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ASSESSMENT OF FLUORIDE CONCENTRATION IN GROUND WATER IN WEST ZONE OF COIMBATORE CORPORATION

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Abstract – The main source of freshwater is considered as Groundwater on the earth and it also contains various ions in it in different concentrations. The ions which is present in water are adaptable for human health upto certain limit and when the concentration of these ions are beyond the permissible limits it will cause serious problems and health issues for humans as well as it is not suitable for domestic purpose also. The main among these ions which causes various dental and skeletal disorders is Fluoride. Using of water which has high concentration of Fluoride may prove to be toxic to humans, animals as well as plants. Excessive concentration of fluoride in the ground water source has been reported in more than 25 countries and India is also one among them in which 4 states are more prone to high fluoride concentration. In view of this an attempts were made to findout the fluoride content in groundwater of West Zone of Coimbatore Corporation. The over permissible limit (0.8-1.5mg/l) of fluoride concentration in drinking water results in various health hazards to humans such as dental fluorosis and skeletal fluorosis affecting millions of people. Therefore, a proper systematic assessment and treatment of groundwater is required for the reduction of toxic level of fluoride.

1. INTRODUCTION – The second largest city in Tamil Nadu is Coimbatore and it is popularly called as Manchester of South India. The population of city as per 2011 census is 1,050,721 and covering an extent of 799.47 sq.km., More industries and textile sectors are situated in Coimbatore and it is a hub for many industries.

In Coimbatore Corporation, for domestic purposes there are nearly 97316 dug wells and 28973 tube wells for supplying the ground water. The saltiness in the ground water is due to the presence of various parameters like fluoride, chloride, sulphates, pH, dissolved oxygen, sulphates, iron etc.

2. FLUORIDE – Fluoride concentration is major concern in hydro geo chemistry since it has ipact on health of human. Fluoride is a common element and it does not found in the elemental form naturally because of its high reactivity. It is found naturally in water, soil, plants, rocks, air etc.

Fluoride, when considered for human health it is mainly used to improve the dental health. It is also found in local water supply and also in over-the-counter products such as mouth rinses, toothpaste and other supplements. Fluoride is used for rebuilding the weakened tooth enamel, it minimize the mineral loss from teeth, prevents the tooth decay and also prevents the harmful oral bacteria. The intake of fluoride for human body is generally through the drinking water, since it has fluoride concentration in certain limit. When this concentration is high in drinking water it will cause

dental fluorosis and skeletal fluorosis. The dental fluorosis results in white spots on the teeth. Mostly this problem affects the younger age group like children and pregnant women.. Skeletal fluorosis is also same as that of dental fluorosis but in this case it affects the bones instead of teeth. By consuming fluoridated water for long term it causes variety of health problems like low IQ in children, bone cancer, arthritis, kidney diseases etc. A study in 2016 indicated that exposure to fluoridated water for longer duration is linked to bone cancer for males in higher rates.

Water content many minerals like calcium, magnesium and fluoride etc. Fluorosis is now worldwide problem not only India. the 20 developing countries like Argentina, U.S.A., Algeria, Libya, Turkey, Iran, China, Australia, south Africa, Kenya, Iraq, Sri Lanka , Canada, Thailand, New Zealand, Japan, and India.

3. OBJECTIVES OF THE STUDY

The objective of the study is to identify the concentration of fluoride in drinking water in Coimbatore corporation west zone. In this paper, the main objectives are

- To study about various water parameters and their effects on human beings.
- To identify and analyze the concentration of fluoride, pH, dissolved oxygen, hardness, chloride and sulphate.
- To suggest and recommend possible measures to minimize the concentration of fluorides in drinking water.

4. SCOPE OF THE STUDY

At least 17 States are affected by elevated fluoride levels in drinking-water, namely; Andhra Pradesh, Assam, Bihar, Delhi, Gujarat, Haryana, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. These have been progressively identified since the first report by Short *et al*. (1937), with Assam being the most recently identified State with high fluoride levels associated with endemic fluorosis. So, this study is important to evaluate the concentration of fluorosis and other water parameters and suggesting suitable treatment methods to minimize them in drinking water.

