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# Physico-chemical analysis of fluorides in ground water of Agra district (U.P.) India

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**Abstract**
The physic-chemical analysis was carried out from the ground water of Agra district (U.P.). About eight water samples out of them. 4 from hand pumps and 4 from the tube wells were collected from different villages around the Agra district (U.P.). The duration of water sample study was from January 2019 to June 2019. The physico-chemical parameters were analyzed as pH, temperature, turbidity, DO, BOD, COD, chlorides, fluorides, sulphates, nitrates and total hardness. It was observed that all other parameters are within range when compared with WHO standards, only fluorides were present in excess amount in tube well water of Bichpuri village. It has also been observed that tube well water samples have higher fluoride ions concentration as campared to hand pump water samples.

**Keywords:** Agra district, fluoride, ground water, physico-chemical parameters

## Introduction

The water is essential for our life and also an important component of the living organisms system. It is being used by man for various purpose like drinking, cooking, bathing, washing, house hold activities, irrigation, electricity generation, industrial production and disposal of sewage and industrial waste. Ground water is the major source of water supply for domestic purposes in the urban as well as in rural areas of our country. Various reasons for this include the non-availability of potable surface water and a general belief that ground water is pure and safer than surface water due to the covering of earth. The ground water contributes only 0.6% of the total water resources on earth. The ground water is the preferred and major source of drinking water in rural as well as in urban areas particularly in the developing countries like India. About 90% of the total drinking water requirement and 50% of the agricultural requirement is fulfilled by the ground water in India but in the era of economical growth. The ground water is getting polluted due to urbanization and industrialization. The ground water is generally colourless but contains salts such as chlorides, sulphates, nitrates etc. of different matals. Water is one of the most important components for sustaining life but it is also the sourse of several sickness in human. The presence of hazardous contaminants like fluoride, nitrate, sulphate, toxic heavy metals etc. have been reported in many parts of India [1, 2]

Fluoride is the major inorganic pollutant of natural origin found in ground water. In minute quantity of fluoride is an essential element needed for normal development and growth of animals and extremely useful for human beings. Fluoride is abundant in the environment and main source to drinking water. Fluoride gets accumulated in hard tissues of the body and plays an important role in mineralization of bones and formation of dental enamel [3]. It is known that growth of many plant species [4] is also stimulated but excessive intake of fluoride is toxic to plants and causes clinical disturbances in animals and human beings are endemic for fluorosis [5].

Fluoride is commonly found above the normal values in ground water of many states like U.P., M.P. Punjab, haryana etc. Indian standards [6] for drinking water prescribes the desirable limit 1.0 mg/L. According to WHO [7] permissible limit for fluorides in drinking water is 1.5 mg/L whereas United States Public Health Science has a range of allowable concentration of fluoride in drinking water for a region depending on its climate conditions. The amount of water consumed and consequently ingested being influenced primarily by the air temperature [8, 9]. According to USPHS, the maximum allowable concentration of fluorides in drinking water in Indian conditions comes to 1.4mg/L while as per Indian standards it is 1.5mg/L [6]. Fluoride ions have dual significance in water supplies. High concentration of fluoride causes dental fluorosis at a same time a concentration less than 0.8 mg/L results in dental carries. The major source of fluoride in ground water are fluoride bearing rocks such as fluoropar, cryolites, fluoropatite and hyroxylapatite [10].The fluorosis in India was first identified in Tamilnadu in 1937 [11] and disease was also identified in different states. At present more than 30 million people in 13 states have been affected by this disease [12]. The disease is making its appearance in newer non-fluorotic areas due to geo-environmental conditions. According to WHO one hospital bed out of four in the world is occupied by a patient who is sick by polluted water.

Fluoride ion concentration in drinking water is playing a vital role in human health systematic fluorosis and is an endemic problem in several developing countries like India,

Pakistan, Africa etc. Exposure to high level of fluoride can cause endemic fluorosis, arthritis, cancer stiff joints, weight loss, brittle bones, anaemia and weakness and characterize endemic fluorosis. Discoloured, blackend, white teeth characterize dental fluorosis [13]. Fluoride can damage a foetus and adversely affect the I.Q. of children. Right level of fluoride in drinking water can provide beneficial effects like developing tooth buds, makes the structure of the enamel and dentin harder and more resistant to acid attack produced by bacteria. Fluoride produced from saliva enters enamel of newly erupted teeth and enhances enamel classification [14].

