ORIGINAL RESEARCH PAPER
Volume-6 | Issue-11 | November-2017 | ISSN No 2277 - 8179 | IF : 4.176 | IC Value : 78.46
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

FLUORIDE IN EAST NILE DRINKING WATER SOURCES KHARTOUM STATE, SUDAN

Environmental Science

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ABSTRACT

The study was conducted in 2014 in the Eastern Nile area, and aimed to assess fluoride in drinking water sources. In this study experimental method was used to determine concentration of fluoride in drinking water sources in dry and wet season. The sources of drinking water were 281 sources the beneficiaries of that about 868,147 population. The sample size was determined according to WHO recommendations. That minimum Numbers for piped drinking water according to the population served, Total number of samples for laboratory analysis are 97 samples spectrophotometer was used to test fluoride in water, and the results were analyzed by using. SPSS Version 20. The Fluoride in drinking water according to WHO guidelines and SSMO standard should not exceed than 1.5 mg/l where the results gave that 7 out of 97 sources exceed than the permissible level in the dry season and 8 out of 97 sources in the wet season. The study observed that all sources with excessive levels of fluoride in specific area. So that the study recommended that this area should be provided with water supply from Blue Nile, and these sources provided with aerators to remove fluoride.

KEYWORDS

Introduction

Fluoride is a halogen, defined as corrosive, pale greenish-yellow gaseous chemical element, the most reactive nonmetallic element known, forming fluorides with almost all the known elements, organic and inorganic: symbol F; atomic weight = 18.998; atomic no. 9; density 1.696; valence 1.

Human health effects

Fluoride has beneficial effects on teeth at low concentrations in drinking-water, but excessive exposure to fluoride in drinking-water, or in combination with. Exposure to fluoride from other sources, can give rise to a number of adverse effects. These range from mild dental fluorosis to crippling skeletal fluorosis as the level and period of exposure increases. Crippling skeletal fluorosis is a significant cause of morbidity in a number of regions of the world. Both national and international groups (USNRC, 1993; IPCS, 2002) have comprehensively reviewed available data on the metabolism and health effects of fluoride in both laboratory animals and humans. The following is a summary of the conclusions that have been developed by these groups, particularly the IPCS working group on fluorides held in May 2001 (IPCS, 2002). The reader is directed to these documents for a more detailed assessment of the data.

Medium and long-term exposure:

A number of sub-chronic and chronic studies have been carried out in laboratory animals in which relatively high doses of soluble fluoride were given in drinking-water. In some studies there is uncertainty regarding the actual dose because commercial laboratory animal rations contain variable amounts of fluoride. Dental fluorosis and a range of effects on bone were noted in several studies. A number of other adverse effects have also been reported, including increased hepatic cell size, nephrosis, myocardial mineralization and degeneration of the Seminipherous tubules in the testis in mice (IPCS, 2002).

Mutagenicity and related end-points:

A large number of mutagenicity studies have been conducted with inorganic fluoride ion. This includes studies in bacteria, insects, laboratory animals and *in vitro* studies with human cells. The results have been mixed, but, in general, fluoride is not mutagenic in prokaryotes. There have been a number of positive. Results in a variety of mammalian cell types of chromosome damage (USNRC, 1993; WHO, 1996; IPCS, 2002). It is generally considered that these effects are due to interference with protein synthesis rather than any direct interaction between fluoride and DNA. Although some cytogenetic damage or changes in sperm cell morphology have been reported in rodents following intraperitoneal injection of fluoride, most studies by the oral route are negative (IPCS, 2002). In commenting on these studies, particularly those in human cells, WHO (1996) has Concluded that the data are probably of limited relevance for humans.

Carcinogenicity:

In 1987, the International Agency for Research on Cancer (IARC) reviewed the available data concerning the carcinogenicity of fluoride and concluded that there Was inadequate evidence of carcinogenicity in experimental animals (IARC, 1987). Two separate sets of long-term fluoride carcinogenicity studies in rats and mice have been published in the 1990s (NTP, 1990; Bucher *et al*., 1991; Maurer *et al*., 1990, 1993). These studies have been extensively reviewed with the general Conclusion that they do not provide adequate evidence to conclude that fluoride is Carcinogenic (USNRC, 1993; WHO, 1996; IPCS, 2002).