COIMBATORE CORPORATION- WEST ZONE

West zone of Coimbatore Corporation consists of twenty wards that has important areas like Saibaba Colony, Vadavalli, Idayarpalayam, Kavundanpalayam that have its zonal office in R.S. puram. Area covered by this zone is 21.5 sq.km., and population is known to be 2,32,021 (approx.) as per census 2010. The density of population is found to be 9383 persons/ sq.km.

WARD NUMBER AND ITS NAME:

Ward No. 5 - Kavundampalayam
Ward No. 6 - Edayarpalayam
Ward No. 7 - Edayarpalayam
Ward No. 8 - Kavundampalayam
Ward No. 9 - Kavundampalayam

Ward No. 10 - Saibaba Colony
Ward No. 11 - Saibaba Colony
Ward No. 12 - K.K. Pudur
Ward No. 13 - Venkitapuram
Ward No. 14 - KovilMedu
Ward No. 15 - P.N. Pudur
Ward No. 16 - Vadavalli
Ward No. 17 - Kalveerampalayam
Ward No. 18 - LingekavundarPudur
Ward No. 19 - Veerakeralam
Ward No. 20 - Seeranayakanpalayam
Ward No. 21 - Poosaripalayam
Ward No. 22 - Alegesan Road
Ward No. 23 - R.S. Puram(WEST)
Ward No. 24 - Ramalingam Road

5. LITERATURE REVIEW

Determination of Fluoride and Chloride Contents in Drinking Water by Ion Selective Electrode by AmraBratovcic and AmraOdobasic

The fluoride element is found in the environment and constitutes 0.06 – 0.09 % of the earth's crust. Fluoride is not found naturally in the air in large quantities. Average concentration of fluoride in air are in the magnitude of 0.5 mg/m3. Fluoride is found more frequently in different sources of water but with higher concentrations in groundwater due to the presence of fluoride-bearing minerals. Average fluoride concentrations in see water are approximately 1.3 mg/L. Water is vitally important to every aspect of our lives. Water is a risk because of the possible input and transmission of infectious pathogens and parasitic diseases. We use clean water to drink, grow crops for food and operate factories. The most common pollutants in water are chemicals (pesticides, phenols, heavy metals and bacteria).According to the US Environmental Protection Agency, there are 6 groups which cause contamination of drinking water: microorganisms, disinfectants, disinfection byproducts,inorganic chemicals, organic chemicals, radioactive substances. This chapter concerns the importance of continuously monitoring of fluoride and chloride in drinking water by using a fluoride (F-ISE) and chloride (Cl-ISE) ion-selective electrodes.

Determination of Fluoride Status in Groundwater of Kommala Area of District Warangal (Andhra Pradesh, India): A Case Study by VeeratiRadhika and G. V. Praveen

The continuous uses of water carrying high amount of fluoride may prove toxic to human, animal and plants. Excessive fluoride concentrations have been reported in ground water of more than 20 developed and developing countries including India where 4 states are facing fluoride problem. In view of this an attempts were made to find out the fluoride content in groundwater of Kommala of Warangal (Andhra Pradesh). Fluoride concentration over permissible limit (0.8-1.5mg/l) in drinking water lead to human health hazards such as dental fluorosis and skeletal fluorosis

affecting millions of people. Preliminary investigation indicates that several health disorders have been indentified in Kommala area of Warangal district of Andhra Pradesh due to excess intake of fluoride through drinking water. Most of people in this area suffer from dental & skeletal flurosis such as mottling of teeth, deformation of ligaments, bending of spinal column and ageing problem. Overall all water quality was found unsatisfactory for drinking purpose without any treatment. So an urgent need is to educate the people on the causes of flurosis, encouraging defluoridation technique for providing fluoride free water in the study area.