## Materials and Methods

Eight water samples out of them four from hand pumps ($S_1$-$S_4$) and four from tube wells ($S_1$-$S_4$) were collected in polythene bottles. The physico-chemical analysis of the collected water samples were analysed for pH, temperature, turbidity, DO, BOD, COD, chlorides, fluorides, sulphates, nitrates and total hardness in the months of January 2019 to June 2019. Temperature was measured by Celsius thermometer, pH and turbidity were measured by digital pH meter (type- 335) digital Nephlo turbidity meter (type-132) respectively. DO, BOD and COD were determined in laboratory. Chloride and nitrates were estimated by volumetric titration with $AgNO_3$. Total hardness was determined by volumetric titration (EDTA method). Sulphate was estimated by UV-VS spectro-photometer (type -118). Fluoride concentration was determined by spectrophotometrically using Alizarin red- S and Spand reagents. The Alizarin red-S method was found useful in higher fluoride range while Spands reagents was employed in low fluoride range [15].The results for ground water are presented in Table-1 and Table-2.

## Results and Discussion

Results are obtained during the physico – chemical of collected water samples analysis have been given in Table - 1 and Table- 2. The pH of sample collected water samples from various villages were in the range of 7.2 to 8.1 from hand pump water and 7.3 to 8.0 from tube well water, Temperature ranged of 17.15 to 28.47$^0$C (HP) and 17.17 to 28.21 $^0$C (TW), turbidity ranged of 0.6 to 5.0 NTU (HP) and 0.7 to 5.0 NTU (TW), DO ranged 5.47 to 6.57 mg/L (HP) and 5.44 to 6.48 mg/L (TW), BOD ranged 8.6 to 11.5 mg/L (HP) and 8.60 to 12.10 mg/L (TW) COD ranged 63.0 to 85.0 mg/L (HP) and 61.0 to 85.0 mg/L (TW), chloride ranged 465 to 1250 mg/L (HP) and 415 to 1200 mg/L (TW), fluorides ranged of 0.50 to 1.60 mg/L (HP) and 0.60 to 1.80 mg/L (TW), sulphate ranged of 165 to 255 mg/L (HP) and 160 to 215 mg/L (TW), nitrate ranged of 22 to 42 mg/L (HP) and 19 to 42 mg/L (TW), total hardness 280 to 750 mg/L (HP) and 55 to 285 mg/l (TW).

Peoples are advised not to use water for drinking and cooking purposes. Instead the villagers are advised to use the other bore well water which may be supplied through taps to the villagers which contains comparatively less fluoride content. Another alternative is to defluoridate the drinking water supplied to the villagers by standard techniques, such as Nalgonda technique. Bore well water with low concentration (<0.5 ppm) of fluoride can be mixed with water having higher concentration of fluorides (>1.5 ppm) and sulphates. The short term solution to minimize the fluoride level in drinking water could be the use of domestic defluoridation filters. Along with the fluoride concentration consumed through water, hot climate conditions, unhygienic surroundings, illiteracy, lack of awareness about the water quantity which they using are some of important reasons for this disease. It is recommended that alternative arrangements for supply of potable water from other safe sources to the affected village or supply of treated potable water to the village may be taken up on top priority. The villagers have to be educated through awareness camps on health, sanitation, nutrition and water quality.

## Conclusion

It is clear shown that the physico-chemical analysis of water samples were analyzes in research laboratory. It is given all other parameters are within range when compared with WHO standards, only is present in excess amount in tube well water [16] of Bichpuri village. It has been observed that tube well water samples have higher fluoride concentration as compared to hand pump water. Regular intake of fluoride rich water seems to be main course for high incidence of fluorosis. Chemical weathering under arid to semiarid conditions with relatively high alkalinity seems to have favored high concentration of fluorides in ground water.

**Table 1:** Physico-chemical analysis of water samples collected from hand pumps of various villages of Agra district (Jan, 2019-Jun, 2019).