Developmental and reproductive toxicity

Effects on the morphology of reproductive organs and reproductive function have been reported in male and female rabbits and mice given doses of greater than 4.5 mg kg–1 body weight per day for varying periods, either orally or by injection. However, in recent studies in laboratory animals, no effects have been observed on reproduction, reproductive organs or the development of the fetus (IPCS, 2002).

Effects on humans:

A number of studies have reported on the acute effects of fluoride exposure following fluoridation overdosing. However, the effects of long-term exposure to naturally occurring fluoride from drinking-water and other environmental sources is the major concern with regard to human health. A large number of epidemiological studies have been conducted in many countries concerning the effects of long-term exposure to fluoride.

Effects on teeth:

The benefits and the detrimental effects of fluoride naturally present in water were well established by the early 1940s. High levels of fluoride present in concentrations up to 10 mg l–1 were associated with dental fluorosis (yellowish or brownish striations or mottling of the enamel) while low levels of fluoride, less than 0.1 mg l–1, were associated with high levels of dental decay (Edmunds and Smedley, 1996), although poor nutritional status is also an important contributory factor. Concentrations in drinking-water of about 1 mg l–1 are associated with a Lower incidence of dental caries, particularly in children, whereas excess intake of fluoride can result in dental fluorosis. In severe cases this can result in erosion of enamel. The margin between the beneficial

effects of fluoride and the occurrence of dental fluorosis is small and public health programs seek to retain a Suitable balance between the two (IPCS, 2002).

Skeletal effects:

Endemic skeletal fluorosis is well documented and is known to occur with a range of severity in several parts of the world, including India, China and northern, eastern, central and southern Africa. It is primarily associated with the consumption of drinking-water containing elevated levels of fluoride, but exposure to additional sources of fluoride, such as high fluoride coal is also potentially very important. This is compounded by a number of factors which include climate, related to water consumption, nutritional status and diet, including additional sources of fluoride and exposure to other substances that modify the absorption of fluoride into the body. Crippling skeletal fluorosis, which is associated with the highest levels of exposure, can result from osteosclerosis, ligaments and tendinous calcification and extreme bone deformity. Evidence from occupational exposure also indicates that exposure to elevated concentrations of fluoride in the air may also be a cause of skeletal fluorosis (IPCS, 2002).

Cancer:

Studies of occupationally exposed populations, primarily from aluminum smelting, have reported an increased incidence of, and mortality from, lung and bladder cancer and from cancers in other sites. However, the data are inconsistent and in a number of studies the results can be more readily attributed to exposure to other substances than fluoride. There have also been a significant number of epidemiological studies examining the possible association between various cancers and exposure to fluoride in drinking-water. However, in spite of the large number of studies conducted in a number of countries, there is no consistent evidence to demonstrate any association between the consumption of controlled fluoridated drinking-water and either morbidity or mortality from cancer (USPHS, 1991; USNRC, 1993; WHO, 1996; IPCS, 2002).

Other possible health effects:

A number of epidemiological studies have been carried out to examine other possible adverse outcomes as a consequence of exposure to fluoride, either from drinking-water or as a consequence of the occupation. Studies on the association between exposure of mothers to fluoride in drinking-water and adverse pregnancy outcome have shown no increased risk of either spontaneous abortion or congenital malformations. No reasonable evidence of effects on the respiratory, haematopoietic, hepatic or renal systems has emerged from studies of occupationally exposed populations. That could be attributed specifically to fluoride exposure. In addition, such studies have failed to produce convincing evidence of genotoxic effects.The majority of fluoride is excreted via the kidneys (USNRC, 1993). Thus, it is reasonable that those with impaired renal function might be at greater risk of fluoride toxicity than those without. In discussing this point, WHO (1996). Concluded that the data were too limited to permit any quantitative evaluation of possible increased sensitivity due to impaired kidney function.

Acute effects:

A number of overdosing incidents have occurred, mostly in small water supplies, that practice artificial fluoridation. With well designed fail-safe equipment and working practices overdosing incidents can be avoided (Leland *et al*., 1980). Where incidents of acute intoxication have been reported following overdosing in water supplies, fluoride levels have ranged from 30–1,000 mg l–1 (Peterson, 1988). To produce signs of acute fluoride intoxication, it is estimated that minimum oral doses of at least 1 mg fluoride per kg of body weight are required (WHO, 1996). Indeed, such doses could be expected from water with a fluoride content of approximately 30 mg l–1. Guideline value 1.5 mg/l (1500 µg/l)

The objectives

- To assess the concentration of fluoride in drinking water.
- To determine the variation of concentration between dry and wet seasons

The methodology

An experimental study was used to determine the concentration of fluoride.

