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FLUORIDE TOXICITY IN GROUND WATER OF BANAS RIVER BASIN AREA OF BONLI TEHSIL,(SWAI MADHOPUR, RAJASTHAN, INDIA) AND ITS IMPACT, CAUSES AND PREVENTION: A REVIEW

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ABSTRACT

Groundwater quality in swai madhopur has been studied with special reference to the presence of fluoride.However,a systematic study is required to understand the behaviour of fluoride in natural water. Fluoride is required by the human being for mineralization of bones and teeth. Hydro-Chemical condition is the main source of fluoride contamination in ground water but run off and atmospheric depositions are also responsible for additional fluoride concentration. This study is carried out to assess the fluoride concentration, causes and its toxicity level in ground water of Banas River Basin area of Bonli tehsil, (Swai Madhopur, Rajasthan, India) and its impact on human physiology on populace, possible sources and prevention, where ground water is the main source of drinking water, for this purpose ground water samples were collected from different locations of study area and analyzed. The analytical results indicated considerable variation of fluoride concentration among the analyzed samples.The result of chemical analysis show the maximum fluoride concentration was reported in Bamanwas Block (3.5 mg/L) and minimum in Morel Tiwara (0.23mg/L). In 34 areas (68% samples) F- concentration comply with BIS and WHO standard, but in 16 areas (32 % samples) excess concentration reported than permissible limits. In some village's dental and skeletal fluorosis and others fluoride related health hazards cases were reported. The socioeconomic impacts of fluoride contaminated water in study area revealed that impact is inequitably distributed in society and the impact was inversely related with the income of people. The possible sources of fluoride in study area are geogenic activities, presence of fluoride bearing minerals, decrease in rainfall, slow rate of water flow etc. In society impacts of fluoride contaminated water in study area is inequitably distributed and the impact was inversely related with the income and education level of people.

Keywords : Fluorosis, Mineralization, Physiology, Morphology, BIS,WHO

I INTRODUCTION

Water is the most precious gift of nature, the most crucial for sustaining life and is required in almost all the activities of human beings. Groundwater is the major source of drinking water in both urban and rural India. , but over the last few decades the water quality and quantity is deteriorating due to it's over exploitation.(1) Fluoride is an ion of the chemical element fluorine which belongs to the halogen group. It is the most electronegative and reactive of the all elements. It occurs as F- ion naturally in soils and water due to chemical weathering of some fluoride containing minerals. Fluorides are ubiquitous in air, water and the lithosphere, where they are seventh in order of frequency of occurrence (0.06 0.09% of the earth crust) WHO (1994). The higher fluoride concentration may cause fluorosis and extreme condition causes even skeletal fluorosis. The F- content in the ground water is a function of many factors such as availability and solubility of F- minerals, velocity of flowing water, Temperature, pH, concentration of Ca and HCO3- ions in water. Higher fluoride quantity causes fluorosis along with many neurological implications1,2. Fluorosis is characterized as dental, skeletal and non-skeletal3, 4. "When fluoride exists in water or food every living organism5 is affected". Commonly known acute health effects include death related to binding of fluorine with serum calcium and magnesium, vomiting, nausea, chronic convulsion,necrosis of the mucosa of the digestive tract, heart failure6, 7 and the effect of fluoride in drinking water on children's intelligence. Recent research correlate fluoride in drinking water with urineBlood plasma, and serum fluoride levels. Fluoride containing compounds are still used to increase the fluidity of metals and slugs in the glass and ceramic industries, fertilizer industry. Fluoride readily crosses the placenta. Fluoride exposure to the developing brain, which is much more susceptible injury caused by toxicants than is the mature brain, may possibly lead to permanent damage. High intake (above 1.5 mg/l) of fluoride create health hazard leading to stiffening of body joints, deformation of bones mottled or chipped teeth, aches and pain in joints. Various workers in our country have carried out an extensive work on water quality with special reference on fluoride for various purposes4, 8-10. In Rajasthan all 33 district are endemic for fluorosis Yadav et al. (2008). Fluoride level in ground water is spread in all the 33 districts and become a health hazard in 25 districts. In the present study water samples were collected from one of the tehsils (SawaiMadhopur tehsil) of the Sawai Madhopur district. The samples collected from thirty villages of Bonli tehsils were analyzed with particular emphasis on Fluoride content.

