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Reseach Article

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Determination of Fluoride Level in Drinking Water in the Costal-Western Libyan Cities

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ABSTRACT

Fluoride has been described as an essential element needed for normal development and growth and extremely useful for human beings but chronic exposure to excessive fluoride more than the permissible limit is known to cause dental fluorosis and skeletal fluorosis in humans. Other effects, including hypersensitivity reactions, renal insufficiency, osteo-renal syndrome, repetitive strain injury, birth defects and neurological manifestation have also been reported. The aim of this study was determination of fluoride level in the ground water in the costal-western cities of Libyan districts to demonstrate the health risks that may be associated with higher levels of fluoride in drinking water. 21 water samples collected from different cities of costal –western Libyan districts. The fluoride concentration was determined using a Lanthanum Fluoride Ion Selective Electrode. In the study area, the results indicated that the fluoride concentration was ranged between 0.01-3.9 ppm, with a mean of 1.32ppm. It is observed that 61% of the samples have fluoride level greater than 0.6-0.7 ppm, the normal level that recommended by WHO.

Keywords - *Fluoride; Dental Fluorosis; Skeletal Fluorosis; Ion- Selective Electrode; WHO.*

INTRODUCTION

Fluoride is a naturally occurring toxic mineral present in drinking water and causes yellowing of teeth. Fluorspar, cryolite and fluorapatite are the naturally occurring minerals, from which fluoride finds its path to ground water through infiltration.[1]

Fluoride has been described as an essential element needed for normal development and growth and extremely useful for human beings. Fluoride is abundant in the environment and the main source of fluoride to humans is drinking water, in which it is the typically the largest single contributor to daily fluoride intake.[2]

In tropical countries, the appropriate level of fluoride concentration in drinking water as recommended by World Health Organization (WHO) should be 0.6-0.7 ppm, while in cool climate countries where the consumption of water is relatively low is 1.2 ppm.[3]

Actual intakes of fluoride from drinking water by individual depend on their individual water intakes, the source or sources of that water, and the use of home water purification or infiltration systems and the disease condition, such as diabetes milletus, which is characterized by high water intake and high urine volume level.[4]

Fluoride content in bottled water varies considerably with brand or source, with packaging date for a given brand, and the information given on the lables or provided by manufacturer.[5]

Fluoride is found in all natural waters at some concentration. Seawater typically contains about 1.3 ppm while rivers and lakes generally exhibit concentrations of less than 0.5 ppm. In ground waters, however, low or high concentrations of fluoride can occur, depending on the nature of rocks and occurrence of fluoride-bearing minerals. Concentrations in water are limited by fluorite solubility.[6]

Fluoride is an essential trace element that has protective effects against bone mineral loss. However, it becomes toxic at higher doses and induces some adverse effects on a number of physiological functions.[7]

Symptoms of acute oral fluoride intoxication in humans include severe nausea, vomiting, hypersalivation, abdominal pain, and diarrhea. In severe or fatal cases, these symptoms are followed by systemic hypocalcemia, convulsions, cardiac arrthymias, cardiovascular collapse and coma. Acute toxic doses range from 1 to 5 mg/Kg. Doses exceeding 15 to 30 mg/Kg may be fatal.[8, 9]

Chronic exposure to excessive fluoride is known to cause dental fluorosis and skeletal fluorosis in humans. Other effects, including hypersensitivity reactions, renal insufficiency, osteo-renal syndrome, repetitive strain injury, birth defects and neurological manifestation have also been reported.[10,11]

Chronic exposure to fluoride also reported to cause haematological effects such as anemia, eosinophilia, and dysplastic changes on granulocytes in the bone marrow[12], as well as aquired osteosclerosis, gastrointestinal symptoms, weight loss, lower extremity pain, and stress fractures of the lower extremities.[9]

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The multiple use of fluoride for dental caries prevention is clearly increasing. It is a common practice to use fluoride in a variety of delivery systems, including dentifrices, pediatric supplements, and professional or self-applied topical solutions or gels as well as dental restorative materials. These dental products may contain fluoride in concentrations as high as 12,300 ppm.[13]

Fluoridated dentifrice include toothpaste, powders, liquids, gels, mouth rinses, NaF tablets, drops, and lozenges, although the amount of fluoride actually swallowed by an individual depends on the amount of toothpaste used, the swallowing control of the person, particularly young children and the frequency of toothpaste used. It is estimated that the amount of fluoride ingested by children aged between 3-12 years range between 14-269 ppm.[14-16]

MATERIALS AND METHODS

Libya is located at the midpoint of African's northern rim, with an area of 1,760,000 square Kilometers in size and a Mediterranean coastline of nearly 1,900 Kilometer long.