The use of a colorimeter in analyzing the fluoride content of public well water byGall E. Brossok, DDS, MS Dennis J. McTigue, DDS, MSRaymond A. Kuthy, DDS, MPH

Water samples from 110 public wells in Ohio were analyzed for fluoride content using both an ion-specific electrode and a colorimeter. In addition to the fluoride testing, analyse were performed on selected known interfering substances in the water. Sixty per cent of the samples differed by > 0.1 ppm fluoride with a mean difference of + 0.14 ppm. Prescriptions for fluoride supplementation based on the colorimetricresults would have been incorrect 44.6% of the time. Sulphate levels had a significant ($P < 0.05$) effect on the accuracyof the coIorimetric results. Without prior distiIlation, the colorimetric method is unsatisfactory for determining fluoride concentration of well water.

Low Cost Household Level Solution To Remove Fluoride From Drinking Water by ManishaPatni, Rambabu, AnkitaMeena

Water with high fluoride content is unsafe not only for human consumption but also for other activities such as irrigation and industrial needs. Therefore, a systematic assessment of fluoride in groundwater is required for the better management of the fluoride toxicity. Defluoridation of drinking water is the only practicable option to overcome the problem of excessive fluoride in drinking water. Therefore in this paper it was aimed to find a suitable low cost environmental friendly method for removal of fluoride in the drinking water that could be used by common man, easy to understand and can be adopted in rural as well as urban background throughout the year. Other possible negative impacts i.e. handling of dangerous chemicals, consequences of wrong dosing of chemicals and possible chemical residuals were also avoided.

Study of fluoride contamination status of ground water in Bassi Tehsil of district Jaipur, Rajasthan, India by Swati Saxena, UmeshSaxena

Water is an essential natural resource for sustaining life and environment but over the last few decades the water quality is deteriorating due to its over exploitation. Fluoride is one of the critical chemical parameter, which influences the quality of ground water. Excess intake of fluoride through drinking water causes fluorosis on human beings in many states ofIndia, including Rajasthan.

The study was carried out to assess the fluoride contamination status of ground water in Jaipur, Rajasthan, India. For this purpose, 50 water samples collected from hand pumps, open wells and bore wells of villages of study area were analysed for fluoride content. Out of 50 villages, maximum 14 villages (28%) were found to have fluoride above 1.5 but below 3.0 mg/L and minimum 5 villages have fluoride content in between the range of 1.0-1.5 mg/L. 6 villages

(12%) have fluoride concentration above 3.0 but below 5.0 mg/L and 12 villages (24%) are having fluoride above 5.0 mg/L. As per the desirable and maximum permissible limit for fluoride in drinking water, determined by WHO and Bureau of Indian Standards, 74% of groundwater sources are unfit for drinking purposes. Due to the higher fluoride level in drinking water several cases of dental and skeletal fluorosis have appeared at alarming rate in this region. After evaluating the data of this study it is concluded that there is an instant need to take ameliorative steps in this region to prevent the population from fluorosis

Determination of Fluoride content in Ground water at Vinukonda Area by YanadiRoa

Some parts of Guntur district in Andhra Pradesh are such regions where people from several generations suffered from fluoride water because of lack of alternatives. The people from these regions use this fluoride water for drinking purpose face many problems such as skeletal fluorosis, formation of stones in the kidney, gastrointestinal disorders and enamel fluorosis. The main objectives of the present study are determination of the present status of fluoride content in groundwater from different areas in Guntur district and assessment of the possible causes for high concentration of fluoride.

Fluoride contamination in water highest inDharmapuri –THE HINDU by S. Prasad dated May 25, 2004.

