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DETERMINATION OF FLUORIDE CONCENTRATIONS LEVEL IN DRINKING GROUND WATER IN SHENDI CITY, RIVER NILE STATE, SUDAN

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ABSTRACT

Fluoride is one of the elements that impact human health at levels lower and higher than the standard, also is consider as a health problem in most areas of the world, where about 200 million people from 25 countries are exposed to high or low concentrations of fluoride from groundwater sources. This descriptive and analytical study was conducted in shendi City to identify concentrations of fluoride in ground water. 150 samples of ground water were tested per season (50 samples for each season), the water samples were collected from ground water sources (wells), distribution system and storage facilities that are used directly by community. Analyzing of samples had been completed according to standard methods for examinations of water, in this study used photometer device for determination concentrations of fluoride. Our study revealed that: the quality of ground water in study area is low fluoride content and below the optimum levels that recommended by WHO and SSMO guidelines for drinking water and seasonal variations have effects on fluoride's solubility and concentrations. Based on the findings of this study we recommend that: community must not depend totally on ground water as main source for fluoride, and community in study area should be use other sources for fluoride intake to obtain on daily required amount of fluoride for protection the health.

Keywords: Groundwater, Concentration, Water Quality Index, Bone Fractures, Shendi City, Guideline

1. INTRODUCTION

Groundwater is the most importance and more safely, its widely used as source of drinking water especially in rural communities around the world and its quality has great health signifcance so its needs a great concern of all purposes Wright et al. 2004, Furi et al. (2011), Kanyerere et al. (2012), Sunkari and Danladi (2016), Raj and Shaji (2017), Rashed and Niyazi (2017). Natural processes and developing in

human activities that release harmful chemicals pose a great threat to the groundwater quality. One of these released chemical constituents is fluoride Sreedevi et al. (2006), Jabal et al. (2014). Fluoride content in groundwater is very importance and must be determined due to its health-related concern. Because, in lower concentrations below 1.5 mg/L (World Health Organization) has effect against dental caries and promotes bone development Apambire et al. (1997), Alfredo et al. (2014) and more than 50% of developed countries fluoridate their water below this level Alfredo et al. (2014). While, at levels greater than 1.5 mg/L, fluoride can cause negative health effects on the teeth through incorporation into growing enamel crystals Aoba and Fejerskov (2002). There are many factors may contributory to the elevated levels of fluoride in groundwater such as variations in regional geology, rock weathering, mineralogy of watersheds and aquifers, water–rock and water–soil interactions Islam et al. (2017). Fluoride level in the human body is increasing according to the increasing of the concentration of fluoride in water Topitsoglou et al. (1995). Thus, drinking water is exactly the largest single contributor to daily fluoride intake Murray et al. (1991). Although fluoride is widely promoted for the prevention of dental caries, its overconsumption in infancy may lead to dental fluorosis and other adverse effects Topitsoglou et al. (1995), Burgstahler (2006). Based on some studies, there are several health effects are associated with fluoride ingestion, these health effects ranging from nausea to neurotoxic effects to death Mullins et al. (1998), Vogt et al. (1982). CDC recommended that a careful monitoring and control of F intake levels in order to avoid overexposure (CDC 2001). Fluoride is one of chemicals that has been known to appear significant effects in individuals through consumption of drinking-water WHO, World Health Organization. (2010), Fawell et al. (2013). It could enter the human body through deferent ways like the ingestion of food, drinking water, inhalation, and dermal contact. While, drinking water is the most important exposure mechanism of fluoride, whereas act 75–90% of fluoride intake Fawell et al. (2013), Kloos and Haimanot (1999). Fluoride in low concentrations in drinking-water, has beneficial effects on teeth development and progress, but in high levels exceed or greater than the WHO guideline value of 1.5 mg/l), can causes a number of adverse effects Malago et al. (2017), Fomon et al. (2000), Petersen and been reported a high prevalence of dental fluorosis among communities that consume drinking water content on high fluoride levels Malago et al. (2017), Dey and Giri (2016), Dessalegne and Zewge (2013). Fluoride enters into water sources from natural resources, or artificial ways such as extraction of aluminum, mining, pottery, making of ceramics, bricks, breakdown of rocks and soils or weathering and deposition of atmospheric particles and manure Islam et al. (2010), Mesdaghinia et al. (2010), Faraji et al. (2014), Maleki et al. (2015), Mohammadi et al. (2017). Several epidemiological studies have been demonstrated that uptake of fluoride in drinking water for long period of time leads to occurrence of adverse effects on the human skeletal tissue. So, the World Health Organization (WHO) has suggested the minimal concentration of 1.5mg/L WHO 'world health organization' (1993), Shanthi et al. (2014), Phipps et al. (1998). Exposure to excessive amount of fluoride over a long time may lead to bone fractures, pain and tenderness in adults, and increased chance of developing pits in the tooth enamel in children aged 8 years and younger (EPA, 2012). Higher concentration of fluoride in drinking water is also linked with cancer Navneet (2010).

