Fluoride concentration of well water in different areas of Sulaimani province

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Abstract

Objectives: To determine the amount of fluoride concentration in well water of different places in Sulaimani province, Iraq.

Materials and Methods: Twenty-two samples of well water were taken from different areas in Sulaimani Province. The areas are different from the geographical point of view. The water samples were directly taken from the wells pumps. Each sample was filtered through a 0.45 µm and 47 mm diameter membrane filter before analyzing by ion chromatography machine. The machine had been standardized for fluoride ion by using Dionex seven anion standard to allow the machine is reading fluoride ions within these certain concentrations. Anion identification is based on the comparison of analyte signal peak retention times relative to those of known standards. Quantitation is accomplished by measuring the peak area and comparing it to a calibration curve generated from known standards.

Results: All the 22 samples had shown the very low amount of fluoride concentration. The maximum concentration was 0.157 mg/l, and the minimum concentration was zero mg/l.

Conclusion: The fluoride ions in the samples taken from different sources of well water in Sulaimani province had shown concentrations that could not provide any benefits for the purpose of caries prevention.

Keywords: *Dental caries, Well water, Fluoride, Sulaimani.*

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Introduction:

The addition of fluoride to municipal water supply has been associated with a dramatic decline in caries incidence in many industrialized western countries[1,2]. Fluoride can also be supplied with drinking bottled water, and some food products and dentifrices[3,4]. Public water fluoridation was first adopted in the United States in 1940, and this procedure is now implemented in more than 30 countries[5].

Fluoride may present in natural springs, rivers, and well water. In areas rich in fluoride-containing minerals, well water may contain up to about 10 mg/l of fluoride. The highest natural level reported is 2800 mg/l6. Most of the fluoride found in ground water is naturally occurring from the breakdown of rocks and soils or weathering and deposition of atmospheric volcanic particles[7].

It is acknowledged that people living in communities with natural fluoride content in their drinking water of about 1 mg/l had about 50% fewer caries comparing with the communities their drinking water containing less than 0.3 mg/l of fluoride[8]. After 14 years of investigation, researchers have found that fluoride level in drinking water of 1.0 mg/l did not cause enamel fluorosis, in contrary, reduced dental caries up to 60% among almost 30,000 schoolchildren in Grand Rapids, Michigan, United States[9,10].

The effect of excess fluoride ingestion from ground water on human health usually is chronic, and the effect appears to be obvious after long-term exposure. Long-term ingestion of fluoride from drinking water above 1.5 mg/l concentration leads to dental and skeletal fluorosis11. It is accepted that excessive

ingestion of fluoride will also increase the risk of bone fractures[8].

Ethically, it cannot be concentrated on the past benefits of water fluoridation to justify constancy of using fluoride in public water supply. There may be different methods for providing approximately if not similar benefits of water fluoridation to the dental public health. The standardization of optimal fluoride level in the water supply was developed on the basis of epidemiological data collected more than 50 years ago[12].

The major field of application today for ion chromatography (IC) is an investigation of aqueous systems; this is very interesting in the analysis of drinking water[13]. Ion chromatography system is regarded as a dependable system for quality control and water analyzes by examining different analytes in the products. It can separate biomolecules according to differences in their net surface charge[13-15]. In this investigation (IC) was applied to determine the level of fluoride ion in the collected well water samples. The determination of common inorganic anions in drinking water is one of the most important applications of ion chromatography worldwide[16]. The Dionex ICS-1500 Ion Chromatography System (ICS-1500) (Fig. 1) performs ion analyzes using suppressed or non-suppressed conductivity detection.

