Research Article

STUDY OF FLUORIDE LEVEL IN THE GROUND WATER OF ALAGILAT CITY, LIBYA: CORRELATION WITH PHYSICOCHEMICAL PARAMETERS

Fathi M. Elmabrok *

Department of Environment and Pollution, Higher Institute Of Water Affairs, Alagilat, Libya

*Corresponding Author Email: fathi96@yahoo.com

Article Received on: 01/08/15 Revised on: 30/08/15 Approved for publication: 14/09/15

DOI: 10.7897/2230-8407.069120

ABSTRACT

Fluoride plays significant role in the human body if it presents between 0.6ppm and 1.5ppm in drinking water but if the concentration is higher than 1.5ppm. It causes dental and skeletal fluorosis. In this study, fluoride levels in ground water samples were collected and analyzed in twenty six villages of Alagilat city, Libya. Sixty five samples were collected in polyethylene plastic bottles and analyzed for fluoride levels with pH, Electrical Conductivity (EC), Calcium (Ca), Magnesium (Mg), Potassium (K), Sulfate (SO_4), sodium (Na), Phosphate (PO_4) and chloride (Cl). Fluoride concentration ranged between 0.8 and 3.2 mg / l with an average of 2.04mg/l. Out of 56 samples above 1.5mgL⁻¹ fluoride (above the recommended value set by the world health organization) is 86.15% and between 0.6 mg/l and 1.5 fluorides is 13.84 %. As per the minimum and maximum permissible limit for fluoride in drinking water, recommended by the WHO, the ground water of the most studied villages is unfit for drinking proposes without prior treatment. From the correlation analysis fluoride was found to be positively correlated with Ca, K, Na, SO_4 , PO_4 , Cl and EC and negatively correlated with Mg and pH.

Keywords: Drinking water, fluoride, Alagilat, Libya, correlation

INTRODUCTION

Water is a vital element for the life and is essential for the health. Libya is situated in the dry zone, and the ground water is considered the major source of drinking water around the country. This source of water has become deteriorated due to different sources of pollution. However, clean drinking water became very scarce and polluted worldwide. Fluoride is considered one of the most dominant elements in the environment. It is found naturally in ground water of different parts of the world. Fluoride is an electronegative element and is never found in the nature in the elemental form. It combines with several elements to form other fluorides. The sources of fluoride in ground water are igneous and sedimentary rocks. Fluorspars, cryolite, fluoroapatite are considered the most common fluoride bearing minerals. Fluorite is the main bearer of fluoride and is found in granite and pegmatite¹⁻⁴. Anthropogenic activities such as burning of coal, manufacturing of aluminum, steel and phosphate fertilizers contain significant amounts of fluoride^{5, 6}. Fluoride was first detected in ground water in Nellore district of Andhra Pradesh India⁷. Fluoride plays an important role in the growth of teeth and reduces dental caries when it presents in optimum levels, high or low concentrations of fluoride in drinking water have caused dental and skeletal fluorosis^{8, 9}. Around 96% of the fluoride is found in bones and teeth. Fluoride also plays an important role in the mineralization of the bones and formation of the dental enamel¹⁰. Fluoride in drinking water has become one of the most health problems around the world, as 200 million people from different countries are subject to dental and skeletal fluorosis.

Many countries, such as China, India, Srilanka, Mexico, Argentina, and many states in Africa, have very high rates of dental and skeletal fluorosis caused by the high levels of fluoride in drinking water^{11, 12}. Fluorosis is widespread in many developed and developing countries such as India, China, United States and Australia¹³. In 1986 fluorosis was reported in 13 of the Indian states, in 1992 it was 15, in 2002 it became 17 and now the effected states exceed to 19, indicating that fluorosis is the most serious problem around the country. Currently,

about 62 million people of which 6 million children are suffering from the disease because of consuming drinking water with high fluoride content¹⁴. Ground water contains high levels of fluoride in many countries of the world, including large parts of Africa, China, the Middle and the Far East, and Asia¹⁵. The recommended limit of fluoride in drinking water, according to the guidelines is up to 1.5 mg/l. higher levels of fluoride in the ground water than the recommended is a major problem worldwide. Fluoride levels in drinking water in different parts of the world are illustrated in table 1. It is assumed that ground water in the western north of Libya contains risky levels of fluoride¹⁶. The aim of this study is to investigate the fluoride concentrations in the ground water in this area.