1.1. WATER QUALITY INDEX

Water quality Index (WQI) is a technique that provides the composite influence of individual water quality parameters on the overall quality of water. It reduces the large amount of water quality data to a single numerical value, understandable and useable by the general people Vasanthavigar et al. (2010), Islam et al. (2010).

1.1.1. CALCULATION OF WATER QUALITY INDEX

Water quality index is calculated by the following equation

Water quality index [WQI] = QiWi

Where, Qi is water quality rating

Qi = 100*[Va-Vi]/[Vs-Vi]

Va = Actual value of the parameters present in water sample

Vs = Standard value

Vi = ideal value

Wi = K/Sn, Where Wi = Unit weightage

K[constant] = 1/[(1/S1) + (1/S2) + (1/S3) + …. + (1/Sn) Maruthi Devi et al. (2011).

Then WQI has been categorized into five classes according to arithmetic method in the following:

Range 0-25 excellent, 26-50 good, 51-75 poor, 76-100 very poor and above 100 unfit for drinking purposes Maruthi Devi, et al. (2011).

2. MATERIALS AND METHODS

2.1. STUDY DESIGN

A descriptive analytic study

2.2. STUDY AREA

Shendi Town is well known historically, and it is the third largest Town in River Nile State. It is in River Nile State, where the Headquarter of Shendi locality is located.

Shendi is located about 176 km north of Khartoum , and 130 km south of El damer (capital of River Nile State). It is bound by River Nile in the west and Kasala State in the East, also bound by south Shendi administrative unit in the South and Shendi administrative unit in the North. Geographically it lies between line 36 East to 31 West longitudinal and line 19 North to 15 South latitudinal. It is in the arid zone of Sudan with annual rain fall ranging between 0 and 119mm per year. Suleiman (2011). Shendi town has no sewerage system, the population depend on septic tanks, aqua privies, pour flush latrines and traditional pit latrines for disposal of fecal waste and other liquid waste. Shendi town has a distribution system of drinking water; the whole Town depends on ground water as source of drinking.

2.3. STUDY POPULATION

water sources, water supply system and household facilities.

2.4. SAMPLE SIZE DETERMINATION

Sample size was determined based on WHO guidelines; therefore 150 samples were examined according to total of population in study area.

2.5. WATER SAMPLE COLLECTION

Samples of drinking water were collected based on WHO Guidelines for water quality assessment WHO 'world health organization' (1993). The samples were gathered from all ground water sources (wells), distribution system and storage facilities that are used directly for drinking purpose in the community per seasons. Where all procedures and standards have been done well and correctly during all steps of samples collection, storage, and transportation. Samples were tested within 24 hr.

2.6. WATER SAMPLES ANALYSIS

For determination fluoride concentration levels, we sued plaintexts fluoride NO 1 tablets, and NO 2 tablets, plainest automatic wavelength selection photometer and round test tubes 10 ml glass.

