Original article

Fluoride Concentration in Drinking water in The Libyan City of Zliten: Dental Perspective

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ABSTRACT:

Background: Having optimally fluoridated drinkable water supply is important to reduce the prevalence of both dental decay and dental fluorosis. This research aimed to report all possible drinking water sources and their fluoride content in the Libyan city of Zliten.
Methods: This descriptive study used a convenient sampling strategy to collect 68 samples from different drinking water sources across the city. The fluoride concentration was identified using potentiometric method by means of fluoride selective ion electrode.
Results: 31 source of desalinated water and 37 ground water source have been identified as drinking water. Moreover, the fluoride content was found to be much lower than recommended by the national and international standards for the desalinated water (0.047 ppm±0.062) while that of ground source was found to range from 0.9 to 2.23 ppm with a mean of (1.43 ppm±0.38).
Conclusion: People in the city have many choices for drinkable water, however, those who drink from the desalinated water consume less water-dissolved fluoride than those who rely on the ground water as a source of drinking. This reflects the fact that the residents have no equal chances to get the sufficient amounts of fluoride necessary for healthy teeth. Accordingly, more research is needed to evaluate the actual effect of this discrepancy in fluoride consumption on the population and consequently to implement the required strategies essential to assure optimum oral health for the whole population.

Keywords: *Fluoride, Drinking water, water fluoridation, dental fluorosis, Zliten*

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INTRODUCTION:

The main source of fluoride intake by human comes from drinking water, the fluoride in drinking water occurs naturally or added to water at adjusted amounts in a procedure called water fluoridation.[1,2,3] Fluoride has both advantageous and harmful effects on human health. Regarding dental health, there is an inverse relationship between fluoride concentration in drinking water and the prevalence of dental caries; while a dose-response relationship exists between the concentration of fluoride in drinking water and the severity of dental fluorosis.[1,3] The most relevant adverse effects on communities, where drinking water and foodstuffs excessively high in fluoride, are dental and skeletal fluorosis These conditions embody the fluoride adverse effect

on dental and general health.[1,2] Therefore, the World Health Organization WHO recommended that that fluoride in drinking water should not exceed 1.5 mg/L0.[1]

The drinking water sources in the city of Zliten include the desalinated water either produced by the private sector in small purification projects or government operated large desalination plants, the other source is ground water including the manmade river which is a ground water extracted from outside the city.

As many other cities in Libya, small water purification projects are becoming the most popular source on which inhabitants are reliant.[4] These are small projects that use the technology of reverse osmosis, where the desalination process will remove nearly all fluoride and other elements from the original water.[5] The produced water is required to be reconstituted to become in line with the standard of Libyan National Centre for Standardization and Metrology LNCSM where it is stated that fluoride in drinking water is 1ppm. The other source of desalinated water in the city is that provided by the General Company for Water Desalination where the company uses the Multistage- Flash technology in its three desalination plants. The design capacity for each is 30000 m3/d. The original water source before desalination is the seawater since all the plants occur on the coast.[5]

Communal water fluoridation is recommended when there is enough financial and human resources besides the availability of a reliable supply of a fluoride containing chemical of acceptable quality and the equipment to pump the material for water fluoridation.[1]

As being arid zone, ground water could be considered as a prime source for drinking, ground water is easily extracted through wells using centrifugal and submerged pumps. These wells are government-owned and run by the General Company for Water and Wastewater (GCWW). As per the hydrological cycle, ground water should contain fluoride at varying concentrations. Also, the geological rocks which are in contact with ground water are known to leach fluoride into the water.[1]

The produced water either from desalination plants or that extracted from municipal wells is then distributed throughout the city via a net of pipelines, this task is allocated to GCWW, the operation and maintenance of all infrastructure water network and water treatment plants are also run by this company.[6] However, the pipeline network does not cover the whole city and thus inhabitants in areas not covered by the network use water supply trucks and pump the water to home storage tanks. In rural areas, people depend on private water supply wells and rainwater reservoirs for domestic use.[6]

Unfortunately, there is no data on contribution of each source to the drinking water. However, there is an increase in the small water purification projects in the city what indicates that it's the most popular source.[4] Also, there is a doubt on the quality of fresh water provided by the government as being not good enough for drinking; whereas people think that the water collected in big reservoirs is not analyzed or treated regularly, which sort as non-potable water due to it's incompatibility with the international standards and consequently people do not use it as a stable and reliable source of drinking water.