| Parameters | Site | Jan | Feb | Mar | Apr | May | Jun |
|---|---|---|---|---|---|---|---|
| pH | $S_1$ | 7.5 | 7.6 | 7.6 | 7.2 | 7.5 | 7.7 |
| | $S_2$ | 7.5 | 7.4 | 7.7 | 7.8 | 7.5 | 7.4 |
| | $S_3$ | 7.6 | 7.4 | 7.5 | 7.9 | 7.5 | 7.9 |
| | $S_4$ | 7.6 | 7.5 | 7.3 | 8.0 | 7.2 | 8.1 |
| Temperature ($^0$c) | $S_1$ | 17.82 | 22.16 | 22.95 | 26.15 | 26.86 | 28.10 |
| | $S_2$ | 17.78 | 21.97 | 23.14 | 26.56 | 26.98 | 27.96 |
| | $S_3$ | 18.25 | 19.48 | 21.23 | 25.14 | 27.84 | 28.47 |
| | $S_4$ | 17.16 | 20.44 | 21.22 | 24.93 | 26.88 | 27.47 |
| Turbidity (NTU) | $S_1$ | 1.8 | 1.9 | 1.6 | 2.0 | 1.9 | 1.9 |
| | $S_2$ | 1.4 | 1.3 | 1.3 | 1.2 | 1.5 | 1.5 |
| | $S_3$ | 0.7 | 0.8 | 0.8 | 0.8 | 0.7 | 0.6 |
| | $S_4$ | 5.0 | 4.9 | 4.9 | 4.9 | 4.9 | 4.8 |
| DO(mg/L) | $S_1$ | 6.37 | 6.15 | 6.57 | 5.92 | 6.32 | 6.40 |
| | $S_2$ | 6.50 | 6.19 | 6.07 | 5.77 | 5.78 | 5.61 |
| | $S_3$ | 6.33 | 5.47 | 5.53 | 6.13 | 6.15 | 6.11 |
| | $S_4$ | 6.27 | 6.11 | 6.05 | 5.87 | 6.38 | 5.55 |
| BOD(mg/L) | $S_1$ | 6.27 | 6.11 | 10.8 | 11.5 | 11.3 | 10.8 |
| | $S_2$ | 11.2 | 11.0 | 10.8 | 9.51 | 9.3 | 10.5 |
| | $S_3$ | 8.6 | 10.6 | 10.8 | 1.51 | 9.31 | 10.7 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | $S_4$ | 9.1 | 9.8 | 10.8 | 1.5 | 1.3 | 10.8 |
| COD (mg/L) | $S_1$ | 84 | 76 | 74 | 78 | 74 | 80 |
| | $S_2$ | 76 | 76 | 84 | 78 | 85 | 79 |
| | $S_3$ | 63 | 66 | 71 | 68 | 70 | 69 |
| | $S_4$ | 59 | 66 | 72 | 68 | 72 | 69 |
| Chlorides (mg/L) | $S_1$ | 1220 | 1200 | 1240 | 1250 | 1215 | 1195 |
| | $S_2$ | 465 | 465 | 500 | 490 | 485 | 480 |
| | $S_3$ | 490 | 970 | 975 | 975 | 970 | 980 |
| | $S_4$ | 1210 | 1170 | 1170 | 1175 | 1160 | 1200 |
| Fluorides (mg/L) | $S_1$ | 1.10 | 1.10 | 1.00 | 0.95 | 0.90 | 1.00 |
| | $S_2$ | 0.80 | 0.90 | 0.90 | 0.80 | 1.00 | 1.00 |
| | $S_3$ | 0.90 | 0.90 | 0.70 | 0.80 | 0.70 | 0.70 |
| | $S_4$ | 1.60 | 1.50 | 1.60 | 1.70 | 1.50 | 1.60 |
| Sulphates (mg/L) | $S_1$ | 235 | 238 | 255 | 250 | 251 | 245 |
| | $S_2$ | 190 | 170 | 170 | 165 | 175 | 185 |
| | $S_3$ | 185 | 195 | 195 | 175 | 170 | 170 |
| | $S_4$ | 220 | 210 | 170 | 170 | 180 | 195 |
| Nitrates (mg/L) | $S_1$ | 23 | 22 | 25 | 27 | 26 | 26 |
| | $S_2$ | 31 | 31 | 35 | 34 | 31 | 33 |
| | $S_3$ | 42 | 41 | 41 | 38 | 38 | 38 |
| | $S_4$ | 29 | 29 | 26 | 30 | 27 | 27 |
| Total hardness (mg/L) | $S_1$ | 741 | 750 | 740 | 740 | 730 | 750 |
| | $S_2$ | 320 | 300 | 310 | 310 | 345 | 305 |
| | $S_3$ | 300 | 285 | 300 | 300 | 285 | 300 |
| | $S_4$ | 290 | 310 | 300 | 300 | 309 | 322 |

$S_1$: Akola, $S_2$: Keetham, $S_3$: kalindi vihar $S_4$: Bichpuri Village.