Dharmapuri district has a high concentration of endemic fluoride and ranks the highest in the State. According to a recent survey by the Tamil Nadu Water and Drainage (TWAD) Board, out of 10,451 handpump sources, 3161 were found highly fluoride contaminated. Sources in the board say "around 30 per cent of the water sources in Dharmapuri and Krishnagiri were found fluoride contaminated when compared with the state average of 6.9 percent."Pennagaram and Palacodetaluks in Dharmapuri district and Kaveripattinam and Bargur account for the highest concentration in Krishnagiri district. As many as 1,028 identified habitations in Dharmapuri and Krishnagiri have been provided with alternative drinking water supply.

"Andhra ground water too dangerous to drink"- Times of Indiadated Apr 16, 2013.

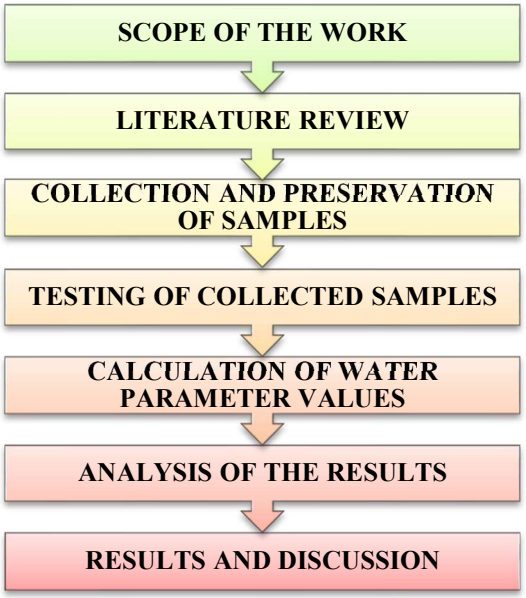
According to a new Central Ground Water Board (CGWB) report, which scientists said could be linked to the spike in cases of cancer, birth defects, miscarriages and fluorosis in the state. According to the latest CGWB report tabled in LokSabha, ground water in 20 districts (except East Godavari, Nizamabad and Srikakulam) was found to have concentration of fluoride above 1.5 mg/L and all the 23 districts were found to have presence of nitrate, above the permissible limit of 45 mg per litre. "The water is too dangerous to drink. Up to 2 mg per litre of fluoride content leads to dental fluorosis. Depending on the length of the exposure, it affects different tissues in the human body affecting teeth, bones, making them brittle and also causing ageing".

Spectrophotometric determination of fluoride in drinking water using Aluminium complexes of triphenylmethane dye by ZaherBarghouthi and Sameer Amereih.

A sensitive spectrophotometric determination of fluoride in drinking water has been developed using aluminium complexes of triphenylmethane dyes (chrome azurol B and malachite green) as spectrophotometric reagents. The sensitivity, detection limit, quantitation limit, and percentage recovery for 1.5 mg/L fluoride for the method using chrome azurol B were found to be 0.125 ± 0.003 μg·m/L , 0.2 mg/L, 0.5 mg/L, and 97.1 ± 4.2, respectively, and for malachite green were 0.143 ± 0.002 μg·m/L, 0.1 mg/L, 0.3 mg/L, and 97.9 ± 4.1, respectively.

6. METHODOLOGY

This represents the methodological framework used for collecting the data and the statistical tools used for analysing the data in order to solve the research problem and answer the research questions from suppliers.



7 DATA COLLECTION

The objective of sampling is to collect representative sample. Representative sample by means a sample in which relative proportions or concentration of all pertinent components will be the same as in the material being sampled. Moreover, the same sample will be handled in such a way that no significant changes in composition occur before the tests are made. The sample volume shall optimal small enough that it can be transported and large enough for analytical purposes. Because of the increasing placed on verifying the accuracy and representatives of data, greater emphasis is placed on proper sample collection, tracking, and preservation techniques.

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8 PROCEDURE FOR WATER ANALYSIS

I. FLUORIDE – Color comparator method

Procedure

Take 100ml sample of a portion of a sample diluted to 100ml in a Nessler cylinder add 5ml of acid cyconl Alizarin reagent mix and keep it in the desk. Compare with colour standards after one hour. Note the volume of standard fluorine with the one which it is compared.

