quality of water and its motion. Fluorides get leached into the groundwater from the igneous or sedimentary rocks in the earth crust. Another source of fluoride is the effluent from chemical processing, electroplating and so on. Small amount of fluoride (<1.00 mg/1) is considered to prevent tooth decay²⁴. But whilst consuming water carries fluorides more than 1.5 mg/1, a chemical situation referred to as fluorosis outcomes on intake of such water for a prolonged duration. Children are by and large affected with the aid of this ailment. Cases of moderate to excessive fluorosis had been suggested from many elements of India.

Study area :

Challakere is an area of Chitradurga district in Karnataka. It has a geographical area of 194.380 sq. kms. It comprises 39 Grama Panchayats and 308 villages with a total population of 2,54,093 as per 2001 census. As a whole, the terrain is not uniform thought parallel chains of hills, mostly bare and stony separated by narrow kanivas and the average elevation of about 500.MSL⁹. The climate of Challakere taluk comes under drought prone

area. The precipitation and distribution of rainfall in study area is highly erratic. The annual average rainfall is 650mm received over 40 rainy days. It varies from as low as 620 mm in the east and as high as 750 mm in west. About 2/3rd of the geological area of Challakere taluk receives less than 700 mm of annual rainfall. The study area had been receiving rainfall mainly from southwest monsoon and slightly from northeast monsoon. Most of the rainfall over this area is contributed by a very poor intensity of rainfall events. The monthly mean temperature ranges from 8.0 to 48°C.



Figure 1. Study area map

In the present investigation, a total of 10 water samples from different localities were collected in clean two litre polythene cans, the cans were then sealed air-tight and are labeled on the cans. Analysis was carried out for fluoride and other physico-chemical parameters according to the procedures outlined by standard methods¹. Therefore, as soon as the collection of water, pH was measured immediately. Later, the other parameters were analysed in the laboratory. Hence, the water was carried to the laboratory in suitable inert bottles. The samples were

analyzed using various analytical method of APHA¹, BIS³ and NEERI³¹.

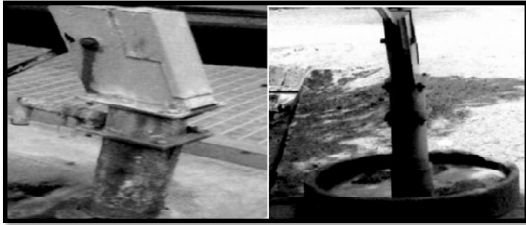


Figure 2. Bore wells used for water sample collection

The presence of fluoride in drinking water is critical because of its physiological consequences on human fitness. 1.5 ppm fluoride is prescribed as acceptable restriction in consuming water⁵⁰. The natural prevalence of fluoride is usually restrained as maximum waters have a concentration less than 0.5 ppm³⁶ and high fluoride awareness in floor water can be due to the presence of fluoride-bearing rocks and the degree of weathering⁴⁵. Fluoride is often referred to as edged sword. Fluoride concentrations more than 1.5 ppm ends in dental and skeletal fluorosis³³. When the concentration of fluoride in water exceeds 10 ppm, crippling fluorosis can make certain⁵⁰. In the present investigation, fluoride values varied from a minimal of 0.4 mg/l to a most of 1.65 mg/l. The BIS³ perfect restrict for fluoride is 1.5 mg/l.

pH is a degree of hydrogen ion in solution. It is used to explicit the intensity of acidic or alkaline circumstance of a solution. It is one of the crucial signs of water excellent and is of exquisite significance to residing structures due to the fact both cellular structure and function may be affected by means of

even small modifications in pH, excessive values of pH lead to scale formation in water heaters and lessen the germicidal capacity of chlorine²⁸.

The knowledge of pH is critical inside the choice of coagulants for water purification. The acidity (low pH) will not have an effect on the health however barely acidic ground water is corrosive and can dissolve metals, specifically copper from pipes and pumps. The corrosion can shorten the economic life of plumbing, warm water cylinders and in some instances, the dissolved metals in the water may additionally motive contamination³⁸.

In the prevailing research, pH values from 6.8-8.4. The approved pH for ingesting purposes is among 6.5-8.5³. In the prevailing take a look at all of the water samples analyzed are all properly with in the permissible limits. The research indicate that with the aid of and huge, the groundwater resources had been found to be alkaline^{10,12,25,30}.