An ion chromatography system typically consists of a liquid eluent (Fig. 2), a high-pressure pump, a sample injector, a guard and separator column, a chemical suppressor, a conductivity cell, and a data collection system. The device was prepared and standardized by introducing seven-anion standard. Therefore, the device could easily quantitate the concentration of any anion in the well water sample with high sensitivity. The data collection system, typically a computer running chromatography software, produces a chromatogram (a plot of the detector output vs. time). The chromatography software converts each peak in the chromatogram to a

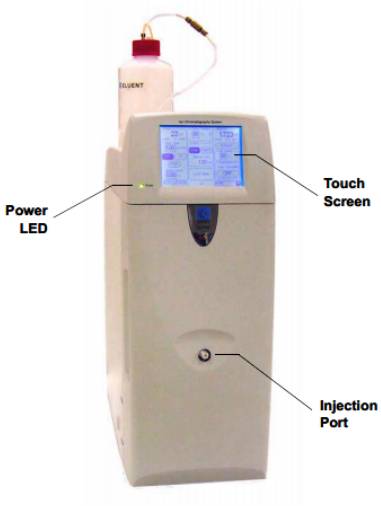

Fig 1: ion chromatography machine ICS 1500[17].

sample concentration and produces a printout of the results[17]. Therefore, the aim of the present study was to investigate the amount of natural fluoride concentration in well water in geographically different areas of Sulaimani province.

Materials and Methods:

Twenty-two water samples were collected from different areas of Sulaimani province (Fig. 3). Different distance locations were chosen from 10 km to more than 200 km from the center of Sulaimani City. Different geographical areas were selected for taking the samples. Some areas were hot and others cold, again some areas were high others were low from the level of water.

The water samples were directly taken from the well pipe. The samples were filtered through 0.45 µm

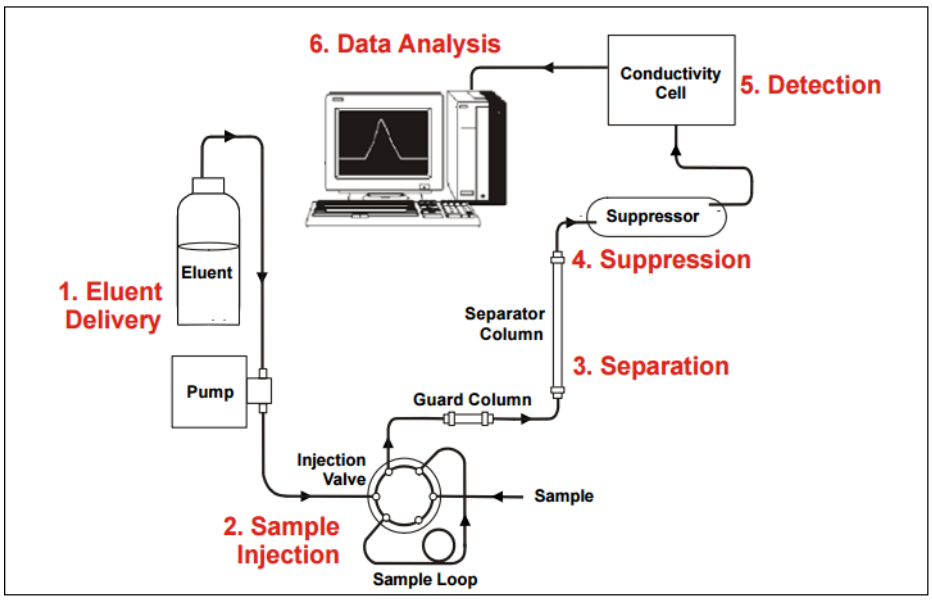

Fig. 2: Ion Analysis Process: A typical IC analysis consists of six stages[17].