**Table 2:** Physico-chemical analysis of water samples collected from tube wells of various villages of Agra district (Jan, 2019- Jun, 2019).

| Parameters | Site | Jan | Feb | Mar | Apr | May | Jun |
|---|---|---|---|---|---|---|---|
| pH | $S_1$ | 7.3 | 7.5 | 7.4 | 7.4 | 7.6 | 8.0 |
| | $S_2$ | 7.8 | 7.45 | 7.6 | 7.6 | 7.6 | 7.9 |
| | $S_3$ | 7.4 | 7.5 | 7.5 | 7.3 | 7.6 | 7.0 |
| | $S_4$ | 7.6 | 7.5 | 7.6 | 8.4 | 7.7 | 7.8 |
| Temperature ($^0$c) | $S_1$ | 17.17 | 21.96 | 22.18 | 25.14 | 26.74 | 27.79 |
| | $S_2$ | 17.12 | 22.10 | 24.23 | 25.78 | 27.00 | 28.14 |
| | $S_3$ | 18.82 | 20.21 | 22.23 | 24.15 | 26.12 | 27.97 |
| | $S_4$ | 17.85 | 21.22 | 22.13 | 25.18 | 27.11 | 28.21 |
| Turbidity (NTU) | $S_1$ | 1.8 | 1.6 | 1.7 | 1.6 | 1.5 | 1.9 |
| | $S_2$ | 1.8 | 1.1 | 1.2 | 1.4 | 1.4 | 1.1 |
| | $S_3$ | 0.8 | 0.7 | 0.7 | 0.7 | 0.8 | 0.8 |
| | $S_4$ | 4.8 | 4.7 | 4.8 | 4.6 | 4.9 | 5.0 |
| DO(mg/L) | $S_1$ | 5.90 | 5.57 | 5.67 | 6.12 | 6.13 | 6.41 |
| | $S_2$ | 6.31 | 6.42 | 5.91 | 5.87 | 5.60 | 5.98 |
| | $S_3$ | 5.98 | 6.17 | 6.11 | 6.27 | 6.23 | 5.87 |
| | $S_4$ | 6.48 | 6.17 | 6.15 | 5.97 | 5.44 | 6.15 |
| BOD(mg/L) | $S_1$ | 10.50 | 12.10 | 10.40 | 10.40 | 11.50 | 11.20 |
| | $S_2$ | 10.30 | 10.20 | 8.60 | 8.90 | 8.80 | 10.50 |
| | $S_3$ | 9.50 | 11.00 | 10.50 | 10.60 | 9.60 | 9.20 |
| | $S_4$ | 11.40 | 11.00 | 9.60 | 9.60 | 9.40 | 9.10 |
| COD (mg/L) | $S_1$ | 76 | 74 | 81 | 84 | 80 | 76 |
| | $S_2$ | 77 | 79 | 81 | 80 | 84 | 85 |
| | $S_3$ | 65 | 61 | 66 | 66 | 69 | 70 |
| | $S_4$ | 68 | 71 | 72 | 66 | 67 | 67 |
| Chlorides (mg/L) | $S_1$ | 1150 | 1190 | 1200 | 1175 | 1175 | 1170 |
| | $S_2$ | 420 | 415 | 420 | 470 | 470 | 460 |
| | $S_3$ | 985 | 985 | 980 | 975 | 990 | 965 |
| | $S_4$ | 1170 | 1180 | 1190 | 1175 | 1175 | 1185 |
| Fluorides (mg/L) | $S_1$ | 1.00 | 0.80 | 0.70 | 0.70 | 0.80 | 0.60 |
| | $S_2$ | 0.90 | 0.70 | 0.70 | 0.80 | 1.00 | 1.00 |
| | $S_3$ | 0.80 | 0.80 | 0.60 | 0.60 | 0.90 | 0.90 |
| | $S_4$ | 1.60 | 1.60 | 1.70 | 1.80 | 1.70 | 1.60 |
| Sulphates (mg/L) | $S_1$ | 210 | 215 | 215 | 210 | 165 | 195 |
| | $S_2$ | 180 | 180 | 165 | 160 | 165 | 165 |
| | $S_3$ | 190 | 190 | 185 | 185 | 190 | 170 |
| | $S_4$ | 200 | 170 | 170 | 190 | 195 | 195 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Nitrates (mg/L) | $S_1$ | 21 | 19 | 19 | 23 | 22 | 22 |
| | $S_2$ | 29 | 30 | 31 | 31 | 33 | 34 |
| | $S_3$ | 37 | 42 | 42 | 41 | 38 | 38 |
| | $S_4$ | 26 | 26 | 29 | 49 | 30 | 28 |
| Total hardness (mg/L) | $S_1$ | 209 | 198 | 188 | 165 | 175 | 188 |
| | $S_2$ | 155 | 178 | 110 | 115 | 185 | 107 |
| | $S_3$ | 831 | 751 | 851 | 55 | 75 | 67 |
| | $S_4$ | 35 | 40 | 75 | 145 | 285 | 145 |

$S_1$: Akola, $S_2$: Keetham, $S_3$: kalindi vihar $S_4$: Bichpuri Village.

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