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FLUORIDE IN THE WATER OF KASHMIR VALLEY: A BI-BEVELLED CONCERN

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ABSTRACT
Currently about a billion people around the world routinely drink unhealthy water. In India two acute health problems arise from drinking water. These are – fluoride and arsenic contamination in ground water. Fluoride is known as a bi-beveled blade, at recommended concentration can be beneficial while it is a health hazard in higher concentrations. The role of fluoride in reducing the risk of dental caries, especially among children, is well recognized. The present study was carried out in 10 districts in Kashmir division of Jammu and Kashmir State which is an Indian state that has its own distinct and peculiar cultural ethos. The demographic situation and level of socio-economic development remains far from satisfactory in this state. A total of 25 sources of water used for drinking purposes in Kashmir division were sampled for assessing their fluoride concentration. A total of 25 sources including 10 from Community tap water, 10 from bore well/open well water samples, 2 from lakes and 3 from free flowing mountain streams were analyzed. The fluoride content in drinking water sources was assessed by Spectrophotometric analysis. Highest Fluoride content recorded was 0.92mg/L. Rest all the samples collected showed more than 0.21mg/L but less than 0.40mg/L. All the water samples analyzed showed that the average Fluoride content in water from any source was 0.24mg/L, while the highest was 0.92mg/L, which is below the Fluoride level that has been set as a Standard. The World Health Organisation guideline for fluoride which is 1.5 mg/L similar to European Economic Council guideline, U.S. EPA, 1998. Thus, there is an urgent need to provide safe drinking water to the people of this state with regular water surveillance and water purification on cost effective methods.

KEYWORDS: Fluoride, Jammu and Kashmir, Caries, Fluoride Estimation, Water Purification.

INTRODUCTION

Target 7C of the Millennium Development Goals demands for halving the proportion of the population without sustainable access to safe drinking water and basic sanitation by 2015 (United Nations, 2000). As for India being a large and developing country it is critical to meet this target, even though the proportion of the population with access to improved sanitation nearly doubled in the last 20 years, however problems have been encountered in measuring "safe" and "sustainable", which also has led to a revision of the target to achieving access to improved sources of water and sanitation (Zetland, 2008). Currently about a billion people around the world routinely drink unhealthy water. In India two acute health problems arise from drinking water. These are – fluoride and arsenic contamination in ground water (Rubina *et al.,* 2003). Fluoride is known as a bi-beveled blade, at recommended concentration can be beneficial while it is a health hazard in higher concentrations. The role of fluoride in reducing the risk of dental caries, especially among children, is well recognized. Fluoride concentration in drinking water less than 0.6 mg/L causes dental caries, whereas high level (> 1.2 mg/L) leads to Fluorosis (Indian Standard Institution, 1983). High groundwater fluoride concentrations have been reported from India, Pakistan (Siddiqui, 1955), West Africa (Jolly *et al.,* 1973), Thailand (Teotia *et al.,* 1991), Sri Lanka (Karthikeyan *et al.,* 1993), and Southern Africa (Grobleri *et al* 2001). A fluoride level of 1 ppm in the drinking water seems to reduce the evidence of dental caries. Fluorine in the body acts in two ways i.e. by increasing resistance of the enamel and by reducing the effectiveness of microbial activity (Hardwick *et al*., 1958). Jammu and Kashmir is an Indian state that has its own distinct and peculiar cultural ethos. The demographic situation and level of socio-economic development remains far from satisfactory in this state. The health status of the people in Jammu and Kashmir has not been able to keep pace with the national level of achievements. The prevalence of dental caries has also been reported to be very high especially in the children below 15 years of age (Bali, *et al.,* 2004). It has been documented previously that the factors which lead to the development of disease are likely to have their roots in a complex chain of environmental events that may have begun years before (Rao, 1984). Fluorine in the environment is found as fluorides which together represent about 0.06–0.09 per cent of the earth's crust (Tebutt, 1983). Fluorine is regarded as an essential constituent in the drinking water. The main source of drinking water in Kashmir is lakes and

rivers flowing through the mountains into the valley. Moreover, the water used by water treatment plants for public water supply is treated for impurities but is not monitored for fluoride level. Literature regarding the concentration of the fluoride in the drinking water in Kashmir Valley is scarce, thus present study was conducted in order to estimate the fluoride concentration of drinking water from various sources used for drinking in Kashmir valley of Jammu and Kashmir state, India.