The sample size determination

The number of sample size that was taken for chemical analysis was determined according to WHO recommendations. That minimum number of piped drinking water according to the population served as shown by **Table** (1): Numbers of samples a total number of samples for laboratory analysis are 97 samples

No of sample	Population served
<5000	1 sample
5000- 100,000	1 sample per 5,000 population
>100000	1 sample per 10000 populations plus 10 additional samples.

Sampling Methods from Taps for Lab Analysis:

- Clean the tap : remove from the tap any attachment that may cause splashing
- Open the tap: turn on the tap at maximum flow and let the water run for
- 1-2 minutes
- Sterilize the tap: sterilize the tap for a minute with the flame.
- Open the tap before sampling: turn on the tap and allow the water to flow for 1-2 minutes at the medium flow rate.
- Firstly sample for physiochemical test was taken after washing container of the same water.
- After that sample for microbial test was taken care in sterilized bottles-
- Fill the bottle and cover it
- A small air should be left
- Attached the label to the container.

The samples were kept properly and transferred to the laboratory for test.

Data Analysis:

The data was statistically analyzed by using computer software, statistical package for social science (SPSS) program Version 20, ArcGIS 10.2 software was used to develop lithology maps for the study area.

The results: Table (1) Fluoride results in dry season in East Nile area 2014

No	Area	Fluoride in dry season
1.	Wad dafeia	1.31
2.	Wad dafeia shar	0.45
3.	Alshigla shimal	0.4
4.	alsafaB4	0.39
5.	Altakaml B1	0.44
6.	Soog alwihda	0.37
7.	Albaraka elraisia	0.94
8.	alfiehaa	0.00
9.	Algadesiea B2	0.00
10.	Algref karkoj	0.00
11.	Algaf karkoj almagabr	0.00
12.	Umm dom	0.00
13.	Hai alnasr B1	0.00
14.	Dar alsalmB3	0.00
15.	Dar alsalmB35	0.00
16.	Dar alsalmB5 shimal	0.00
17.	Dar alsalmB8 hreka	0.00
18.	Altelal B algadeeda	0.00
19.	Dar alsalmB1	0.00
20.	Dar alsalmB	0.00
21.	Dar alsalmB11	0.00
22.	Ishlag police	0.00
23.	Alffihaa B1	0.00
24.	Wad elhaj	0.00
25.	Community draining water supply rural area Alkriab	0.00
26.	Mrbee alshreif shiml	0.00
27.	Mrbee alshreif sharq	0.00
28.	Soba alginiaab sharq	0.00
29.	Soba altwerab	0.00
30.	Alaelafoon almareekh	0.00
31.	Alaelafoon alistad	0.00
32.	Alhedaba	0.00
33.	alshrage	0.00
34.	Umm takaly	0.00

