



## Colorimetric and Potentiometric Determination of Fluoride Content in Kamleen Groundwater

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### ABSTRACT

Samples of groundwater were randomly collected from twenty eight different areas around central Kamleen locality during the summer season from May to August 2011. The fluoride content in these samples was colorimetrically and potentiometrically determined. The results obtained showed that the contents of fluoride ranged from 0.01 to 1.89 ppm. The fluoride level of groundwater of five areas of Kamleen locality did not conform with the maximum permissible limit of 1.5 ppm; Fadoul (1.69 ppm), Eltakala Abashar (1.63 ppm), Eltorabi Elgadida (1.89 ppm), Elkasabmar (1.51 ppm) and Eltakala Rofaa (1.55 ppm).

### المستخلص

تم جمع عينات من المصادر الجوفية بطريقة عشوائية من ثماني وعشرين منطقة مختلفه من انحاء ووسط محلية الكاملين خلال فصل الصيف في الفترة من مايو الى اغسطس للعام 2011 م. وقد تم استخدام طرق الاقطاب انتقائية الأيون والمطيافية الونية لتعيين محتوى الفلوريد في هذه العينات وقد اوضحت النتائج ان محتوى الفلوريد يقع في المدى من 0.01 الي 1.89 جزء من المليون . وجد ان هنالك خمس مناطق قد تجاوزت الحد المسموح به عالميا لايون الفلوريد (1.5 جزء من المليون) وهي فضل (1.66 جزء من المليون), التكلة أب شُر (1.63 جزء من المليون), الترابي القديمة (1.89 جزء من المليون), الكسمبر (1.51 جزء من المليون) بالإضافة الى التكلة رفاعة (1.55 جزء من المليون).

**KEYWORDS:** Groundwater, Determination of fluoride.

### INTRODUCTION

Water is one of the most critical needs for human beings; its availability is an important factor for the establishment of any community. People deeply depend on water, not only for their survival but also for numerous functions of the society. The production of adequate and safe drinking water is the most important factor contributing to the decrease in mortality and morbidity rates in developing countries. The World

Health Organization (WHO 2004) reported that nearly half of the population in these countries suffers from health problems associated with lack of water or the presence of microbiologically contaminated drinking water<sup>(1,2)</sup>. In the developing countries more than 60 percent of the populations have no access to pure drinking water<sup>(3)</sup>. Fluoride has a significant mitigating effect against dental caries if the concentration is approximately 1 mg/l. However,

continuing consumption of higher concentrations can cause dental fluorosis and in extreme cases even skeletal fluorosis <sup>(4)</sup>. High fluoride concentrations are especially critical in developing countries, largely because of lack of suitable infrastructure for treatment. Traces of fluorides are present in many waters, with higher concentrations often associated with groundwater <sup>(5)</sup>. It accounts for 0.3g/Kg of the earth crust and exists in the form of fluorides of a number of minerals, such as fluorspar, cryolite. <sup>(6)</sup>. In ground water fluoride concentration varies with the type of rock through which water flows, but it does not usually exceed 10 mg per liter. The guideline value for fluoride in drinking water is 1.5 mg/l (WHO, 2004, 2011). In groundwater, the natural concentration of fluoride depends on the geological, chemical and physical characteristics of the aquifer, the porosity and acidity of the soil and rocks, the action of other chemical elements, and the depth of the aquifer. Fluoride is a common constituent occurring naturally in groundwater. Most Natural sources of fluoride in ground water in naturally occurring forms are the breakdown of rocks soil, weathering, and deposit of atmospheric volcanic particle <sup>(7)</sup>. The solubility of fluoride increases with increasing temperature and fluoride may be added by dissolution of HF gas (8.9).

-The main objectives of this research work are:

1-To determine the concentration of fluoride that polluted underground of different areas of Kamleen locality

3- To ascertain the compliance of Kamleen drinking groundwater with international standard of drinking water.

## MATERIALS and METHODS

### Colorimetric determination of fluoride content

-Total of 28 groundwater samples from ground water of Kamleen area were randomly collected from different localities of Kamleen, particularly at the center, over a period of three months during the summer season (from May to August) of the year 2011. All samples were collected in 1000-cm<sup>3</sup> polythene bottles.

-A series of standard solutions of fluoride; 0.00, 0.5, 1.00, 1.5 and 2.00 ppm were prepared.