MATERIAL & METHODS

The study area for the present study was the Kashmir division of Jammu and Kashmir State, India. The Kashmir valley is 100 km wide and 15,520.3 km^2 in area. Kashmir Valley has a moderate climate, which is largely defined by its geographic location, with the towering Karakoram Range in the north, Pir Panjal Range in the south and west and Zanskar Range in the east. The Himalayas divide the Kashmir valley from Ladakh while the Pir Panjal range separates it from the Great Plains of northern India. Jammu And Kashmir State has been divided into three divisions, Jammu division, Kashmir Valley and Ladakh, which comprise of 22 districts of these Kashmir valley comprises of 10 districts. The present study was carried out in 10 districts in Kashmir division. A total of 25 sources of water used for drinking purposes in Kashmir division were sampled for assessing their fluoride concentration. Some important water bodies from famous tourist destinations were also included because they are a direct source of drinking water for many and also a source of water for treatment plants in Kashmir which is supplied to public. The sources of water samples included in the present study were from natural sources as well as from the community water supply.

Collection of samples

Water was collected from a total of 25 sources used for drinking purposes. Out of these 10 were from Community tap water, 10 from bore well/open well water samples, 2 from lakes and 3 from free flowing mountain streams. Collection of samples from open sources of water was done very cautiously in order to prevent the surface contaminants being included in the sample water. Water from the natural sources was collected 1 meter below the surface layer. A dip sampler was used in situations where a sample was to be recovered from an outfall pipe or places where direct access was limited. The long handle on such a device allowed access from a discrete location where water was collected from open sources. Samples were transferred into suitable, one liter pre-cleaned, high density polyethylene bottles. Samples were kept away from direct sunlight, overfilling of the containers was prevented and containers securely and placed in plastic bag. All the samples were allowed to stand at 4^0C during the storage. All pertinent data was recorded in the site logbook and on field data sheets. Seals were attached to all the samples prior to shipment for analyses. A code number was placed on all the containers which was decoded only after the results were derived and the not know the source of the water sample.

Analysis

Analysis of the samples was done using The Hach DR 5000 UV-Vis Spectrophotometer. Samples for analysis were collected in dry pre washed bottles using the standard procedure for grab (or) catch samples in accordance with standard methods of APHA (1995) [15] while collection temperature of these areas was noted by 1100C thermometer. All the chemicals and reagents used were of analytical grade. Distilled water was used for the preparation of solutions (Hari haran *et al.*, 2011).

RESULTS

A total of 25 sources including 10 from Community tap water, 10 from bore well/open well water samples, 2 from lakes and 3 from free flowing mountain streams were analysed. The mountain streams and lakes were selected as they remain the sources of drinking water for the people living in the areas as Gulmarg, Pahalgam and Sona-Marg where extreme low temperature makes the community water supply impossible to reach every house for 12 months thus stream water is consumed. The samples were divided into three categories based on the source of the water or the sampling station. The community water source (Cs), the natural water sources (Ns) and the Tourist destination water sources (Ts). The fluoride content in drinking water sources was assessed by Spectrophotometeric analysis. The results showed that the highest fluoride content in samples collected from community water supply sources (Table 1) was 0.38 mg/L in the sample which was collected from District Bandipora (Cs9) which was followed by 0.30 mg/L recorded the in sample from Ganderbal District (Cs4). The lowest fluoride level of 0.10 mg/L was seen in community water supply of District Baramulla (Cs2) while Districts Srinagar (Cs1) and Pulwama (Cs1) had 0.12 mg/L Fluoride each.