So far, there is no published research tried to investigate the mean concentration of fluoride in drinking water in the Libyan city of Zliten; accordingly, this research was conducted to fill in this gap and aimed to report all possible drinking water sources and their fluoride content in the city of Zliten which will be beneficial to evaluating whether or not the residents' fluoride intakes from drinking water fell within the international recommended ranges.

METHODS AND MATERIALS:

A descriptive study design was followed to collect 68 drinking water samples from different water sources and regions of the city of Zliten that is located on a narrow coastal plain eastern of Tripoli. A convenient

Table 1. Main water sources for the city of Zliten.

Water source	Number of provider	Delivery of water	Intended use
Small water purification projects	29	Filled in bottles of 10L to 20L	Drinking
Desalination plants	2	pipelines (GCWW) OR Transported in large volume tanks	Drinking and Domestic use
Municipal Deep wells	37 wells over 6 localities	pipelines(GCWW)	Domestic use
Manmade river	1(ground water from outside city)	pipelines(GCWW)	Domestic use and plants irrigation

sampling strategy was used, in that all the possible drinking water sources in the city were included, all non-functioning sources were excluded which were 6 deep municipal wells. Tthe city was divided into six zones A to F, which is based on the population distribution over the six localities of the city and not on the geological nature of the city. By this, each municipal well was given a letter indicating the locality (A to F) and a number that indicates the site of the well in a locality. For example, E4 means the well in site 4 in the locality E of the city. Table 1 shows the main water sources for the city.

The guidelines for water sample collection by LNCSM were followed. The samples were collected in plastic or glass bottles. All bottles were thoroughly cleaned and rinsed with a detergent. The collected samples were representative and the volumes collected were sufficient for replicate analysis. Sample preservation was not required and samples were kept cool. After labeling, they were sent to the lab of the local Environment Sanitation Affair for determination of fluoride concentration and the results were produced in particle per million, PPM .

Potentiometric method using a fluoride selective ion electrode (ELIT 8221F$^-$ 41936) is carried out to evaluate fluoride content of the water samples. Although many different methods available for the measurement of fluoride concentration, this method is considered reliable and has been used in many scientific research and hence utilized in this study. All data were tabulated and presented using appropriate descriptive statistics (mean and standard deviation). No comparisons were made using statistical tests.

RESULTS:

Tables 2 and 3 show the different fluoride concentrations in both Municipal deep wells and Small water purification projects respectively. Surprisingly, water produced by the government-owned two large desalination plants contain nil fluoride.

Table2. Fluoride in municipal wells

Well location	F in ppm	Well location	F in ppm
A1	1.49	**D1**	1.96
A2	0.95	**D2**	2.00
A3	1.59	**D3**	2.23
A4	1.86	**D4**	1.97
A5	1.60	**D5**	1.63
A6	1.20	**D6**	1.10
A7	2.03	**D7**	2.02
A8	1.03	**E1**	2.08
A9	1.05	**E2**	1.59
B1	1.64	**F1**	1.05
B2	1.69	**F2**	1.20
B3	0.90	**F3**	1.11
B4	1.13	**F4**	1.13
B5	1.32	**F5**	1.20
B6	0.99	**F6**	1.13
C1	1.77	**F7**	1.09
C2	1.00	**F8**	1.20
C3	1.18	**F9**	1.32
C4	1.77	**M ± SD**	**1.43±0.38**

Table3. F in ppm from small water purification projects

Project No	F in ppm	Project No	F in ppm
1	0.17	**16**	0
2	0.02	**17**	0.09
3	0	**18**	0.01
4	0.02	**19**	0
5	0.11	**20**	0
6	0	**21**	0
7	0.02	**22**	0.05
8	0.08	**23**	0
9	0.04	**24**	0
10	0.07	**25**	0.2
11	0.05	**26**	0.02
12	0.05	**27**	0.02
13	0	**28**	0
14	0.07	**29**	0.04
15	0.24	**M ± SD**	**0.047±0.062**
		Median	**0.02**

DISCUSSION:

This cross sectional survey aimed to measure the fluoride level in drinking water from different possible sources in the city of Zliten. This will partially help in explaining the prevalence of dental caries or fluorosis in the city and guides the dentists to make a decision on providing preventive fluoride therapy for their patients.