- SPADN (Zirconium alizarin lake red (A.R, UK))

### Procedure

The standard method for determination of fluoride was essentially followed. Spectrophotometer model HACH 5000 DR Origin -HACH-US was used for absorbance measurements. The maximum absorbance of 580 nm was automatically selected. 10-cm<sup>3</sup> each of standard solutions and groundwater samples was taken. 2-cm<sup>3</sup> of SPADN reagent was added, stirred for 1 minute and the absorbance was measured against blank solution. Table (1) shows the absorptiometric data. Figure (1) calibration curve and Table (2) the fluoride content of Kamleen water samples.

Table 1: Fluoride absorptiometric calibration data

Standard	Concentration (ppm)	Absorbance
1	0.00	0.000
2	0.50	0.258
3	1.00	0.453
4	1.50	0.637
5	2.00	0.852

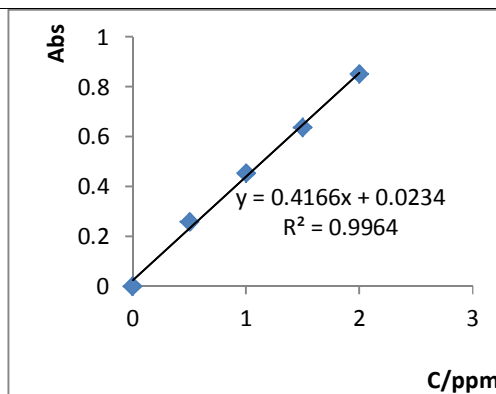


Figure 1: Fluoride absorptiometric calibration curve

Table 2: Fluoride content of Kamleen water samples by colorimetric method

Location	Concentration (ppm)
Fadoul	1.69
Eltikaina Abood	1.12
Elmasoodia	0.01
Elsidaira	0.81
Eltakala Abashar	1.63
Abdelmalik	0.22
Elrayhana Elsigaira	0.29
Elkamleen	0.37
Elmeailig Elshargia	0.32
Eldibaiba Abdallah	0.24
Ellaota	0.88
Kalkol	1.02
Elhilaila	0.92
Elgadeed Elsoug	0.51
Elgadeed 1	0.38
Eldibab	0.51
Elyaban	0.67
Elbagair 2	0.30
Elbagair 1	0.85
Elrayhana Elkabira	0.13
Location	Concentration (ppm)
Elmeailig Elganobia	0.61
Elkasabmar	1.51
Elgaba	0.73
Elgaba	0.73
Eltorabi Elgadima	1.89
Eltakala Rofaa	1.55
Eliedaid	0.68
Elnoba Samah	0.23
Eltorabi Elgadida	1.52

### Potentiometric determination of fluoride content

-A series of standard solutions of fluoride; 0.10, 1.00 and 10.00 ppm were prepared.

-TISAB solution containing:

-In 57-cm<sup>3</sup> of acetic acid (glacial), 58g sodium chloride and 4g of cyclohexane diaminotetra acetic acid (CDTA) were dissolved and mixed in about 500-cm<sup>3</sup> of de-ionized water. 5-cm<sup>3</sup> of NaOH solution was added, stirring continuously till the pH reached 5.5 ± 0.3. The solution was diluted to 1dm<sup>3</sup>.

-50-cm<sup>3</sup> of each 0.10, 1.00 and 10.00 ppm of fluoride standard solutions was

pipetted into 100-cm<sup>3</sup> beaker and 1-cm<sup>3</sup> of TISAB was added by pipette with stirring.

-The electrodes were immersed in the standard solution and potential in mV was measured and recorded in Table (3).

-A calibration curve of electrode potential (mV) against log<sub>10</sub> concentration of fluoride ion in ppm was drawn in Figure (2).

-To 50-cm<sup>3</sup> of water sample, 1 cm<sup>3</sup> of TISAB was added and the fluoride electrode was immersed and the ion-meter was turned on and the reading was recorded (mV) in Table (4)<sup>(10, 11)</sup>.

Table 3: Fluoride electrode calibration data

Solution (ppm)	Log (ppm)	T (°C)	potential (mV)
0.10	-1	28.0	-411.4
1.00	0	29.0	-471.039
10.00	1	28.9	-526.833

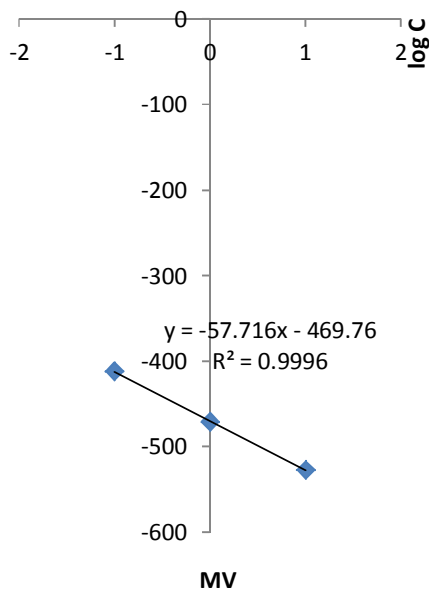


Figure 2 :Fluoride electrode calibration curve

*Table 4: Fluoride concentration in Kamleen water samples by direct potentiometric measurement*