Table 1: Concentration of Fluoride Found in Deferent parts of the World

No	Concentration (mg /l)		References
	Minimum	Maximum	
1	0.6	5.83	17
2	0.018	5.92	18
3	0.20	2.40	19
4	0.60	1.2	20
5	0.0912	0.2283	21
6	0.78	6.10	22
7	0.02	2.42	23
8	1.17	4.3	24
9	0.14	5.39	25
10	0.73	3.02	26
11	0.80	3.20	present Study

MATERIALS AND METHODS

The study area is situated between the latitude 32° 45' 25" and longitude 12° 22' 34" in the city of Alginat. It is around 85 km from Tripoli and about 4 meters above the sea level (figure 1). The average maximum temperature is about 45°C and minimum 20 °C with an average annual rainfall of 150mm. It has a dry climate with hot

summer. Ground water is considered the main source of water supply. The dominant soils are *entisols* and *aridisols*. Furthermore, the level of fluoride in the ground water of this area has not been measured before. The present study has undertaken to analyze the fluoride content and physic- chemical characters of ground water in the study area.

A total of 65 ground water samples were collected in February 2013 from 26 villages of Alginat city, Libya. The samples were collected from public wells, private wells, water sources in the health centers, and schools. First, the water was left to run for few minutes from the wells to pump out the standing water before taking the final samples. The samples were collected in pre cleaned sterilized polyethylene

plastic bottles of 1L capacity then the samples were placed in clean containers and immediately put in ice boxes. The ice boxes were shipped to Syracuse, Italy where the fluoride was analyzed in the laboratories of Ecocontrol Sod Company. The concentration of fluoride was determined in terms of mg L^{-1} . The standard permissible value of fluoride according to ^{3, 5, 18, 27} are given in table 2. Other physic- chemical parameters were also analyzed such as pH, electrical conductivity (EC), Calcium (Ca), Magnesium (Mg), Potassium (K), Sulfate (SO_4), Phosphate (PO_4), Chloride (Cl), and Calcium bicarbonate ($\text{Ca}(\text{HCO}_3)_2$). All analysis including fluoride were analyzed in the laboratories of Ecocontrol Sod Company, Italy where standard techniques were used (Table 3)

Figure 1 . Location of Alagilat City (The study area)

Table 2: Limits of Fluoride Concentration (mg /l)

Standard	Minimum concentration	Maximum concentration
Libyan standard	1	1.5
European standard	0.7	1.5
WHO 2004	0.7	1.5
APHA	0.7	1.5

Table 3: Standard Methods and Equipments used to analyze the Parameters

Parameter	Test method	Equipment
Ca	EPA 6010C : 2007	ICP-OES***
Mg	EPA 6010C : 2007	ICP-OES
K	EPA 6010C : 2007	ICP-OES
Na	EPA 6010C : 2007	ICP-OES
Cl	UNI EN ISO 10304 – 1 : 2009	IC**
F	UNI EN ISO 10304 – 1 : 2009	IC
PO_4	UNI EN ISO 10304 – 1 : 2009	IC
SO_4	UNI EN ISO 10304 – 1 : 2009	IC
EC	-----	EC-meter model 470*
pH	-----	pH-meter model 370*

***Inductively coupled plasma optical emission spectrometry, **Ion chromatography,* measured in the field

RESULTS AND DISCUSSION

The ground water samples collected from sixty five wells of Alagilat city, Libya Figure 1. All results obtained of the samples were compiled and presented in figures from 2 to 11 parameter wise. Fluoride concentration in this study is depicted in Figure 2. Fluoride concentration in the study area varied from 0.8 to 3.2mg/l with an average of 2.04mg/l. Out of 56 samples above 1.5mg/l fluoride

(above the recommended value set by the world health organization) is 86.15% and between 0.6 mg/l to 1.5 fluorides is 13.84 %.