Turbidity is accountable for the light to be scattered or found rather than instantly transmission via the sample. It is the size, form and refractive index of the suspended particulate depend rather than the general attention of the depend gift in the water samples. The size of the suspended count varies and it ranges from colloidal to course dispersion, depending upon the degree of turbulence and also from natural inorganic materials to the ones that are fantastically organic in nature. It decreases the mild penetration, limits the manufacturing of phytoplankton, which in consequence decreases the photosynthetic pastime and depletion of oxygen content. Under flood

conditions and soil erosion, outstanding quantities of topsoil are washed into receiving streams. Groundwater is much less turbid since, sand is a great filtering media. In the present examine, the turbidity values ranged among 3 to 38 NTU. The BIS³ applicable limit for turbidity is 25 NTU. In the present observation, cross their permissible restrict on the subject of the BIS requirements.

Electrical conductivity is a measure of water's ability to deliver electric current. Pure water is a bad conductor of strength and such materials are called electrolytes. Its fee relies upon on concentration and degree of dissociation of the ions in addition to migration velocity of the electric discipline. In the existing observe, the values of electrical conductivity ranged among a minimal of 850 to a most of 1775 $\mu\text{mhos/cm}$. Owing to the fact that during put up-monsoon season the dissolution of salts, minerals and different soil elements will increase due to increase within the groundwater table⁴³. Most of the inorganic salts such as sodium, chloride, potassium, sulphate and nitrate are accountable for increasing the EC values of groundwater structures.

The variability of EC may want to be defined to the natural attention of ionised substances present in water. Higher the awareness of acid, base and salts in water, better could be the EC¹⁷. However the better values of electrical conductivity ($>2000 \mu\text{mhos/cm}$), may be due to lengthy house time and lithology. Ballulcraza and Ravi² had proved the version of the conductivity of the water because of the residential instances and the geographical features of the web sites. Similar

observation become made by means of Paliwal³², Hedge *et al.*¹³ found the EC between 839 $\mu\text{mhos/cm}$ to 15,310 $\mu\text{mhos/cm}$ and the effects of analysis showed that, 50% samples have the conductivity values above one thousand $\mu\text{mhos/cm}$ indicating excessive mineralization in the vicinity. Tiwari⁴⁹ confirmed that the electrical conductivity ranged from 375 to 925 $\mu\text{mhos/cm}$.

Total hardness of water is the sum of concentration of alkaline earth steel cations present in it. Calcium and magnesium are the precept cations providing hardness. It is defined as the attention of multivalent cations. At saturated conditions, the cations react with anions in water to form strong precipitate. Hardness in natural water comes particularly from the leaching of igneous rock and carbonate rocks (dolomite, calcite and limestone). Water contain the soluble salts is known as difficult water³⁴. Temporary hardness (carbonate hardness) is due to carbonate and bicarbonates of calcium and magnesium. Permanent hardness is because of sulphate, chlorides of calcium and magnesium.

In the existing research, total hardness values varied from at the very least 340 to a most of 897 mg/l. The BIS³ perfect restriction for general hardness is 600 mg/l. The total hardness (ppm) has been categorized in phrases of equivalents of calcium carbonate hardness^{1,19}. The outcomes obtained suggest that more than 60 % of water samples studied belongs to the very hard class.

Calcium is critical micro-nutrient in an aquatic environment. Water receives the calcium leached from the rocks and deposits

like limestone, dolomites, calcite, gypsum, amphiboles, feldspar and business waste also crucial sources of calcium²⁷. In the Present take a look at, the calcium values ranged from a minimum of 42.5 mg/l to a most of 115.4 mg/l. The BIS³ acceptable limit for calcium is 200 mg/l consuming water. However, within the present have a look at, the calcium values are within the prescribed restrict of BIS ingesting water standards. Excess awareness of calcium has frequently been stated to purpose kidney or bladder stone^{15,18,46}.

Magnesium is an critical element of basic igneous rocks, volcanic rocks, metamorphic rocks, and sedimentary rocks and serpentine are some of the foremost magnesium bearing minerals. In ground water, the calcium content generally exceeds the magnesium content in accordance with their relative abundance in rocks but contrary to the relative solubility in their salts. As inside the case of calcium carbonate, magnesium carbonate is more soluble in water containing sodium salts¹⁶.