In Libya, it is commissioned that drinkable water should contain a level of fluoride of 1PPM, this policy is in accordance with WHO guidelines for fluoride in drinking water. One PPM fluoride in water is beneficial in reducing dental caries prevalence. However, this limit was exceeded in number of cities in Libya and what exaggerates the dilemma is lack of public awareness regarding oral health.[7-9]

The fluoride level in the natural wells of water in Zliten have been found to fluctuate from 0.9 to 2.23 ppm. This kind of variation in concentration of fluoride in the same region has been reported in other studies.[1,10]

Amongst all collected samples of natural water, about 50% contain optimum levels of fluoride that fall within the WHO recommendations for fluoride level in drinking water. Except for area E where fluoride level is found higher than recommended for its two wells. All other regions in the city have at least one well where the fluoride level is within the permissible amount required by LNCSM. These results indicate that dental fluorosis might be of no concern in most locations and dental caries prevention is optimized, however, it was reported that people do not use these sources for drinking.

In contrast to another region in the west of Libya, Al-Fateh University of Tripoli attributed the increased incidence of fluorosis to the dominant consumption of ground water, in which fluoride content found to be 5 ppm.[11] A much higher concentrations of fluoride in the ground water was found in cities of southern Libya; where the Fluoride contents documented as 8.8, 4.7, 7.2, 4.2 and 6.7 ppm. for Mourzouk, Qatron, AL-Shati – Barak, Obari, and Sebha respectively. [12,13]

Our findings indicate a higher concentration of fluoride than that found in ground water reservoir located mainly under the center of Tripoli the capital city where the mean F was 0.51 ± 0.041.[14] It is also higher than that found in the Northeast of Libya where the mean concentration of fluoride in the ground water was 0.24±0.32.[15]

It is known that Fluoride occurs in natural water systems as a result of runoff from weathering of fluoride-containing rocks and soils and leaching from soil into groundwater. Atmospheric deposition of fluoride-containing emissions from coal-fired power plants and other industrial sources also contributes to amounts found in water, either by direct deposition or by deposition to soil and subsequent runoff into water, none of these contributors exist in Zliten which contributes to finding a relatively low fluoride level in its natural water.[16] Moreover, lower fluoride concentrations in water are anticipated in the ground water of calcium-rich aquifers;[16] Zliten is an area where calcium-rich limestone rocks occur, these bedrocks have little fluoride concentration as they are not of volcanic origin.[17]

In small water purification projects, desalination in most of these spots results in almost fluoride free water, table 2. The mean concentration of fluoride was 0.047±0.062 and the highest reported concentration of fluoride in water was 0.24 ppm. This concentration is much lower than what is recommended in the national and international standards. These results are in accordance with what was found in another report from a western Libyan city that show a very low concentration in the produced water.[18] This source of water, however, is becoming popular for drinking regardless the fact that it lacks the protective role against dental caries. Therefore, it is expected that dental caries risk would be high especially when this situation is coupled with the scarcity of other preventive dental services provided in the public or private sectors.[1,9] producing and marketing a product with specifications less than what is required by the local standards indicates the lack of adherence of producers to the regulations and standards stipulated by the LNCSM. This lack of adherence might be attributed to weak surveillance and monitor activities of the LNCSM and the Libyan Food and Drug Control Centre.

Water from large desalination projects, although it is a government produced tap water, it lacks the optimum fluoride concentration. This is a result of the financial shortage and the absence of technical facility, material and human resources to analyze the produced water and to assure that it has all required minerals, including fluoride, in optimum concentrations.

CONCLUSION:

People in the city have many choices for drinkable water, the desalination one is not the best option since its fluoride content is very low and does not provide the protective role against dental caries. Most of the ground water sources contain optimal fluoride as recommended internationally regardless of its safety for drinking from chemical and biological perspectives.

According to these alarming findings, it seems that there is a real chaos regarding the quality of drinkable water in the city, therefore, strict laws and regulations for drinkable water production should be implemented and mentored regularly by the responsible sectors in the country.

Clinicians are advised to consider this insufficiency of fluoride level in desalinated water when establishing preventive measures for their patients. Equally important is to guard against fluorosis whereas fluoride content is high in a number of ground water sources that might be utilized by some residents.

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