35.	Alhawela	0.00
36.	Umdwanban almashtal	0.00
37.	Umdwanban wast	0.00
38.	Umdwanban alhasania	0.00
39.	Umdwanban alseadab	0.00
40.	Umdwanban alsamra	0.00
41.	Alisalat algwaze	0.00
42.	Alisalat algwad bakhet	0.00
43.	Alisalat algalabat	0.00
44.	Alisalat alhusonab	0.00
45.	aldoma	0.00
46.	Aldibaba	0.00
47.	Alhufra umdawanban	0.00
48.	Alhufra shiml	0.00
49.	Ram alla	0.00
50.	Alshgla alrado	0.00
51.	idbabikerB5 altaweedat	0.00
52.	idbabikerB2 altaweedat	0.00
53.	alalojab	0.00
54.	Alradab sharq	0.00
55.	Idbabiker wast	0.00
56.	Haj alnoor	0.00
57.	Idbabiker aljliab	0.00
58.	Idbabiker shimal	0.00
59.	algar	0.00
60.	alrahmab	0.00
61.	Alrehan alnorab	0.00
62.	altukonab	0.00
63.	Umm alia	0.00
64.	Aldalaga shariq	0.00
65.	alshbala	0.00
66.	Aljadiab sharq	0.00
67.	Aljadiab garb	0.00
68.	alhor	0.00
69.	Alshahk alameen	0.00
70.	Um kitra	0.00
71.	alzalamzb	0.00
72.	Algrembab wast	0.00
73.	alfadnia	0.00
74.	Alfadnia janob sharq	0.00
75.	Alfadnia alzanab	0.00
76.	alsamra	0.00
77.	Alhujaj south	0.54
78.	Alhujaj shimal	0.45
79.	id um dom	0.00
80.	Setra fareeg idreis	0.00
81.	Setra fareeg wast	0.00
82.	Alshegla hai alsalam	0.00
83.	Alshegla abo algasim	0.00
84.	Goz wad altahr	0.00
85.	Abo safiha	0.00
86.	almetamr	0.00
87.	Abo dlage	0.00
88.	Wad abo salih sharq	0.00
89.	alirageib	0.00
90.	Mahaliat wadi soba	0.00
91.	Alfaki abo algasim	0.00
92.	Dar alsalam almadars	0.00
93.	Hafeer goz wad altahr	0.00
94.	Hafeer almetmir janob	0.00
95.	Hafeer Abo sefaha	0.00

Table (2) Fluoride results in rainy season in East Nile area 2014

No	Area	Fluoride in rainy season
1.	Wad dafeia	0.06
2.	Wad dafeia shar	0.27
3.	Alshigla shimal	0.08
4.	alsafaB4	0.41
5.	Altakaml B1	0.02
6.	Soog alwihda	0.05
7.	Albaraka elraisia	0.07
8.	alfiehaa	0.25
9.	Algadesiea B2	0.01
10.	Algref karkoj	0.34
11.	Algaf karkoj almagabr	0.04
12.	Umm dom	0.13
13.	Hai alnasr B1	0.25
14.	Dar alsalmB3	0.53
15.	Dar alsalmB35	0.7
16.	Dar alsalmB5 shimal	0.29
17.	Dar alsalmB8 hreka	0.29
18.	Altelal B algadeeda	0.35
19.	Dar alsalmB1	0.11
20.	Dar alsalmB	0.00
21.	Dar alsalmB11	0.00
22.	Ishlag police	0.32
23.	Alffihaa B1	0.00
24.	Wad elhaj	0.00
25.	Community draining water supply rural area alkriab	1.96
26.	Mrbee alshreif shiml	0.39
27.	Mrbee alshreif sharq	0.45
28.	Soba alginiaab sharq	0.48
29.	Soba altwerab	0.69
30.	Alaelafoon almareekh	1.91
31.	Alaelafoon alistad	1.59
32.	Alhedaba	0.5
33.	alshrage	0.1
34.	Umm takaly	0.94
35.	Alhawela	0.53
36.	Umdwanban almashtal	2
37.	Umdwanban wast	1.44
38.	Umdwanban alhasania	0.37
39.	Umdwanban alseadab	1.17
40.	Umdwanban alsamra	1.08
41.	Alisalat algwaze	0.75
42.	Alisalat algwad bakhet	0.32
43.	Alisalat algalabat	1.24
44.	Alisalat alhusonab	0.53
45.	aldoma	0.82
46.	Aldibaba	1.08
47.	Alhufra umdawanban	0.00
48.	Alhufra shiml	0.75
49.	Ram alla	1.66
50.	Alshgla alrado	124
51.	idbabikerB5 altaweedat	1.32
52.	idbabikerB2 altaweedat	0.13
53.	alalojab	0.37
54.	Alradab sharq	0.1
55.	Idbabiker wast	0.37
56.	Haj alnoor	0.41
57.	Idbabiker aljliab	0.27
58.	Idbabiker shimal	0.24
59.	algar	0.31
60.	alrahmab	0.1
61.	Alrehan alnorab	1.59
62.	altukonab	0.54
63.	Umm alia	0.00
64.	Aldalaga shariq	0.36
65.	alshbala	0.00
66.	Aljadiab sharq	0.48
67.	Aljadiab garb	0.51
68.	alhor	1.82
69.	Alshahk alameen	0.00
70.	Um kitra	1.14
71.	alzalamzb	0.00
72.	Algrembab wast	0.2
73.	alfadnia	1.22
74.	Alfadnia janob sharq	2.1
75.	Alfadnia alzanab	0.68
76.	alsamra	0.4
77.	Alhujaj south	0.54
78.	Alhujaj shimal	0.96
79.	id um dom	0.21
80.	Setra fareeg idreis	0.96
81.	Setra fareeg wast	1.16