II STUDY AREA

Rajasthan 60% land is part of Great Indian Desert, Thar Desert that suffering from acute water crisis, Rajasthan state being largest state of the country having 10.4% of total geographical area of the country with only 1% of water resources available to the state for 5.5% population. The Banas River originates in the Khamnor Hills of Arawali range, about 5 Km from Kumbhalgarh in Rajsmand district and meets the Chambal river near the village of Rameshwar in Swai Madhopur district. It lies entirely within Rajasthan and it flows in Rajsmand, Chittorgarh, Bhilwara, Tonk and Swai madhopur district in Rajasthan, and aligned NE-SW and the major tributaries of this are Berach, Menali, Kothari, Khari, Dai and Morel. Sawai Madhopur district is located in the eastern part of the Rajasthan State, it lies between 250 45' to260 41 N latitude and 75059' to 770 0' E longitude.

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Administratively, the district is divided into 4 subdivisions viz. Gangapur, Bamanwas, Bonli and Sawai Madhopur and has seven tehsils i.e. Gangapur, Bamanwas, Malarna Dungar, Bonli, Chouth Ka Barwara, Sawai Madhopur and Khandar. The total area of Sawai Madhopur tehsil is 5042.99 km2 with a population of about 1, 20,998. Out of this 19.04 percent of total population lives in towns and 80.96 percent in rural area. The climate of the district can be classified as semi-humid. It is characterized by very hot summers and very cold winters with fairly good rainfall during south-west monsoon period. Many villages contain high fluoride concentrations in the ground water and people suffer from fluorosis.