Calculation

Flouride mg/l = ml of std. solution * 50 * 100/ ml of sample

II. CHLORIDE – Argentometric method

Procedure

Take 50mL well mixed sample adjusted to pH 7.0-8.0and add 1.0 mL $K_2Cr_2O_7$. Titrate with standard $AgNO_3$ solution till $AgCrO_4$ starts precipitating as pale red precipitate. Standardise $AgNO_3$ against standard NaCl. For better accuracy titrate distilled water (50mL) in the same way to establish reagent blank. A blank of 0.2 to 0.3mL is usual.

Calculation

Chloride mg/L = (A –B)x N x 35.45 x 1000 / mL sample

where,

A = mL $AgNO_3$ required for sample

B = mL $AgNO_3$ required for blank, and

N = Normality of $AgNO_3$ used

III. DISSOLVED OXYGEN – The Winkler method with azide modification

Procedure

Collect sample in a BOD bottle using sampler. Add 1mL $MnSO_4$ followed by 1mL of alkali-iodide-azide reagent to a sample up to the brim. The tip of the pipette should be below the liquid level while adding these reagents. Mix well by inverting the bottle 2-3 times and allow the precipitate to settle leaving 150mL clear supernatant. The precipitate is white if the sample is devoid of oxygen, and becomes increasingly brown with rising oxygen content. At this stage, add 1mL conc. H_2SO_4. Replace the stopper and mix well till precipitate goes into solution. Take 201mL of this solution in a conical flask and titrate against standard Na_2S2O_3 solution using starch (2mL) as an indicator. When 1mL $MnSO_4$ followed by 1mL alkali-iodide-azide reagent is added to the samples as in (2) above, 2mL of original sample is lost. Therefore 201mL is taken for titration which will correspond to 200mL of original sample.

Calculation

1mL of 0.025N $Na_2S_2O_3$ = 0.2mg of O_2

DO in mg/L = (0.2 x 1000) x (0.025N) ml of Thiosulphate/ 200

IV. HARDNESS – EDTA titration method

Procedure

Take 25 or 50mL well mixed sample in porcelain dish or conical flask. Add 1-2mL buffer solution followed by 1mL inhibitor. Add a pinch of Eriochrome black T and titrate with standard EDTA (0.01M) till wine red colour changes to blue, note down the volume of EDTA required (A). Run a reagent blank. Note the volume of EDTA (B). Calculate volume of EDTA required by sample, C = (A-B). For natural waters of low hardness, take a larger sample volume, i.e. 100-1000mL for titration and add proportionately larger amounts of buffer, inhibitor and indicator. Add standard EDTA titrant slowly from a micro burette and run a blank using redistilled, deionised water of the same volume as sample. Apply blank correction for computing the results.

Calculation

a. Total hardness as $CaCO_3$ mg/L = C x D x 1000 / mL sample
where, C = volume of EDTA required by sample
D = mg $CaCO_3$ equivalent to 1mL EDTA titrant
b. Calcium hardness $CaCO_3$ as mg/L = C1 x D x 1000 / mL sample
where C1 = volume of EDTA used by sample
D = mg $CaCO_3$ equivalent to 1mL EDTA titrant
c. Magnesium hardness = Total hardness as $CaCO_3$,
mg/L – Calcium hardness as $CaCO_3$, mg/L.