Fluoride showed positive correlation with sulfate in Figure 12. Phosphate showed positive correlation with fluoride. Correlation coefficient is 0.392 and chloride showed positive correlation with fluoride and the coefficient correlation is 0.315.

The correlation of some selected ions and other elements with fluoride are shown in Figures 11, 12 and 13. The ions of Ca, K and Na showed positive correlation with fluoride levels. The correlation coefficients were 0.579, 0.122, and 0.323 respectively. The positive correlation of fluoride with Ca and K may be due to low solubility of fluorides of these cations²⁷. However, it was reported positive correlation of fluoride with Ca in the ground water. The positive correlation is noticed by those authors may be attributed to the presence of lime stone in those areas²⁸. Fluoride showed positive correlation with sulphate in figure 12. Phosphate showed positive correlation with fluoride and the correlation coefficient is 0.391 and chloride showed positive correlation with fluoride and the correlation coefficient is 0.315. Mg and pH negatively correlated with fluoride and the correlation coefficients are -0.17 and -0.05 respectively Figures 11 and 13.

The pH values varying from 6.9 to 7.7 Figure 3. The permissible limit of pH in drinking water is 6.5 to 8.5 Libyan standards²⁹. Maximum pH value was found in well number 25 and the minimum value was found in sample number 19. The pH of the water samples is alkaline it may be due to high calcite in the study area.

The electrical conductivity varying from 1.32ms/cm at 25°C to 10.68 ms/cm at 25 °C figure 3. All samples showed EC below the permissible limit for drinking water (300mohs) as per Libyan standard²⁹. Maximum value was found in well number 19 which was 10.68 and the minimum one was 1.32 in the well number 39. The electrical conductivity is positively correlated with fluoride and the correlation coefficient is 0.343 Figure 13.

The sulphate concentration is varied from 244 to 2893mg/l Figure 4. The ground water samples analyzed showed higher concentrations of sulfate than the prescribed permissible limits for drinking water. The Libyan permissible limit of sulfate is 400 mg/l. The maximum level of sulfate was recorded at the well number 29 of the study area while

the minimum one 244 mg/l was observed in well number 39. Sulfate showed Strong correlation with Ca and Na and weak positive correlation with K.

The variation of phosphate is shown in Figure 5. The Phosphate concentration is varied from 0.2 to 0.44 mg/l. The maximum level of the phosphate is found in the sample number 19 and the minimum one was 0.2mg/l in the sample number 32.

In the most of the ground water samples the chloride concentration is above the maximum Libyan permissible limit of drinking water (25mg/l). The range of chloride content is varied from 236 to 3443 mg/l. The maximum content was found in the well number 19 and the minimum value was noticed in the well number 22 Figure 6.

The level of calcium varied from 80.80 to 944 mg/l. The highest value of calcium ion was found in the well number 63 and the lowest one was found in the well number 19 Figure 7. The Libyan permissible limit of calcium is 200 mg/l.

The level of Magnesium is from 3.4mg/l to 3040 mg/l. The maximum value was found in sample number 22 and the minimum one was recorded in the sample number 39. All Mg concentrations were above the limit recommended by the Libyan government²⁹.

The variation of potassium is shown in Figure 9. The potassium concentration is varied from 6.3 to 223.6 mg/l. The maximum level of the potassium is found to be 223.6 mg/l in the sample number 9 and the minimum one was 6.3mg/l in the sample number 22. Whereas, sodium ranged between 122.6 and 1678 mg/l the maximum value was noticed in the sample number 19 while the minimum one was found in the sample number 39 Figure 10.

Figure 2: Concentration of fluoride in the water samples (dotted line is the permissible limit)

Figure 3: The levels of EC and pH in the ground water samples

Figure 4: Concentration of SO₄ in the ground water samples

Figure 5: Concentration of PO₄ in the ground water samples

Figure 6: Concentration of Cl in the ground water samples

Figure 7: Concentration of Ca in the ground water samples

Figure 8: Concentration of Mg in the ground water samples

Figure 9: Concentration of K in the ground water samples

Figure 10: Concentration of Na in the ground water samples

Figure 11: Correlation of the cations with fluoride concentration in the ground water samples

Figure 12: Correlation of some anions with fluoride concentration in the ground water samples

Figure 13: Correlation of pH and EC with fluoride concentration in the ground water samples

ACKNOWLEDGEMENT

The author sincerely wishes to thank the Libyan authority for Research, science and Technology for the sponsorship.