However, the study area is bounded by the Mediterranean coast of about 350 Kilometer long, starting from Masrata city to Zawara city, while from the south the border point between Libya and Tunisia terminates in an escarpment that rises to form the Nafusah mountain, a plateau with elevations of up to 1,000 meters (Figure 1).

A total of 21 groundwater samples were collected from Governmental ground water supply from different cities located in the costal-western region of Libya, using plastic bottles of 1,000 ml. The bottles were rinsed Tree times with the source of water before sample collection and tightly capped to protect samples from atmosphere CO_2, adequately labeled and stored at 4-8 ^{0}C, then analyzed within 72 hours of sampling in the Institute of Oil Research in Tripoli.

The fluoride concentration was determined on the unfiltered water samples using a Lanthanum Fluoride Electrode (Orion Model 94-09) with a reference electrode (Orion Model 407A), both samples and standard were 1:1 diluted with TISAB II (Orion Total Ionic Strength Adjustment Buffer II). Fluoride concentration was read off directly from the Ion Meter after calibration with two fluoride standards.[17]

RESULTS

The results of fluoride level in ground water samples (Table 1). The fluoride concentration in all 21 samples of government groundwater supply analyzed from Libyan north-western region ranges from 0.01 to 3.9 ppm, with a mean of 1.32 ppm.

It is observed that 61% of water samples have fluoride concentrations greater than 0.6-0.7 ppm (Table 2). In one water sample, fluoride concentration was found beyond permissible limit (0.01ppm) and in thirteen samples, fluoride concentration were above permissible limit that ranged between 1.19-3.9 ppm, while seven samples were between 0.49-0.78 ppm which can be considered as within the normal variation of the fluoride level that recommended by WHO for hot climate countries (0.6-0.7 ppm)

Table 1: Fluoride level in ground water of costal-western region of Libya

Sample number	City	F-level ppm	Sample number	City	F-level ppm
1	Zwara	0.01	12	Zleeten	1.51
2	Central region of Tripoli	0.49	13	Tarhona	1.52
3	Eastern region of Tripoli	0.49	14	Alswani	1.6
4	Southern region of Tripoli	0.49	15	Alkumas	1.63
5	Western region of Tripoli	0.53	16	Surman	1.65
6	South-eastern region of Tripoli	0.59	17	Benghasher	1.83
7	Masrata	0.74	18	Alegelat	1.84
8	Sabrata	0.78	19	Zahra	2.09
9	Janzoor	1.19	20	Regdaleen	2.21
10	Zawya	1.28	21	Elgmael	3.9
11	Alazizya	1.32			

Table 2: Mean of fluoride level

Sample	Range (Min-Max) (ppm)	Mean (ppm)	%Samples with F-concentration more than 0.6-0.7 ppm	Total
Waters from north-west Libya	0.01-3.9	1.32	61.00%	21

DISCUSSION

In Libya the Mediterranean and the Sahara desert are the country's most prominent natural features. In most of the coastal lowland , the climate is Mediterranean with warm summers, mild winters and scanty rainfall, while in the desert the climate has a very hot summers and extreme

diurnal temperature. Deficiency in rainfall is reflected in an absence of permanent rivers or streams and the approximately twenty perennial lakes are brackish or salty.[18] Therefore the source of drinking water is dependent on the ground water.