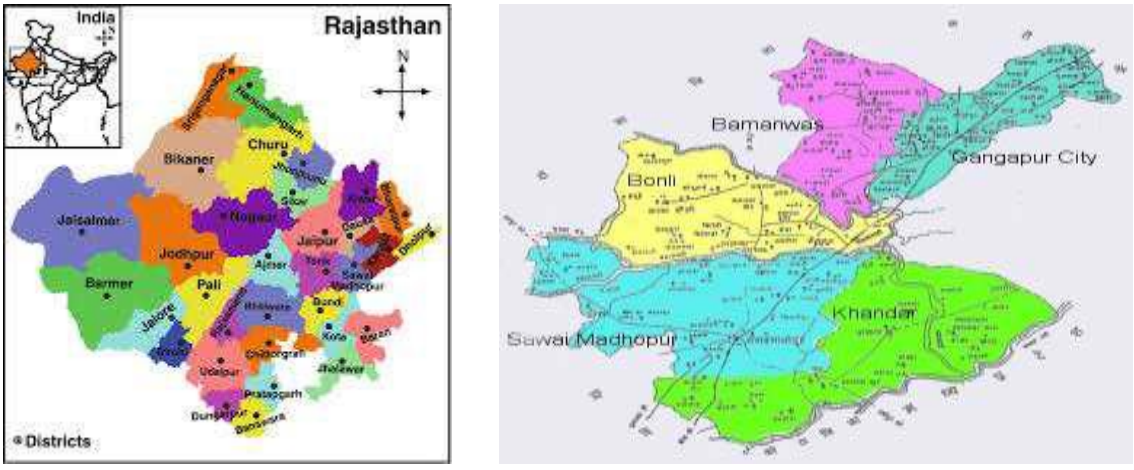

Figure: ***1. The Location Map Of Study Area***

III MATERIAL AND METHODS

Ground water samples from fifty area located in Banas basin river of Jahazpur tehsil (Bhilwara, Rajasthan, India) were collected pre cleaned polythene bottles during June 2014 with necessary precautions. The samples were collected from open wells, bore wells, hand pumps and PHED supply. The fluoride concentration was determined by using fluoride ion selective electrode APHA (2012) that measures fluoride concentration of range 0.01 mg/l to 1000 mg/l. The standard fluoride solutions of 1 ppm and 10 ppm were prepared from a stock solution of 100ppmof sodium fluoride solution and TISAB was used as buffer solution. The ion meter was calibrated for of -59.2±2 (APHA, 2012). Colour, Odour and Taste were determined by conventional methods and EC, Temperature and pH were determined on site using by portable instruments. Physical parameters like pH, TDS and EC were determined with the help of digital portable water analyzer kit (Model 161 E). The chemical analysis was carried out for chloride, total calcium and magnesium hardness, dissolve oxygen and total alkalinity by volumetric titration methods

IV RESULTS AND DISCUSSIONS

The results reported for fluoride concentration in ground water of Banas river basin area of Bonli tehsil (swaimadhopur, Rajasthan, India) are illustrated graphically in Figure 1. The ground water of Banas river basin area of Bonli tehsil(swaimadhopur, Rajasthan, India) is categorised upon the basis of fluoride concentration in ground water, these three categories of water represented in Table 3.

Category-I of water include 55% samples have lower fluoride concentration in ground water and category-3 with 15 % samples have the highest fluoride concentration (Figure 3). In 34 area or 68% samples the fluoride concentration in ground water was comply with WHO and BIS standard, but in 32% samples fluoride concentration was found more than permissible and desirable limits of WHO (1996) and BIS (2012). The fluoride concentration in study area was range. The range of fluoride concentration in ground water of study area reported was from 0.151 mg/l to 5.2 mg/l and the maximum concentration was reported in Bamanwas Block (3.5 mg/L) and minimum was in Morel village (0.151 mg/l) (Table 3). 55% samples fall in category-I in which fluoride concentration in ground water determined was below 0.1 mg/l, use of this water for drinking purpose is safe for populace. In this area no possibility of any kind of dental and skeletal fluorosis and this concentration has anti caries effect to teeth enamel. 16% of samples were found in category-II in which fluoride concentration is between maximum desirable limit and the maximum permissible limit as recommended by BIS -10500 (2012). 15% of samples fall in category-III, in which fluoride concentration was 1.5 mg/l to 3.00 mg/l. The most alarming condition of health hazards was observed in these areas. In 15 % samples and 16 areas of category III the fluoride concentration was exceeded the permissible and desirable limits, ground water of these area was found unfit for drinking purpose, hence this water cannot be used for drinkingpurpose without proper treatment.In the populace of 16 area (32% samples) of study area which belong to category III cases of fluoride health hazards reported such as morphological and physiological changes in calcified tissues (teeth and bones), Dental fluorosis which is characterized by discoloured, blackened, mottled or chalky white teeth, is a clear indication of overexposure to fluoride during childhood when the teeth were developing, Chronic intake of excessive fluoride can lead to the severe and permanent bone and joint deformations termed as skeletal fluorosis .Fluoride has been found to have adverse effects on the structure and functions of the animal nervous system Varner et al. (1998), Shivarajashankara et al. (2002), Eswar et al. (2011). Over the last two decades more subtle injuries from human F exposure in the form of lower intelligence have been reported in several countries Chen et al. (2008), Susheela (2012), Poureslami et al. (2011). This effect of F may be due to its ability to cause CNS (central nervous system) cellular injury through several mechanisms including free radical generation and excitotoxicity Bhatnagar et al. (2011).Excessive intake of fluoride causes problems of Thyroid gland and skin of animals Prerna Sharma (2007) and may causes adverse effect on fertility of human being, level of mental work capacity and intelligence quotient of children Lu et al. (2000), and the excess fluoride concentration also affect Ca functioning which is for bone formation, muscle movement and contraction, blood clotting and constant disfunction leads to the knock knee system, excessive accumulation of calcium fluoride in the renal system, and leading to stones formation in the kidney and eventual renal failure Meena et al. (2012). Complaints of the male infertility with an abnormality in sperm morphology and also low testosterone levels are said to involve fluoride