V. pH VALUE – Electrometric method

Procedure

a. Before use, remove electrodes from storage solutions (recommended by manufacturer) and rinse with distilled water.
b. Dry electrodes by gently blotting with a soft tissue paper, standardise instrument with electrodes immersed in a buffer solution within 2 pH units of sample pH.
c**.** Remove electrodes from buffer, rinse thoroughly with distilled water and blot dry.
d. Immerse in a second buffer below pH 10, approximately 3 pH units different from the first, the reading should be within 0.1 unit for the pH of second buffer.
e**.** For samples analysis, establish equilibrium between electrodes and sample by stirring sample to ensure homogeneity and measure pH.
f. For buffered samples (or those with high ionic strength), condition the electrodes after cleaning by dipping them into the same sample, and read pH.
g. With poorly buffered solutions (dilute), equilibrate electrodes by immersing in three or four successive portions of samples. Take a fresh sample and record the pH.

Calculation

The pH value is obtained directly from the instrument.

VI. SULPHATE – Gravimetric method

Procedure

Take 150ml of sample in beaker and make it acidic with HCL.
Heat the solution to the boiling point and add it to $Bacl_2$ solution. Slowly with stirring add this till precipitation is complete.
Digest the precipitation to 90^0c for 2 hours.
Filter out the solution through the filter paper.
Wash the precipitate with warm distilled water till wash water is free from chlorides by using$AgNo_3$ till there is no colour change.
Dry the filter paper and precipitate to 750^0c in muffle furnace for 30 minutes.
Cool and weigh the precipitate with crucible.

Calculation

Weight of residue = W_2-W_1

Quantity of sample (mg/l) = (W_2-W_1)x411.5x1000
ml of sample

W_1 - Weight of crucible

W_2 – Weight of crucible with residue after muffle heating

8. RESULTS AND DISCUSSIONS

The analysis of water are carried out to find the fluoride content of the collected ground water samples. The tests were done in laboratory by color comparator method that gives the exact value of the fluoride content. Also various water parameters like chloride, dissolved oxygen, hardness, pH, sulphate was measured.

This study was carried to find the fluoride content in the ground water in Coimbatore Corporation West Zone. The water samples from the respective zone (20 wards), were collected and tested for fluoride. In addition to fluoride, the water parameters like chloride, dissolved oxygen, hardness, pH and sulphates in water samples are also examined.

CONCLUSION

In this study water samples were tested for fluoride and based on the results obtained, the following conclusion was derived.

Wards that has high fluoride content,
Ward no. 11 (Saibaba Colony) - 1.2 mg/l
Ward no. 12 (K.K. Pudur) - 1.2 mg/l

Wards that has least fluoride content,
Ward no. 17 (Kalveerampalayam) -0.2 mg/L
Ward no. 23 (R.S.Puram-West) -0.2 mg/L
Ward no. 24 (Ramalingam Road) -0.2 mg/L

Wards that has high chloride content,
Ward no.11 (Saibaba Colony)- 509.89 mg/l
Ward no.12 (K K Pudur) - 509.89 mg/l

Wards that has least chloride content,
Ward no.7 (Edayarpalayam) - 49.99 mg/l

Wards that has high dissolved oxygen content,
Ward no.12 (K K Pudur) - 5.7 mg/l
Ward no.7 (Edayarpalayam) - 5.6 mg/l

Ward that has least dissolved oxygen content,
Ward no.21 (Poosaripalayam) - 4.4 mg/l

Ward that has high total hardness content

Ward no.14 (Kovil Medu) - 605 mg/l

Ward that has least total hardness content,
Ward no.13 (Venkitapuram) - 165 mg/l

Ward with high pH content,
Ward no.22 (Alagesan Road) - 8.14

Ward with least pH content,
Ward no.9 (Kavundampalayam) - 7.64

Defluoridation

Thus the water has to be defluorinated in order to minimize the effect of fluoride on human beings. As with the treatment of other chemical contaminants, such as arsenic, fluoride cannot be removed by typical water treatment means. Synthetic iron exchange and precipitation processes, activated alumina filters and reverse osmosis typically used to remove fluoride from water in developed countries.

Though many treatments are done to reduce the risk of recontamination of water, defluoridation techniques helps in reduction of cost. Because water is only needed for drinking and cooking (about 25% of total water usage) needs to be treated, municipal water treatment is rare.

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