2.6.1. FLUORIDE LEVEL TEST (F)

Test was completed according to standard methods for examinations of water as fallowing steps: the test tube was filled with sample to the 10 ml mark as a blank, other test tube was Filled with sample to 10 ml mark and added fluoride NO 1 tablet then crushed & mixed to dissolve, then one fluoride NO 2 tablet was added, crushed and mixed to dissolve, Waited for five minutes to allow full color development, fluoride choice on photometer was selected, photometer reading in usual manner after using the blank sample had been taken and The fluoride result is displayed as Mg/L.

2.7. DATA ANALYSIS

Data were analysed by computer using both Microsoft Excel and Microsoft word, and then the results are presented in percentage tables and other statistical graphs.

3. RESULTS

Table 1

Table 1 Ground Water Samples Analysis for Fluoride Levels in Summer Season

Sampling location	Number of tested samples	Fluoride concentration Mg/L			Percentage %		
		0<1Mg/L	1<1.5Mg/L	>1.5Mg/L	0<1Mg/L	1<1.5Mg/L	>1.5Mg/L
Sources (Wells)	22	15	7	0	68.2	31.8	0

Storage facilities	6	6	0	0	100	0	0
Distribution system	22	18	4	0	81.8	18.2	0
Total	50	46	4	0	92	8	0

The above table shows that 92% of tested samples are indicated fluoride concentration levels ranged **(01> mg/l)** and 8% of them demonstrated that fluoride concentration levels ranged **(1> 1.5 mg/l)**.

Table 2

Table 2 Ground Water Samples Analysis for Fluoride Levels in Autumn Season

Sampling location	Number of tested samples	Fluoride concentration Mg/L			Percentage %		
	s	0<1Mg/L	1<1.5Mg/L	>1.5Mg/L	0<1Mg/L	1<1.5Mg/L	>1.5Mg/L
Sources (Wells)	20	18	2	0	90	10	0
Storage facilities	9	9	0	0	100	0	0
Distribution system	21	19	2	0	90.5	9.5	0
Total	50	46	4	0	92	8	0

The above table shows that 92% of tested samples are indicated fluoride concentration levels ranged **(01> mg/l)** and 8% of them demonstrated that fluoride concentration levels ranged **(1> 1.5 mg/l)**.

Table 3

Table 3 Ground Water Samples Analysis for Fluoride Levels in Winter Season

Sampling location	Number of tested samples	Fluoride concentration Mg/L			Percentage %		
		0<1Mg/L	1<1.5Mg/L	>1.5Mg/L	0<1Mg/L	1<1.5Mg/L	>1.5Mg/L
Sources (Wells)	18	16	2	0	88.9	11.1	0
Storage facilities	9	7	2	0	77.8	22.2	0
Distribution system	23	21	2	0	91.3	8.7	0
Total	50	44	6	0	88	12	0

The above table shows that 88% of tested samples are indicated fluoride concentration levels ranged **(01> mg/l)** and 12% of them demonstrated that fluoride concentration levels ranged **(1> 1.5 mg/l)**.

Table 4

Table 4 Fluoride Range Measurement Over the Seasons Based On WQI

Quality category	Water quality based on F+ content	Summer		Autumn		Winter	
		Samples	%	Samples	%	Samples	%
0-25	excellent	11	22	25	50	31	62
26-50	good	25	50	19	33	12	24
51-75	poor	12	24	5	10	3	6
76-100	Very poor	2	4	1	2	4	8
Above 100	Unfit for drink	0	0	0	0	0	0
Total		50	100	50	100	50	100
General WQI		61.7		33.3		21.7	

The above table 4 shows that water quality is poor (61.7), good (33.3) and excellent (21.7) poor in summer, good in autumn and excellent in winter respectively.

