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# Estimation of fluoride concentration in drinking water and common beverages in United Arab Emirates (UAE)



Tarun Walia<sup>a,\*</sup>, Salem Abu Fanas<sup>b</sup>, Madiha Akbar<sup>b</sup>, Jamal Eddin<sup>b</sup>,  
Mohamad Adnan<sup>b</sup>

<sup>a</sup> Department of Growth & Development, College of Dentistry, Ajman University of Science and Technology, Ajman, United Arab Emirates

<sup>b</sup> College of Dentistry, Ajman University of Science and Technology, Ajman, United Arab Emirates

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## KEYWORDS

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**Abstract Objective:** To assess fluoride concentration in drinking water which include tap water of 4 emirates - Abu Dhabi, Dubai, Sharjah and Ajman plus bottled water, commonly available soft drinks & juices in United Arab Emirates.

**Methods:** Five different samples of tap water collected from each of the four emirates of UAE: Ajman, Sharjah, Abu Dhabi and Dubai; twenty-two brands of bottled water and fifteen brands of popular cold beverages, purchased from different supermarkets in U.A.E were tested using ion selective electrode method and the fluoride concentration was determined.

**Results:** The mean fluoride content of tap water samples was 0.14 mg F/L with a range of 0.04–0.3 mg F/L; with Ajman tap water samples showing the highest mean fluoride content of 0.3 mg F/L. The mean fluoride content for both bottled drinking water and beverages was 0.07 mg F/L with a range of 0.02–0.50 mg F/L and 0.04–0.1 mg F/L respectively. Majority (68.2%) of the bottled water are produced locally within U.A.E while a few (31.8%) are imported.

**Conclusions:** The tap water, bottled water and beverages available in U.A.E show varying concentrations of fluoride, however none showed the optimal level necessary to prevent dental caries. Dental professionals in U.A.E should be aware of the fluoride concentrations before prescribing fluoride supplements to children.

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\* Corresponding author.

E-mail address: [ttww@yahoo.com](mailto:ttww@yahoo.com) (T. Walia).

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## 1. Introduction

Fluoride intake has always been considered a key factor for prevention of dental caries and improvement of public dental health. Fluoride makes the tooth-enamel surface acid resistant by preventing bacterial demineralization and promotes

remineralization of initial non-cavitated carious lesions. It also shows antimicrobial activity; in low concentrations it prevents bacterial adhesion to tooth structure while in high concentration the fluoride ion is highly toxic to certain oral microorganisms (Theodore et al., 2006).

Several methods of fluoride delivery are available; either in the form of systemic fluoride or topical fluoride. Of all available methods, addition of fluoride to public drinking water has been identified the most economical and the safest delivery system (Mužinić et al., 2009). The main source of systemic fluoride in children is from drinking water (tap + bottled), carbonated beverages and other juice drinks (Rodrigues et al., 2009). Worldwide, vast majority of consumers that include children are replacing their daily water intake by bottled water, probably attributed to the fear of less purity of natural water supply and the presence of contaminants such as micro-organisms or sand particles (Ahiropoulos, 2006). The United Arab Emirates (UAE) is the fifth leading country in terms of per capita bottled water consumption, with 37.3 gallons per person as compared to 9.9 gallons per person of the global average (Beverage Marketing Corporation, 2014).

The recent recommendation of US Public Health Service (USPHS) for optimal fluoride concentrations in community water systems is 0.7 mg/l, as this concentration not only prevents dental caries but also lowers the risk of dental fluorosis (USPHS, 2015). Bottled water manufacturers by law are not required to mention fluoride concentrations on the outer label of their product however they do mention the concentration of added fluoride which may not necessarily be accurate. Systematic review undertaken on fluoride concentration in bottle water (Ceci and Paulo, 2015) concluded that many researchers have reinforced a common warning that there is a discrepancy between the found amount of fluoride and the informed concentration in the label. Precise concentration of fluoride levels in drinking water along with other drinks consumed by general public carries a great significance. It can affect decision of dental health professionals while prescribing their patients with any additional fluoride supplements. Additional sources of unintentional fluoridation through soft drinks and beverages may put children at risk of high fluoride intake (Jackson et al., 2002; Machiulskiene et al., 2009) taking into consideration that majority of cold beverage manufacturers do not mention the water source in their preparation.