REFERENCES

- Deshmukh AN, Shah KC & Sriram A, Coal Ash : A source of Fluoride pollution, A case study of Koradi Thermal Power Station, District Nagpur, Maharashtra. *Gondwana Geological Magazine*, 1995; 9: 21 – 29.
- Farooqi, A., Masuda, H. and Firdous, N, Toxic fluoride and arsenic contaminated ground water in the Lahore and Kasur districts, Punjab, Pakistan and possible contaminant sources. *Environmental pollution*, 2007; 145: 839 – 849. <http://dx.doi.org/10.1016/j.envpol.2006.05.007>
- Kudesia, V.P, *Environmental Chemistry*. Pragati Prakashan, Meerut, 2003; 2nd ed.pp 145 – 148
- Rao S, Fluoride in ground water, Varaha River Basin, Visakhapatnam District, Andhra Pradesh, India. *Environmental Monitoring and Assessment*, 2009; 61(3) 387 – 398 <http://dx.doi.org/10.1023/A:1006165615097>
- Anderson MA, Zelazny LWM & Bertsch PM, Fluoro – complexes on model and soil exchangers. *Crop Science Society of America Journal*, 1991; 55 (1) 71 – 75. <http://dx.doi.org/10.2136/sssaj1991.03615995005500010012x>
- Tailor GS & Chandel CPS, To assess the Quality of Ground Water in Malpura Tehsil (Tonk – Rajasthan, India) with emphasis to fluoride concentration. *Nature and Science*, 2010; 8(11) 20 – 26.
- Short, H. E., G. R., Mc Robert, T.W., Bernard and Mannadinayar, A.S, Endemic fluorosis in the Madras Presidency. *Indian Journal of Medical Research*, 1937; 25, 553 – 561.
- Abdulrahmani, A, Fluoride content in drinking water supplies of Riyadh, Saudi Arabia, *Environmental Monitoring and Assessment*. 1996; 48: 261 – 272
- Jenkins, G.N, *the Physiology and Biochemistry of the Mouth*, Blackwell Science Publications, London, 1978; pp: 466.
- Ceopalan, C, The changing Epidemiology of Malnutrition in Developing Society. *Current Science*, 2003; 77, p.1257
- Edmunds M. & Smedley P, Fluoride in natural waters – occurrence, controls and health aspects. *Essentials of Medical Geology* (ed. O. Selinus, B. Alloway, J.A. Centeno, R.B. Finkelman, R. Fuge, U. Lindh & P. Smedley) pp. 301 – 329. Elsevier, Amsterdam, 2010; the Netherlands
- Chandrajith R., Abeyapala U., Dissanayake C.B. & Tobschall H.J, Fluoride in Ceylon tea and its implications to dental health. *Environmental Geochemistry and Health*, 2007; 20: 429 – 434 <http://dx.doi.org/10.1007/s10653-007-9087-z>
- Grimaldo, M., V.H. Borja – Aburto, A.L. Ramirez, M. Ponce, M. Rosas and F. Diaz – Barrige, Endemic fluorosis in San Luis Potosi, Mexico. *Environmental Res.*, 1995; 68: 25 - 30. <http://dx.doi.org/10.1006/enrs.1995.1004>
- Raju N, Dey S & Das K, Fluoride contamination in ground waters of Sonbhadra District, Uttar Pradesh, India. *Current Science*, 2009; 96(7) 979 – 985.
- Apambire, W.B., Boyle, D.R. and Michel, F.A, Geochemistry, genesis, and health implications of fluoriferous ground water in the upper regions of Ghana. *Environmental Geology*, 1997; 33, 13 – 24. <http://dx.doi.org/10.1007/s002540050221>
- Geological Map of the World at 1: 25. 000.000, Commission for the Geological Map of the World, UNESCO, September 2000 (2nd) edition.
- Kausik Kumar Das, Tanuja Panigrahi & R.B.Panda, Occurrence of Fluoride in Ground water of Patipal Panchayat in Balasore District, Odisha, India, *Journal Of Environment.*, 2012; 1, 33 – 39.
- Shashank S, Pandey. A.C, Nathawat.M.S, Evaluation of fluoride concentration in ground water in hard rock terrain in Garhwa district, Jharkhand, India, *International Journal Of Environmental Science.*, 2012; 3, 1022- 1030.
- Rizwan R & Gurdeep S, Ground Water Quality Status With Respect To Fluoride Concentration in Industrial Area Of Angul District Orissa, India, *Ind.J.Sci.Res, And Tech.*, 2013; 54 – 61.
- Shobana R & Soruba R, Ground water quality of five villages in Natham City, Dindigul District Tamil Nadu, India, *Int J Curr Sci.*, 2012; 68 – 70.
- Jitumoni B & Deepjyoti S, Estimation of the concentration of Fluoride in the Ground water of Tinsukia Town Master Plan of the Tinsukia district, Assam, India, *Applied Science research.*, 2011; 3, 202 – 206.
- Nagaraju A, Sarma M.R.S, Aitkenhead – Peterson J.A, Sunil K, Fluoride incidence in groundwater case study from Talupula, Andhra Pradesh, India, *Environmental Monitoring and Assessment.*, 2011; 172: 427 – 443. <http://dx.doi.org/10.1007/s10661-010-1345-3>
- Maimuna Waziri, Umar Musa, Stephen S. Hati, Assessment Of Fluoride Concentration in Surface Waters and Ground waters Sources in Northeastern Nigeria, *Resources and Environment.*, 2012; 2: 67 – 72. <http://dx.doi.org/10.5923/j.re.20120202.10>
- Battaleb. S – Looie & Moore. F, A study of Fluoride Groundwater occurrence in Posht – e- kooh – e- Dashtestanm South of Iran., 2010; 11, 1317 – 1321.
- B.M.Kalshetty, S.M. Gaonkar, R. S. Gani, M.B. Kalashetti. Assessment and toxicity of fluoride from ground water sources in and around Bagalkot district, Karnataka, India. *Int.Res.J.Pharm.* 2013; 4(5): 246 – 249 <http://dx.doi.org/10.7897/2230-8407.04552>