toxicity Tailar & Chandel (2010). Recent reports also indicate that early cataract development of cataract in human eyes due to excess consumption of fluoride The Guardian UK (1995).A lack of fluoride intake during development will not alter tooth development but may result in increased susceptibility of enamel to acid attacks eruption. However, caries is not a fluoride deficiency disease. Acute ingestion of a large fluoride does can provoke gastric and kidney disturbances, and can be lethal Whitford (2011), Acute excess fluoride intake interferes with calcium metabolism and many enzyme activities, activating both proteolytic and glycolticfunctions and cell respiration by inhibiting Na+/K+ -ATPase, and can be fatal with doses of 5-10g in adults and 500mg in small children Lech (2011). Socioeconomic impact of fluorosis concentration studied in populace of study area, the percentage of fluoride debility cases found less with rising income and the impacts of poor quality water are distributed inequitably within the studied society. The social, health, and economic impacts of contaminated ground water depends on spatial distribution of fluoride, dependence of the populace on fluoride contaminated water, awareness of water quality, levels education and economic status of populace at risk. Good nourishment and medical care could be reason for this decline. Higher income group of society could escape the ill effects of fluoride contaminated water.Low rainfall increase reaction time of fluoride bearing rocks with water and slow down the movement of water that increase fluoride content in ground waters, whereas increased rainfall decrease fluoride content. Arid climate are prone to high fluoride content. Banas river basin area of Bonli tehsil(swaimadhopur, Rajasthan, India) is part of arid semi zone that is why higher fluoride content is present in ground water.

Table-1: Standards of Drinking water quality recommended by different organization

S. No.	Parameters (mg/l)	WHO(2006)	USPH (1985)	BIS (1999)	ICMR (1975)
1.	pH	6.9-9.2	-	6.5-8.5	7.0-8.5
2.	TDS	500-1500	2000	2000	1500
3.	EC (mmhos/cm)	1.400	300	-	-
4.	Total Alkalinity	120	-	600	600
5.	Total Hardness	500	-	600	600
6.	Calcium Hardness	75-200	-	200	-
7.	Fluoride	1-1.5	1.5	1.5	1.5
8.	Chloride	200-600	250	1000	200

All value are in mg/l except pH and EC

Figure-2: Physico-chemical analysis of water sample collected from different villages of Sawai Madhopur District.