Magnesium has been an essential constituent of chlorophyll with out which no atmosphere ought to work. Its high content lowers the software of water for home use²². High concentration of magnesium can also motive laxative outcomes¹⁸. In the present investigation, magnesium values numerous from at the very least 17 mg/l to a maximum of 93.5mg/l. Garg *et al.*⁷, Subba Rao *et al.*,⁴⁶ and Sathisha & Puttaiah³⁹ have also made similar findings.

Nitrate is found within the soil while nitrogen and oxygen combine. Autotrophic

oxidation of ammonia is known to occur in steps, the primary to nitrate and then from nitrate to nitrite. Nitrate is critical for boom of many plant species, which includes most of those we consume. Yet it becomes a hassle if it receives into water in extra quantities. Decomposition of organic matters in soils, leaching of soluble chemical fertilizers, human and animal excreta, untreated effluents of nitrogenous industries and sewage disposal are potential source of nitrate concentration in ground water²¹.

Nitrate can reason health issues particularly those six months of age and younger. Nitrate interferes with their blood's ability to delivery oxygen. This causes an oxygen deficiency, which leads to a dangerous situation known as "Methemoglobinemia or blue baby syndrome" in adults¹¹. The maximum commonplace symptom of nitrate poisoning is bluish skin coloring, specifically across the eyes and mouth. In the present look at, the nitrate values ranged between a minimal of 0.3 mg/l to a maximum of 1.94 mg/l. From the information, it is clear that, the nitrate awareness multiplied at some point of monsoon season compared to put up-monsoon and pre-monsoon seasons. This may additionally be due to seepage of home wastes, agricultural runoff and septic effluents in the course of rainy season and attain the floor water table. In the existing research, the nitrate values are within the prescribed limit of BIS drinking water standards. A comparable observation has been made by Shivashankaran⁴³.

Phosphorous is reliable and does now not purpose any direct health effects to human beings and other organisms. Small

amount of phosphorous in drinking water is essential for dwelling beings. However, the presence of phosphorous in large quantities in fresh water indicates pollutants through sewage and industrial waste^{20,31}. Like nitrogen, phosphorous is also an critical element to all forms of terrestrial life as nutrients element and maintaining number one productivity in the surroundings. Generally, Phosphate ranges in natural water are low and arise among 0.001 mg/l and 0.024 mg/l with a median concentration of 0.012 mg/l in the tropical rivers²⁶. Phosphorous is one of the crucial nutrient restricting the growth of the autotrophs and biological productiveness of the device. High phosphorous content material causes expanded algal growth often as blooms. In the present observe the phosphate values ranged from a minimum of 0.4 mg/l to maximum of 0.84 mg/l. The contribution of the phosphate to the groundwater can also be due to presence of the rocks enriched with phosphorus and different mineral deposits. During natural procedure of weathering the rocks step by step releases the phosphorus as phosphate ions which soluble in water and the mineralized phosphate compounds breakdown the phosphate attention.

Chlorides occur in water in various concentrations. The chloride content increases because the mineral contents increases. It is normally located in soils and rocks. The number one source of chloride is sedimentary rocks and saline water intrusion and the minor resources are igneous rocks. High concentration of chloride makes water unpalatable and not worthy for ingesting and different purposes. Chloride ion is typically present in plant water and its presence may

be attributed to the dissolution of salt discharge from chemical industries, oil wells, sewage discharges, contamination from leachates. The salty flavor produced via chloride ion depends on chemical composition of the water (Kumar, 2002). Chloride in shallow groundwater is a useful indicator of contaminants from human assets compared to history concentration (e.G Urban land use, septic tanks, agricultural fields, strong waste dumping website).

Chlorides in excess, imparts salty taste to water and people are now not accustomed to excessive chloride ai-e subjected to laxative effect³⁵. Chlorides in reasonable concentration are no longer dangerous to humans. Concentration substantially in excess of 100 mg/l may also purpose physiological damage. At awareness above 250 mg/l the water becomes salty flavor. Hence, the chlorides are generally constrained to 250 mg/l in materials meant for public use. In the existing take a look at, chloride values ranged from at the least 66.5 mg/l to a maximum of 586.2 mg/l It is additionally found that chloride ion attention endure a conjugational relationship with mineral content of the respective water samples as chloride content material increases with increasing mineral content²⁸. The BIS³ ideal limit for chloride is a thousand mg/l. In the present investigation, the values of chloride for all of the seasons are with inside the permissible variety as prescribed via BIS drinking water standards.