26. G. Alagumuthu and M. Rajan, Monitoring of fluoride concentration in ground water of Kadayam block of Tirunelveli district, India: Correlation with physic- chemical parameters, *Rasayan J, Chem*2008; 920 – 928
27. Handa. BK. Geochemistry and genesis of fluoride containing ground waters in India. *Groundwater*, 1975; 275 – 281 <http://dx.doi.org/10.1111/j.1745-6584.1975.tb03086.x>
28. Chakraborti. D, Chanda. C. R, Samana. G, Chowdary. U.K, Mukerjel. S.C. and Pal A.B. et al, Fluorosis in Assam, India, *Current Science* 2000; 78, 1421-1423
29. Libyan National Center for Standardization and Metrology, (LNCSM 10: 2008).
30. CEC (Council of the European Communities), 1998. Council Directive of 3rd November 1998 on the quality of water intended for human consumption (98/83/ EEC). Official Journal of the European Communities, No.L330/32
31. WHO, Guidelines for Drinking Water Quality, World Health Organization, Geneva 2004, 3rd
32. APHA. Standard method for the examination of the water and wastewater 17th edition, American Public Health Association, New York, U.S.A, 1989

Cite this article as:

Fathi M. Elmabrok. Study of fluoride level in the ground water of Alagilat city, Libya: Correlation with physicochemical parameters. *Int. Res. J. Pharm.* 2015; 6(9):616-622 <http://dx.doi.org/10.7897/2230-8407.069120>

Source of support: Libyan authority, Conflict of interest: None Declared

Disclaimer: IRJP is solely owned by Moksha Publishing House - A non-profit publishing house, dedicated to publish quality research, while every effort has been taken to verify the accuracy of the content published in our Journal. IRJP cannot accept any responsibility or liability for the site content and articles published. The views expressed in articles by our contributing authors are not necessarily those of IRJP editor or editorial board members.