TABLE 1: Community water supply Source/ Sampling Stations

S. No	Sampling Station (District)	Fluoride content (mg/L)
Cs1	Srinagar	0.12 mg/L
Cs2	Baramulla	0.10 mg/L
Cs3	Pulwama	0.12 mg/L
Cs4	Ganderbal	0.30 mg/L
Cs5	Anantnag	0.28 mg/L
Cs6	Kupwara	0.24 mg/L
Cs7	Budgam	0.26 mg/L
Cs8	Shopain	0.19 mg/L
Cs9	Bandipora	0.38 mg/L
Cs10	Kulgam	0.29mg/L

Table 2 shows that the highest amount of fluoride in the natural water source was 0.28 mg/L from District Pulwama (Ns3) followed by 0.26 mg/L of Fluoride in natural water source of District Srinagar(Ns1). While District Anantnag (Ns5) had lowest Fluoride content of 0.10 mg/L in water from natural source. Which was closely followed by district Kulgam (Ns10) (0.14 mg/L) and District Kupwara (Ns6) (0.18 mg/L). The average Fluoride content from any of the natural sources within Kashmir division was recorded to be 0.197 mg/L.

TABLE 2: Natural water Source/ Sampling Stations

S. No	Sampling Station (District)	Fluoride content (mg/L)
Ns1	Srinagar	0.26 mg/L
Ns2	Baramulla	0.21 mg/L
Ns3	Pulwama	0.28 mg/L
Ns4	Ganderbal	0.20 mg/L
Ns5	Anantnag	0.10 mg/L
Ns6	Kupwara	0.18 mg/L
Ns7	Budgam	0.20 mg/L
Ns8	Shopain	0.20 mg/L
Ns9	Bandipora	0.20 mg/L
Ns10	Kulgam	0.14 mg/L

Table 3 presents the fluoride content in the water from Natural water Source at Important Tourist places in Kashmir division. It was seen that the highest Fluoride content was recorded in water from famous Dal Lake (Ts1) with 0.92 mg/L of Fluoride in it. Manasbal Lake (Ts2) situated in District Bandipora had second highest Fluoride content with 0.36 mg/L. The lowest Fluoride content of 0.1 mg/L was recorded in the water from Lidder river (Ts3) flowing through famous hill station Pahalgam.

TABLE 3: Other Important Tourist places (Natural water Source) Sampling Stations

S. No	Sampling Station	Fluoride content (mg/L)
Ts1	Dal Lake (Srinagar)	0.92 mg/L
Ts2	Manasbal Lake (Bandipora)	0.36 mg/L
Ts3	Lidder river (Pahalgam)	0.1 mg/L
Ts4	Stream water (Gulmarg)	0.26 mg/L
Ts5	Sind river (Sona Marg)	0.20 mg/L

Overall the results showed that the average fluoride contents of samples Cs1,Cs2, Cs3, Cs8, Ns5, Ns6, Ns10 and Ts3 fall in the category having fluoride less than 0.20 mg/L, means the water can be assumed Fluoride free. Ts1 showed the highest Fluoride content which was 0.92mg/L. Rest all the samples collected showed more than 0.21mg/L but less than 0.40mg/L. All the water samples analyzed showed that the average Fluoride content in water from any source is 0.24mg/L, while the highest was 0.92mg/L, which is below the Fluoride level that has been set as a Standard. The WHO guideline for fluoride is 1.5 mg/L (World Health Organization., 1995), which is the same as EEC guideline, U.S. EPA (European Economic Council., 1998.).