In a hot climatic country such as UAE, consumption of water and other drinks increases tremendously. Bottled water consumption was doubled between 2003 and 2008 in the middle-eastern countries (Saleem, 2008).

It becomes imperative to estimate whether fluoride levels in drinking water are within the recommended and accepted levels to prevent dental caries and reduce the risk of dental fluorosis. To our knowledge this is the first study conducted in U.A.E. to determine the fluoride content in drinking water and commonly consumed beverages by children.

The aim of the present study was to (1) assess fluoride concentration in tap water, bottled water and popular soft drinks and juices consumed in UAE, (2) confirm accuracy of the labeling of fluoride levels on bottled water and (3) compare fluoride concentration in water bottles of same company in different batches.

## 2. Materials and methods

The study estimated the fluoride levels in tap water, mineral bottled water and popular cold beverages available in U.A.E. Five different samples of tap water were collected from each of the four emirates of UAE: Ajman, Sharjah, Abu Dhabi and Dubai. Twenty-two brands of mineral bottled water and fifteen brands of popular cold beverages were purchased from different supermarkets in U.A.E. Three samples from each brand of bottled water with different batch numbers and date of bottling; and two samples of each brand of cold beverage were obtained (Table 1). All samples were stored in a dark place at room temperature; the mineral water and beverages were kept in their original closed plastic container, until the fluoride analysis was made.

Orion 4-Star pH/ISE Benchtop Meter and Orion ionplus® fluoride electrode (Orion Cat No. 1010103, Thermo Electron Corporation, Beverly, MA, USA) was used to estimate the fluoride levels in the collected samples (Christian et al., 2013). Prior to sample testing, the machine was calibrated for accurate results.

After shaking the containers, 50 ml of sample was obtained from each mineral water, tap water and beverage samples and was transferred in a coded glass container so that the person testing the sample remains unaware of the brand to prevent any bias. Fluoride standards ranging from 0.2 to 1.00 mg/L<sup>-1</sup> of fluoride were used to calibrate the measurement. The sample and fluoride standard solutions (0.2, 0.4, 0.6, 0.8 and 1 ppm) were diluted with equal quantities of TISAB II (Total Ionic Strength Adjustment Buffer). These solutions containing 25 ml of sample and 25 ml of TISAB were mixed for two minutes with benchtop stirrer (Orion Cat. No.096019). The electrode potentials of the sample solutions were directly compared with those of fluoride standard solutions. The fluoride ion concentration was determined using the Orion Ionplus Fluoride Electrode (Orion Cat. No. 9609BNWP) which was immersed in the solution until the reading was displayed on the 4-Star benchtop pH/ISE meter. Two readings were taken for each sample and the average was recorded. One sample from each tap water, mineral bottled water and beverages was selected randomly and the fluoride content was re-estimated to assess accuracy of the method.

The data obtained were analyzed using SPSS version 22. Comparison of two readings for each sample was done by Paired t-test and correlation analysis while ANOVA was used to compare the fluoride concentration in the samples.

## 3. Results

Table 2 shows fluoride concentration in 20 different tap water samples collected from four emirates of UAE: Abu Dhabi, Ajman, Dubai and Sharjah. The mean fluoride content of tap water samples was 0.14 mg F/L. Tap water samples collected from Ajman showed the highest fluoride concentration with mean fluoride content of 0.3 mg F/L, followed by Sharjah followed by Abu Dhabi and Dubai; with no significant difference in fluoride levels in tap water between different emirates.

The fluoride concentration in twenty-two most popular brands of bottled mineral water available in U.A.E ranged between 0.02 and 0.50 mg F/L (Table 3). Mean fluoride concentration of mineral bottled water is 0.07 mg F/L. Zula bottled water had the highest fluoride concentration of 0.50 mg F/L; while the lowest fluoride concentration was

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