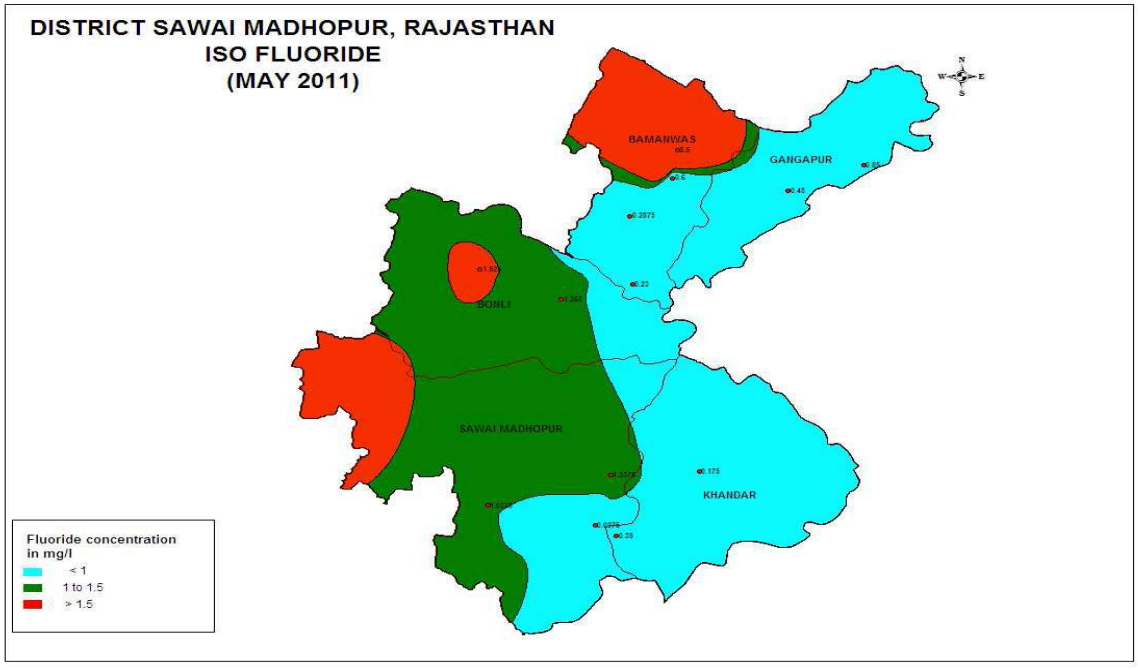

Table-2: Concentration of fluoride and Biological effects.

S. No	Fluoride in drinking water mg/l	Effect
1.	0.002 mg/l in air	Injury to vegetation
2.	1 mg/l in water	
3.	2 mg/l or more in water	Mottled enamel
4.	3.1 to 6.0 mg/l in water	Osteoporosis
5.	8 mg/l in water	0%osteoporosis
6.	20 – 80 mg/day or more in water or air	Crippling skeletal fluorosis
7.	50 mg/l in food or water	Thyroid change
8.	100 mg/l in food or water	Growth retardation
9.	More than 125 mg/l in food or water	Kidney change
10.	2.5 – 5.0 gm in actual dose	Death

Table 3. **Categorisation of ground water of Banas river basin area of Bonli tehsil (swaimadhopur, Rajasthan, India) based on fluoride concentration.**

Category of Samples	Range of Fluoride conc.	No. Of Area
Category 1	<1	36
Category 2	1 to 1.5	20
Category 3	> 1.5	10

Figure 3. *% of each category of water sample of Banas river basin area of,* Bonli tehsil (swaimadhopur, *Rajasthan, India).*

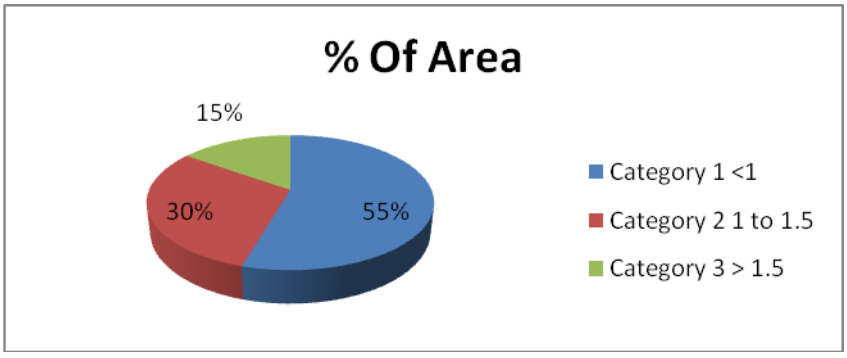

Figure 4. *No. of area and their % each Category of ground water of Banas river basin area of,* Bonli tehsil (swaimadhopur, *Rajasthan, India)*

Figure 5. *Dental Fluorosis And Skeletal Fluorosis.*

IV CONCLUSIONS

This study reveals that the ground water is the only source for people in the study area, and the results of the chemical analysis of ground water shows considerable variation. Most of the water samples do not comply with ICMR, BIS and WHO standards for drinking purpose. The water quality in the investigated area is found to be suitable for drinking only in few locations. As the fluoride contents was found in samples as high as 7.9mg/l, Inhabitants are bound to suffer with fluorosis. Authors recommended for providing safe water to residents of villages where Fluoride content is to be more than permissible limits.

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