DISCUSSION

In India, investments in community water supply and sanitation projects have increased steadily from the 1st Five-Year Plan to the 12th plan. The provision of clean drinking water has been given priority in the Constitution of India, with Article 47 conferring the duty of providing clean drinking water and improving public health standards to the State. The government has undertaken various programs since independence to provide safe drinking water to the rural masses. Till the 10th plan, an estimated total of Rs. 1,105 billion spent on providing safe drinking water (Patil, 2013). One would argue that the expenditure is huge but it is also true that despite such expenditure lack of safe and secure drinking water continues to be a major hurdle and a national economic burden. While accessing drinking water continues to be a problem, assuring that it is safe is a challenge by itself. Water quality is affected by both point and non-point sources of pollution. These include sewage discharge, discharge from industries, run-off from agricultural fields and urban run-off. Water quality is also affected by floods and droughts and can also arise from lack of awareness and education among users. The World Health Organization (World Health Organization, 1995) and Indian Council of Medical Research (Indian Council of Medical Research, 1975) have described the drinking water quality guidelines including the value for fluoride as 1.5 mg/l. It is important to consider climatic conditions, volume of water intake and other factors when setting national standards for fluoride (Fawell *et al.*, 2006). This point is extremely important, not only when setting national standards for fluoride, but also when taking data from one part of the world and applying them in regions where local conditions are significantly different. The entire State of Jammu and Kashmir lies between 32.17" and 36.58" North altitude and East to West, the State lies between 73.26" and 80.30" longitude. In Kashmir valley the average temperature in summer temperature 24.1 °C (75.4 °F) Average winter temperature 2.5°C (36.5 °F). The climate found in the zone is of a particular type. Srinagar has a humid subtropical climate, much cooler than what is found in much of the rest of India, winters are cool, and temperature remains below freezing at night, summers are

warm with daily mean of 30.1 °C (86.2 °F). The average annual rainfall is around 710 millimeters (28 in). Summer is usually mild and with good little rain, but relative humidity is generally high and the nights are cool. The precipitation occurs throughout the year and no month is particularly dry. The hottest month is July (mean minimum temperature 6°C, mean maximum temperature 32°C) and the coldest are December–January (mean minimum temperature−15°C, mean maximum temperature 0°C). The consumption of water of a region depends upon the temperature of the area. The mean temperature of Kashmir valley is lower as compared to most of the other states in India. Therefore the water consumption by the people and children should be much less than the average level of water consumed by children and adults in other parts of the country. One of the most important sources of fluoride for humans is drinking water. Lack of fluoride in children nutrition can lead to failing of healthy teeth and bones. In ground water and water from Municipal Corporation the level of fluoride to prevent both dental caries and fluorosis is an important factor. The results from previous studies elsewhere reveal that higher incidences of dental caries are likely to occur if fluoride concentration in the drinking water is less than 0.5 ppm. To prevent dental caries, the water should be fluorinated to bring concentration up to 1 ppm. Any one of the various methods for fluoridation of drinking water should be adopted as reported by Calavska (Calavska, 1987). Epidemiological data regarding dental caries in children of Jammu and Kashmir State is scarce. The mean caries as reported in National oral health survey and fluoride mapping, Jammu and Kashmir State 2002–2003 in 5 years olds of Kashmir division was 1.7, for 12 year olds it was 1.1, while it increased to 2.0 in 15 years and 5.5 in 35-44 years (Bali, *et al.,* 2004). These results from previous studies show that the caries level in Kashmir is more than the WHO Oral Health Goals 2010 target of mean DMFT/dmft of 1.5 (Hobdell *et al.,* 2010). The possible reason for the increased prevalence of dental caries in this population can be due to insufficient Fluoride content in the drinking water. Moreover, the recent trends of urbanization have led to a definite increase in consumption of carbohydrate foods and in turn increase in caries. Further the amount of water consumed would be less because of cold climatic conditions and this would have a cumulative effect in increasing the prevalence of the dental disease as very small amount of Fluoride is ingested with drinking water. The intake range of Fluoride from all sources is set at 0.05 mg/kg/day for all ages greater than 6 months, because it confers a high level of protection against dental caries and is associated with no known unwanted health effects. Adequate intake level of Fluorides, 0.01 mg/ day, has been set for infants below 6 months (Food and Nutrition Board, 1997) (Petersen, 2005) most of which is derived from the water which is used to prepare the infant food or milk.

RECOMMENDAION

We recommend that the authorities should perform a survey for the standards of drinking water in the Kashmir Division and should direct the concerned departments for proper fluoridation of water. As it is evident from the results that the water from the community sources which is processed lacks proper amount (1.5 mg/l) of Fluoride as described by World Health Organization and Indian Council of Medical Research (World Health Organization, 1995) (Indian Council of Medical Research, 1975). There is an urgent need to provide safe drinking water to the people with regular water surveillance and water purification on cost effective methods.

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