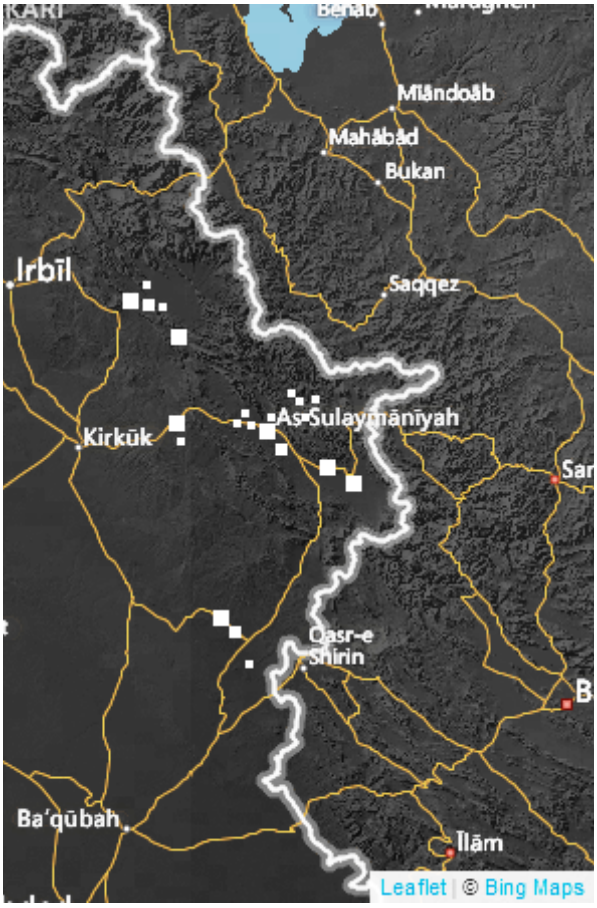

Fig. 3: The locations that the samples were taken.

and 47 mm diameter membrane filter (Whatman-Germany) before injecting to ion chromatography machine (Dionex ICS1500-USA). The samples were kept in dark plastic bottles and placed at room temperature until the fluoride analysis was undertaken. Each sample was labeled to indicate its location. The samples introduced to ion chromatography machine for measuring the fluoride ion concentration in them.

The machine had been standardized for anion elements measurement by using Dionex seven anion standards (Dionex seven anion standards- Sunnyvale-California-USA) (Fig. 4). For fluoride anion, the standardization was adopted from zero up to 20 mg/l

Fig. 4: (Dionex seven anion standards- Sunnyvale-California-USA).

presuming that the unknown sample concentration of fluoride may fall in between these two standards. Five milliliters of each sample was introduced into the machine for determination of fluoride anions concentration in addition to the other six-anion elements. The maximum level of anion concentration of each anion was drawn through a diagram on the printable ion chromatography machine screen.

Results:

It can be noticed that the samples from different water sources (well water) have different concentration of fluoride ion, starting from zero mg/l up to 0.157 mg/l. The mean concentration of the total samples was observed to be 0.055 mg/l, Figure 5.The amount of fluoride concentrations of twenty-two samples that were collected in Sulaimani province of Iraq are shown in Table 1.

Discussion:

The samples showed very low fluoride concentration in all areas. In some areas, there were minimum concentrations of fluoride to zero mg/l that means no fluoride ions detected in the samples. Again, no sample

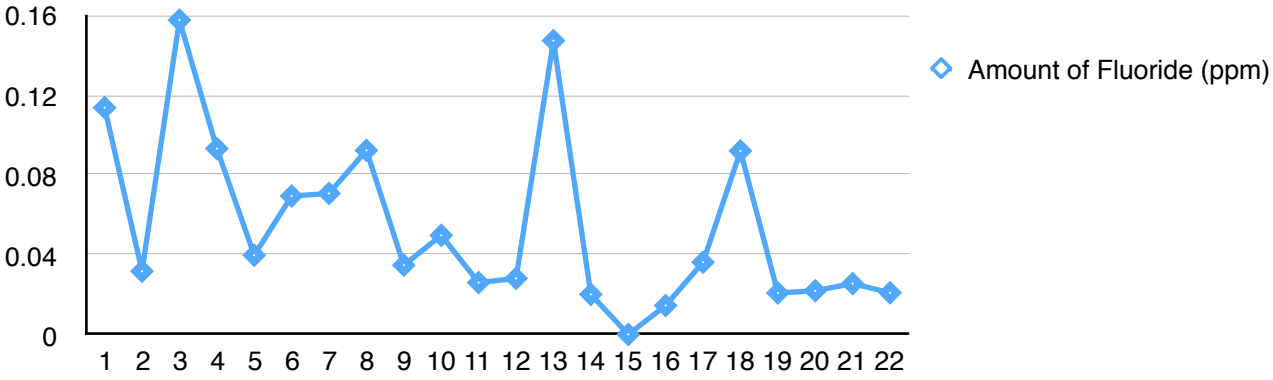

Fig. 5: Fluoride concentration (mg/l).

Table 1: Descriptive statistics of fluoride concentrations.