82.	Alshegla hai alsalam	0.7
83.	Alshegla abo algasim	0.75
84.	Goz wad altahr	0.53
85.	Abo safiha	0.00
86.	almetamr	0.00
87.	Abo dlage	1.53
88.	Wad abo salih sharq	0.53
89.	alirageib	0.00
90.	Mahaliat wadi soba	0.00
91.	Alfaki abo algasim	1.93
92.	Dar alsalam almadars	0.11
93.	Hafeer goz wad altahr	0.00
94.	Hafeer almetmir janob	0.26
95.	Hafeer Abo sefaha	0.27

Table (3) Comparison between fluoride results in dry season and wet season in East Nile area 2014

No	Area	Fluoride in dry season	Fluoride in rainy season
1.	Wad dafeia	1.31	0.06
2.	Wad dafeia shar	0.45	0.27
3.	Alshigla shimal	0.4	0.08
4.	alsafaB4	0.39	0.41
5.	Altakaml B1	0.44	0.02
6.	Soog alwihda	0.37	0.05
7.	Albaraka elraisia	0.94	0.07
8.	alfiehaa	0.00	0.25
9.	Algadesiea B2	0.00	0.01
10.	Algref karkoj	0.00	0.34
11.	Algaf karkoj almagabr	0.00	0.04
12.	Umm dom	0.00	0.13
13.	Hai alnasr B1	0.00	0.25
14.	Dar alsalmB3	0.00	0.53
15.	Dar alsalmB35	0.00	0.7
16.	Dar alsalmB5 shimal	0.00	0.29
17.	Dar alsalmB8 hreka	0.00	0.29
18.	Altelal B algadeeda	0.00	0.35
19.	Dar alsalmB1	0.00	0.11
20.	Dar alsalmB	0.00	0.00
21.	Dar alsalmB11	0.00	0.00
22.	Ishlag police	0.00	0.32
23.	Alffihaa B1	0.00	0.00
24.	Wad elhaj	0.00	0.00
25.	Community draining water supply rural area Alkriab	0.00	1.96
26.	Mrbee alshreif shiml	0.00	0.39
27.	Mrbee alshreif sharq	0.00	0.45
28.	Soba alginiaab sharq	0.00	0.48
29.	Soba altwerab	0.00	0.69
30.	Alaelafoon almareekh	0.00	1.91
31.	Alaelafoon alistad	0.00	1.59
32.	Alhedaba	0.00	0.5
33.	alshrage	0.00	0.1
34.	Umm takaly	0.00	0.94
35.	Alhawela	0.00	0.53
36.	Umdwanban almashtal	0.00	2
37.	Umdwanban wast	0.00	1.44
38.	Umdwanban alhasania	0.00	0.37
39.	Umdwanban alseadab	0.00	1.17
40.	Umdwanban alsamra	0.00	1.08
41.	Alisalat algwaze	0.00	0.75
42.	Alisalat algwad bakhet	0.00	0.32
43.	Alisalat algalabat	0.00	1.24
44.	Alisalat alhusonab	0.00	0.53
45.	aldoma	0.00	0.82
46.	Aldibaba	0.00	1.08
47.	Alhufra umdawanban	0.00	0.00
48.	Alhufra shiml	0.00	0.75
49.	Ram alla	0.00	1.66
50.	Alshgla alrado	0.00	124
51.	idbabikerB5 altaweedat	0.00	1.32
52.	idbabikerB2 altaweedat	0.00	0.13
53.	alalojab	0.00	0.37
54.	Alradab sharq	0.00	0.1
55.	Idbabiker wast	0.00	0.37
56.	Haj alnoor	0.00	0.41
57.	Idbabiker aljliab	0.00	0.27
58.	Idbabiker shimal	0.00	0.24
59.	algar	0.00	0.31
60.	alrahmab	0.00	0.1
61.	Alrehan alnorab	0.00	1.59
62.	altukonab	0.00	0.54
63.	Umm alia	0.00	0.00
64.	Aldalaga shariq	0.00	0.36
65.	alshbala	0.00	0.00
66.	Aljadiab sharq	0.00	0.48
67.	Aljadiab garb	0.00	0.51
68.	alhor	0.00	1.82
69.	Alshahk alameen	0.00	0.00
70.	Um kitra	0.00	1.14
71.	alzalamzb	0.00	0.00
72.	Algrembab wast	0.00	0.2
73.	alfadnia	0.00	1.22
74.	Alfadnia janob sharq	0.00	2.1
75.	Alfadnia alzanab	0.00	0.68
76.	alsamra	0.00	0.4
77.	Alhujaj south	0.54	0.54
78.	Alhujaj shimal	0.45	0.96
79.	id um dom	0.00	0.21
80.	Setra fareeg idreis	0.00	0.96
81.	Setra fareeg wast	0.00	1.16
82.	Alshegla hai alsalam	0.00	0.7
83.	Alshegla abo algasim	0.00	0.75
84.	Goz wad altahr	0.00	0.53
85.	Abo safiha	0.00	0.00
86.	almetamr	0.00	0.00
87.	Abo dlage	0.00	1.53
88.	Wad abo salih sharq	0.00	0.53
89.	alirageib	0.00	0.00
90.	Mahaliat wadi soba	0.00	0.00
91.	Alfaki abo algasim	0.00	1.93
92.	Dar alsalam almadars	0.00	0.11
93.	Hafeer goz wad altahr	0.00	0.00
94.	Hafeer almetmir janob	0.00	0.26
95.	Hafeer Abo sefaha	0.00	0.27