Figure 1

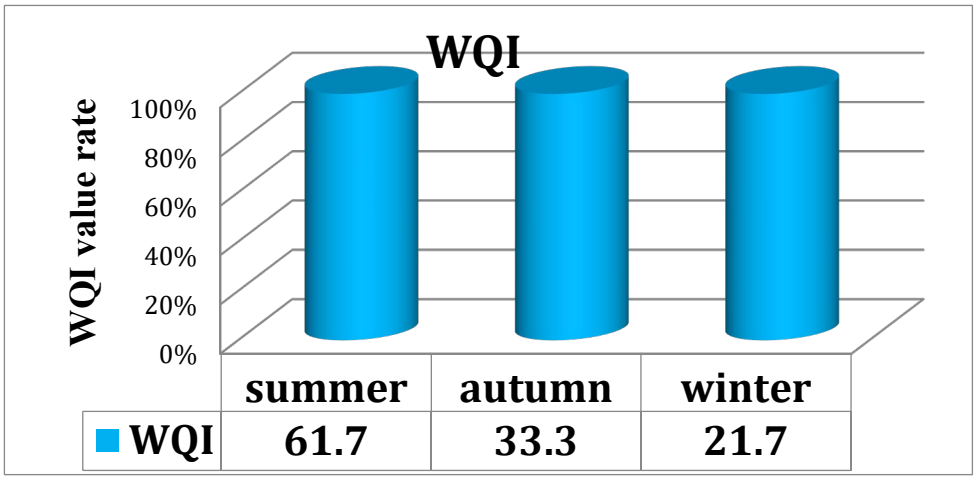

Figure 1 Comparison of Water Quality Index (WQI) Per Seasons

4. DISCUSSION

Our present study revealed that 92% and 8% of examined samples are indicated that concentrations of fluoride in drinking ground water rating between **(01> mg/l)** and (**1> 1.5 mg/l)** respectively in summer and autumn seasons, while in winter season 88% and 12% of tested samples are pointed that concentrations of fluoride ranged between **(01> mg/l)** and (**1> 1.5 mg/l)** respectively. These low concentrations level of fluoride is very beneficial for health of teeth and protection from dental decay. But consumption of ground water with low fluoride contents

over a lifetime may lead to negative effects and causing health problem on teeth, especially when the community in study area depend on ground water as the main source of fluoride, because these concentrations level of fluoride not sufficient to access required amount of fluoride for protection health of community. Where the optimal concentrations level of fluoride beneficial for health of teeth ranged from (1.0 – 1.2 mg/l) according to CDC recommendation. Whereas (CDC) have recommended 1.0 to 1.2 milligrams per liter (mg/L) of fluoride as the optimum beneficial concentration in drinking water for dental protection (DES, 2007). The results of current study agree with previous study conducted by Ramadan and Hilmi (2014), to determine the maximum safe limit for fluoride in potable water in Khartoum state according to climate conditions of the Sudan, they reported that the optimal concentration of fluoride in potable water must be in range 0.32- 0.35 mg/l according to Sudanese conditions.

The present study regarding WQI is pointed that ground water quality based on fluoride concentrations, quality of water is excellent, good, and poor in winter, autumn, and summer respectively. According to WQI value we observed that there is effect of climate conditions on fluoride concentrations therefor variations in ground water quality had been found from season to another, also temperature may have effect on solubility and concentrations of fluoride. The results of present study showed that low of fluoride concentrations level because majority of tested samples are indicated 1> mg/l fluoride content and other of them showed nil fluoride, these results are below permissible concentration that recommended by WHO and SSMO showed (1.5 mg/l). So according to these results, dental decay and some negative health effects in next generations may be occurring if completely depending on drinking ground water as the main source of fluoride.

5. CONCLUSION

According to the findings of this study we summarized that the ground water in study area has low fluoride concentrations level and seasonal variations have effects on fluoride solubility and content.

6. RECOMMENDATIONS

Groundwater is a main source for drinking and domestic purposes in study area. So based on the findings of this study we recommend that: community must not depend totally on ground water as main source for fluoride, and community in study area should be use other sources for fluoride intake to obtain on daily required amount of fluoride for protection the health.

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