Element	value
Sample size	22
Mean	$5.481818182 \cdot 10^{-2}$
Standard error of the Estimated Mean	$9.360640255 \cdot 10^{-3}$
Median	$5.481818182 \cdot 10^{-2}$
Standard deviation	$4.390529458 \cdot 10^{-2}$
Sample variance	$1.927674892 \cdot 10^{-3}$
Kurtosis	$3.144687775 \cdot 10^{-1}$
Skewness	1.091570365
Range	0.1576
Minimum	0
Maximum	0.1576

showed acceptable fluoride concentration to reach a preventive level of about 0.7-1.2 mg/l18. These results indicate that the people in these areas cannot get any benefits of fluoride intake from natural water sources. Data from the local government also showed no a valuable fluoride concentration in the local rivers, natural springs, and the lakes. The people from and around Sulaimani province do not have any systemic fluoride supply, even municipal water supply. This indicates that the people are at high risks of dental caries.

The major sources of fluoride intake in Sulaimani are toothpastes and mouth washes and into some extents topical fluoride application that is accomplishing in some dental clinics and Sulaimani Dental School. These supplements do have an effect on the outer surface of the erupted teeth. They do not deposit through the entire thickness of the teeth[19]. In order to achieve maximum benefit from fluoride supplement, fluoride should be taken systematically. Systematic fluoride supply can be provided by adding fluoride to the public water supply, bottled drinking water and by tablets and drops[20,21]. By ingestion of fluoride during tooth formation, the fluoride will precipitate through the entire thickness of the teeth crystals[21], resulting in the formation of hydroxy fluoroapatite crystals instead of hydroxyapatite crystals. hydroxy fluoroapatite is more caries-resistant than hydroxyapatite. Moreover it prevents demineralization and promotes remineralization[22]. Also, fluoride incorporates into dental plaque and leads to decrease bacterial activities[21,23].

The maximum level of fluoride in this investigation was 0.157 mg/l, and the minimum level was zero mg/l. The mean concentration of all 22 samples was 0.0548 mg/l. The maximum and the minimum levels of these samples found to be very low for caries prevention. A similar low concentration has been determined in a study conducted in 4434 samples tested in different provinces of Iran; average fluoride concentration was estimated 0.43 ± 0.17 mg/l with zero and 3.06 as minimal and maximal values respectively[24]. Another study conducted in another province in southern Iraq was Babil. They investigated 50 samples taken from bottled, and tap water originated from Euphrates River; the samples showed 0.147±0.055 to 0.368±0.145 mg/l and 0.058±0.056 m/l to 0.146±0.140 mg/l, respectively[25]. The estimated fluoride concentrations in the drinking bottled waters of 14 different brands had a range of 0.13 to 0.5 mg/l, with a mean of 0.28 mg/l in another two southern provinces in Iraq[26]. A very low concentration of fluoride had been shown the middle city of Iraq, Baghdad. Among 27 samples, 25 samples showed a fluoride concentration less than 0.5 mg/l27. Another study was done on the prevalence of dental fluorosis in a sub-district area in northern Iraq; this study explored a high level of fluoride concentrations (2.05–2.22 mg/l) with moderate enamel fluorosis (1.62) in Sinjar people according to community fluorosis index[28].

Water with high fluoride concentration occurs in large and extensive geographical belts associated with a) sediments of marine origin in mountainous areas, b) volcanic rocks and c) granitic and gneissic rocks. These areas usually have calcium-deficient groundwaters in basement aquifers. People settled in these areas suffer from endemic enamel fluorosis. An example of this belt extends from Iraq and Iran through Syria and Turkey to the Mediterranean region, and hence from Algeria to Morocco[29].

A study conducted by centers of disease control and prevention CDC reaffirm the benefits of community water fluoridation from the point of view of cost and effectiveness i.e. water fluoridation decreases dental caries and saves money. Water fluoridation for larger communities of more than 20,000 people it costs about 50 cents per person, every $1 invested in this preventive measure results in approximately $38 saving in dental treatment costs. In the same study revealed

that every person saves $16 in very small communities (<5,000) and $19 for larger (>20,000) communities each year. The analysis in the study assumed the cost of installation and maintenance of the equipment and operating water plants, the expected effectiveness of fluoridation, estimates of expected cavities in non-fluoridated communities, treatment of cavities, and time lost visiting the dentist for treatment[30,31].

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