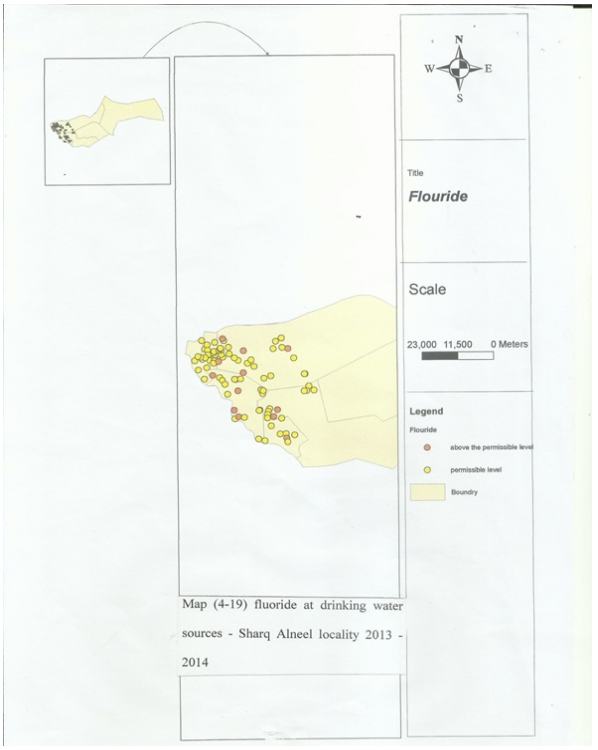
T-Test Table (4) Comparison between Fluoride results in dry and wet season on drinking water as sources – East Nile 2014

Group Statistics					
Fluoride in seasons	The season	N	Mean	Std. Deviation	Std. Error Mean
	Dry	97	.5284	.35710	.03626
	Wet	97	.7871	1.28047	.13001

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Fluoride in seasons	**Equal variances assumed**	8.831	.003	-1.916	192	.057	-.25867	.13497	-.52489	.00755
	Equal variances not assumed			-1.916	110.843	.058	-.25867	.13497	-.52613	.00879

Map of Fluoride at drinking water sources – Sharq Alneel Locality 2013 – 2014



Map (4-19) fluoride at drinking water sources - Sharq Alneel locality 2013 - 2014

Discussion:

The Fluoride in drinking water according to WHO guidelines and SSMO standard should not exceed than 1.5 mg/l where the results gave that 7 out of 97 sources exceed than the permissible level in the dry season and 8 out of 97 sources in the wet season. The P-value of seasonal variation is .003. So that, there is no different results between dry and wet seasons.

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