Chinoy *et al.*⁵ survey of fluoride in 90 endemic villages of Mehsaua and Banaskantha districts of north Gujarat, India.

Gangal⁶ studied on fluoride threat of groundwater in the Jaipur district, Rajasthan, India. Sharma *et al.*⁴² geological have a look at of fluoride in groundwater of Sanganer tehsil of Jaipur district, Rajasthan, India. Nagaraj Naik *et al.*²⁹ notably worked on fluoride toxicity⁷ in groundwater resources of Arsikere taluk in Karnataka and suggested that the fluoride awareness values vary from 2.0 to 3.0 mg/l. Garg⁸ studied on fluoride in drinking water and fluorosis. Bisnoi and Arora⁴ studied on the potable groundwater high-quality Focus on fluoride in some villages of Haryana, India. Indermitte *et al.*¹⁴ studied fluoride levels in the faucet water of Estonia. Shailaja *et al.*⁴⁰ studied on the fluorides awareness in groundwater and its impact on health. Recently, Sajidu *et al.*³⁷ studied on the groundwater fluoride stages in villages of southern Malawi and removal studies the usage of bauxite.

Manjunatha *et al.*²³ mainly addresses the physico-chemical concentration of groundwater in Challakere, Karnataka. Their results of all the findings is extremely important to the future economy and growth of rural India. If the resource is to remain available as high quality water for future generation it is important to protect from possible contamination. Thirumala and Kiran⁴⁷ have analysed the seasonal variations in ground water in Davangere area of Karnataka. The water samples were compared with BIS standards. The ground water was moderately polluted and impact to health hazards. In their study, the water was quite good for irrigation due to elevated salinity.



Figure 3. Dental fluorosis in young peoples

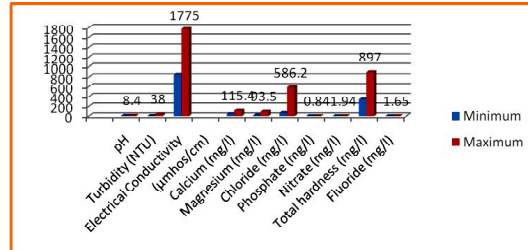


Figure 4. Minimum and maximum values of physico-chemical parameters in ground water samples of Challakere taluk

Table-1. Minimum and Maximum values of physico-chemical parameters compared with WHO and BIS standards

Parameters	Min.	Max.	WHO Permissible limit	BIS Permissible limit
pH	6.8	8.4	6.5-8.5	6.5-8.5
Turbidity (NTU)	3	38	5	0
Electrical Conductivity (µmhos/cm)	850	1775	1500	0
Calcium (mg/l)	42.5	115.4	75	200
Magnesium (mg/l)	17	93.5	150	100
Chloride (mg/l)	66.5	586.2	200	1000
Phosphate (mg/l)	0.4	0.84	0.1	0
Nitrate (mg/l)	0.3	1.94	45	100
Total hardness (mg/l)	340	897	200	600
Fluoride (mg/l)	0.4	1.65	0	0.3-1.2

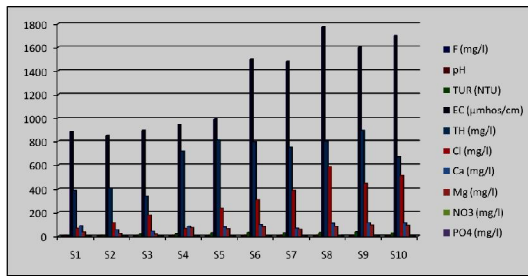


Figure 5. Fluoride and physico-chemical parameters in different sites of groundwater samples in Challkere taluk



Figure 6. Skeletal fluorosis was rarely common in young children's

Presently carried research study give greater specific answer on influence of geomorphological circumstance than anthropogenic activities in the tested groundwater samples of the have a look at region. Local geological settings may helps the growing concentration of physico-chemical traits in groundwater. The factors like gradual stream, longer duration of touch among aquifer and water, dissolving of minerals at the time of weathering, residential time, drainage pattern and floor water hyperlink. Porosity of the soil and rock also alters the characteristics of the groundwater. The high level contents of the parameters determined can be minimized if the groundwater is recharged with the available water inside the rainy season. This not best dilutes the components of the

groundwater however also raises the groundwater level that depletes because of huge-scale exploitation.

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