Location	Potential (mV)	T°C	Fluoride con- (ppm)
Fadoul	-481.854	29.3	1.624
Eltikaina Abood	-468.644	30.6	0.958
Elmasoodia	-349.194	29.5	0.008
Elsidaira	-462.735	30.0	0.757
Eltakala Abashar	-481.665	29.5	1.611
Abdelmalik	-431.622	30.0	0.218
Fadoul	-481.854	29.3	1.624
Elrayhana Elsigaira	-430.605	29.5	0.210
Elkamleen	-437.606	28.1	0.278
Elmeailig Elshargia	-434.732	29.5	0.248
Eldibaiba abdallah	-423.804	29.5	0.160
Ellaota	-465.412	28.9	0.842
Kalkol	-467.932	28.5	0.932
Elhilaila	-466.472	27.3	0.879
Elgadeed Elsoug	-451.642	28.5	0.486
Elgadeed 1	-438.71	29.0	0.290
Eldibab	-451.958	30.0	0.492
Elyaban	-453.912	29.0	0.533
Elbagair 2	-430.09	28.5	0.209
Elbagair 1	-464.358	29.6	0.808
Elrayhana Elkabira	-434.928	29.4	0.248
Elmeailig Elganobia	-455.374	29.5	0.564
Elkasabmar	-479.303	29.1	1.466
Elgaba	460.700	28.8	0.698
Eltorabi Elgadima	-485.319	29.5	1.865
Eltakala Rofaa	-478.801	30.0	1.438
Eliedaid	-456.801	28.9	0.597
Elnoba Samah	-426.549	29.0	0.178
Eltorabi Elgadida	-479.818	30.0	1.497

## RESULTS and DISCUSSION

The guideline value of fluoride is 1.5 ppm (WHO 2011) for short term exposure. The highest value of fluoride content appeared in water sample of Eltorabi Elgadima (1.89ppm), while the least, in sample of Elmasoodia (0.01ppm); the mean value of fluoride content was (0.77ppm) with standard deviation of 0.54ppm. The fluoride concentration in Kamleen groundwater samples that were exceeding legal level of WHO (2011) was shown in samples of Fadoul (1.76ppm), Eltakala Abashar (1.63 ppm), Eltorabi Elgadida (1.89 ppm), Elkasabmar (1.51 ppm)

and Eltakala Rofaa (1.55 ppm). The increase of fluoride content might due to hard hydrological formation of Kamleen area. The presence of an area of water recession resulted also in an increase in fluoride level to the extent that it became unfit to animal and human consumption. In addition, some studies indicated also the presence of salt pockets, in the area extending from Soba to Jabel Moya that also had negative effect on the quality of that water. According to WHO (2011) and Sandanello (1971) <sup>(13)</sup> these fluoride contents have significantly high health risks. In comparison, the colorimetric

method gave A higher fluoride content than the potentiometric method. The statistical analysis of the t-test in Table

5 shows that there is no statistical difference between the two methods.

Table 5: Independent samples t-test of fluorid

Independent samples test							
T-test for equality of means							
Anions		t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Fluoride content	Equal variances assumed	-0.389	54	0.699	-0.06	-0.34	0.23

Figure 3 shows the comparison between the means of the potentiometric and colorimetric results.

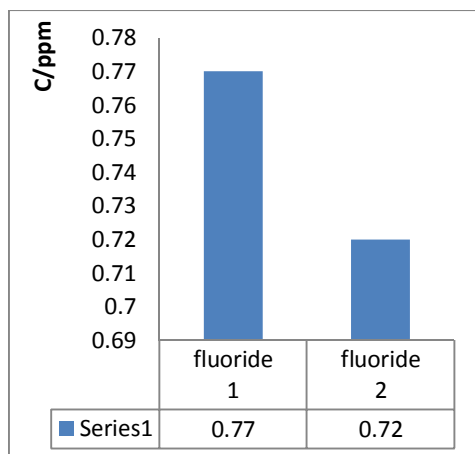


Figure 3: The mean concentration of the fluoride colorimetric results (fluoride1) and potentiometric results (fluoride 2).

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