This study demonstrated that the fluoride level in ground water in the north-western costal region of Libya in 21 places ranged between 0.01-3.9 ppm with a mean of 1.32 ppm. The fluoride level was generally higher than the level recommended by WHO (0.6-0.7 ppm).[3]

It is noted in this study that low fluoride concentration were observed in wells of low land (altitude less than 100 M), while high fluoride concentration were observed in high land (altitude between100-20 M) approximately, that located in south western area near to mountainous of Naphosa. Also the distribution of fluoride concentration seems to follow a definite and regular pattern with a significant relationship between altitude or depth of drinking water sources and fluoride concentration.

It is well documented that waters with high fluoride concentration occurs in a large and extensive geographical belts associated with sediments of marine origin in mountainous areas, volcanic rocks, granitic and gneissic rocks.[19]

It is also possible that the high fluoride concentrations observed are related to the mineral contents of the soil. It is well documented that in ground waters, however, low or high fluoride concentration of fluoride can occur, depending on the nature of rocks and occurrence of fluoride bearing minerals. Concentrations in water are limited by fluorite solubility so that in presence of 40 mg/L calcium it should be limited to 3.1 mg/L. It is absence of calcium in solution which allows higher concentration of fluoride.[20]

Therefore higher fluoride concentration can be expected in ground waters from calcium poorer aquifers and in areas where fluoride-bearing minerals are common. Fluoride concentrations may also increase in ground waters in which cation exchange of sodium or calcium occurs.[21]

The relation of high fluoride concentration in relation to the mineral contents of the soil, incidence of dental fluorosis, relation of fluoride in natural ground water and dental caries is needed to be elucidated by future researches. Based just on our experience, the incidence of dental fluorosis of variable degrees is commonly noticed in children of cities, towns and villages around the capital Tripoli which may be attributed to a high concentration of fluoride in drinking water.

Besides dental fluorosis recent studies concluded that excessive consumption of fluoride may lead to skeletal fluorosis, muscle fiber degeneration, low haemoglobin levels, deformities in RBCs, excessive thirst, headache, skin rashes, nervousness, neurological manifestation similar to Alzheimer's disease, depression, gastrointestinal problems, urinary tract malfunctioning, nausea, abdominal pain, reduced immunity, repeated abortions, male sterility, destruction of enzymes, anabolic action of osteoblasts, genetic mutation and carcinogenicity.[2,9,11,12,22]

A country's ability to collect, clean and distribute water to its users reflects the health of population. Therefore, treatment of high concentration of fluoride in drinking water is necessary in order to eliminate any negative effect on the mass population. High concentration level of fluoride can be prevented or minimized by

1. Using alternative water sources.

2. By improving the nutritional status of population at risk.

3. By removing excessive fluoride (defluoridation).

Three specific treatments (defluoridation) have been deemed successful in removal of fluoride from drinking water. Coagulation Activated Alumina and Membrane process. Membrane process is the most significant process in water treatment includes reverse osmosis, ultra-filtration and micro-filtration.[23]

Information from this work may will provide a base for further studies and a guide to practicing dentists in different parts of the country who are using fluoride in preventive dentistry. It may also will influence the decision for partial defluoridation of drinking water sources.

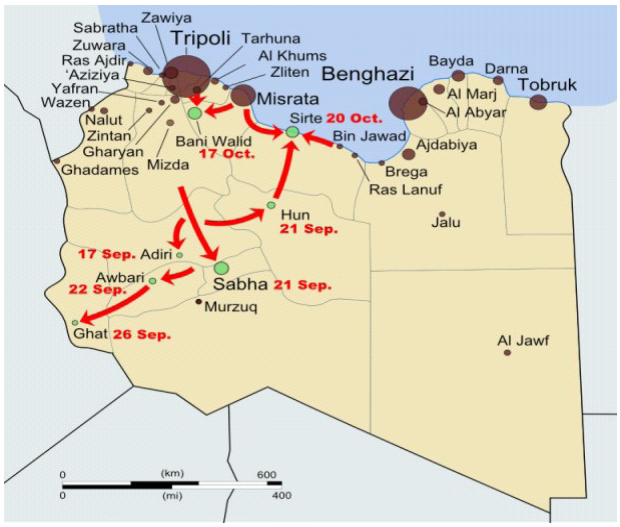

Figure 1: Libya map shows the study area

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