

Evaluation of the fluoride concentration in mineral water and guaraná-based soft drinks in Manaus, Amazonas

Avaliação da concentração de flúor em águas minerais e refrigerantes à base de guaraná comercializados em Manaus-AM

Abstract

Purpose: To evaluate the fluoride concentration in bottled mineral water and soft drinks marketed in Manaus, Amazonas state, Brazil.

Methods: Fifteen commercial brands of mineral water and seven types of "guaraná"-based soft drinks sold in the Amazon region were analyzed. The beverages of three different batches were acquired from the local market. The samples were analyzed in duplicate, using an ORION 720-A ion analyzer with the ORION 96-09 ion-specific electrode, previously calibrated using standard solutions containing from 0.125 to 1.0g $\mu\text{F}/\text{mL}$. The readings in mV were converted into ppm of fluoride by linear regression.

Results: The samples of mineral water and soft drinks displayed fluoride concentration ranges of 0.04-1.02 and 0.04-0.14 $\mu\text{F}/\text{mL}$, respectively. Only one brand of mineral water had a concentration of fluoride higher than the official Brazilian recommendation for human consumption.

Conclusion: In general, the fluoride concentration in the bottled mineral water and soft drink beverages sold in the Amazon is negligible to provide any preventive effect in terms of caries control, even though the bottles of mineral water advertise the content as "Fluoridated Mineral Water".

Key words: Mineral water; fluoride; carbonated beverages

Resumo

Objetivo: Avaliar a concentração de flúor em amostras de águas minerais e refrigerantes comercializados em Manaus, AM, Brasil.

Metodologia: Foram analisadas 15 marcas comerciais de água mineral e 7 tipos de refrigerantes à base de guaraná da Amazônia, adquiridos de três diferentes lotes, no mercado local. As amostras foram analisadas, em duplicata, utilizando um analisador de íons, ORION 720-A, e um eletrodo íon-específico, ORION 96-09, previamente calibrados com soluções-padrão, contendo de 0,125 a 1,0g $\mu\text{F}/\text{mL}$. As leituras foram obtidas em mV e transformadas em ppm de flúor por regressão linear.

Resultados: Foram observadas concentrações de flúor variando de 0,04-1,02 e 0,04-0,14 $\mu\text{F}/\text{mL}$ em águas minerais e refrigerantes, respectivamente. Apenas uma marca de água mineral apresentou concentração maior que a recomendada no Brasil para consumo humano.

Conclusão: Em geral, a concentração de flúor nas águas minerais e refrigerantes, em Manaus, AM, é desprezível em termos de efeito preventivo para controle de cárie, embora os produtores destaquem na embalagem "Água Mineral Fluoretada".

Palavras-chave: Águas minerais; flúor; bebidas gasosas

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Introduction

Water fluoridation is the most efficient public method to prevent and control dental caries (1-2), yet there is a risk factor for dental fluorosis when the fluoride concentration exceeds the recommended values (3). In 1975, the Ministry of Health Resolution No 635-Dsb (4) established the recommended limits for the fluoride ion concentration in water, considering the mean daily maximum temperature of each geographic region. For cities such as Manaus, with annual temperatures ranging between 26.8-32.5 °C, the recommended minimum fluoride concentration in the water is 0.6 mg/L; maximum level is 0.8 mg/L, and excellent concentration is 0.7 mg/L, so that water fluoridation should provide the benefits of caries prevention without increasing the risk for developing dental fluorosis.

The mineral water production in Brazil has increased every year, as well as the Brazilian *per capita* consumption, which increased from 15.3 L per year in 1998 to 23 L in 2007 (5-6). To prevent and detect dental fluorosis, the Ministry of Health has suggested constant control of the fluoride content in bottled mineral water and other industrialized beverages, such as soft drinks, juices, and teas. According to the Brazilian Ministry of Health, these products must have the maximum allowed regulated fluoride ion content shown on the labels and packaging, and a systematic analysis should be conducted by the national sanitary control agency to verify adherence to the standard guidelines (7).

The municipality of Manaus, capital of the state of Amazonas, in the Amazon region of Brazil, does not have public fluoridated water supply. However, even in cities without fluoridated water supply, daily fluoride ingestion through beverages can reach good or even higher levels of fluoride intake (8). In Manaus, the public water supply does not have good treatment conditions, and large part of the population has to use bottled mineral water and industrialized beverages, such as Amazon guaraná-based soft drinks, which may present some variation in fluoride content due to geochemical factors.

Considering that fluoride use must be optimized to maximize its benefits and minimize its deleterious effects concurrently, it is imperative to regulate the appropriate fluoride concentration in water and industrialized products in order to have a beneficial effect on dental caries control without increasing the prevalence of dental fluorosis (1). Therefore, the aim of this study was to assess the concentration of fluoride in mineral water and Amazon guaraná-based soft drinks commercially available in the municipality of Manaus, state of Amazonas, Brazil.

Methodology

Fifteen commercial brands of mineral water and 7 brands of Amazon guaraná-based soft drinks were selected and analyzed for their fluoride content. Three bottles per product brand were bought in Manaus, AM, during the first semester of 2008, and each bottle belonged to a different lot. The

samples were stored in their original bottles until the chemical analysis.

The water and soft drink samples were analyzed in duplicate by using an ion analyzer, ORION 720-A, and a specific electrode, ORION 96-09, previously calibrated with standard fluoride solutions, containing from 0.25 to 2.0 µgF/mL, buffered with TISAB (acetate buffer 1.0 M, pH 5.0, containing 1.0 M NaCl and 0.4% cyclohexane diamine tetracetic acid) in the proportion of 1:1, obtaining a calibration curve from 0.1 to 1.0 µgF/mL (9). A sample of 0,5 mL of each beverage was used in the analyses. Read-outs were obtained in mV and transformed into ppm of fluoride by linear regression. After 20 readings, a new calibration was performed.

Results

The fluoride concentration in 15 brands of mineral water ranged from 0.04 to 1.02 ppmF. In 7 (47%) of the commercial brands (PA, SC, SCG, BL, YA, YAG, AQ) the concentration of fluoride ranged from 0.04 to 0.08 ppmF, while in the other 7 brands (PR, PEL, PER, SAC, SACG, AC, ACG) the concentration varied from 0.10 to 0.47 ppmF; in only one (7%) brand (PRA) the fluoride ion concentration was higher than 0.7 ppmF (mean concentration of 1.02 ppmF) (Table 1).

When the labels on the packaging were compared, 6 brands of mineral water (SC, SCG, YA, YAG, BL, AQ) should not be sold as "Fluoridated Water", according to the classification given by their own manufacturers and stated on the product information. Another irregularity was that the labels of 3 foreign brands of water (PEL, PA, PER) did not specify the levels of ion fluoride present in their composition.

Regarding the Amazon guaraná-based soft drinks, 5 out of 7 commercial brands (71%) showed mean values lower than 0.1 ppmF, and 2 brands (17%) showed a mean concentration of 0.1 ppmF.

Discussion

It is equally important to control the quality of public fluoridated water supplies (10) and to investigate the fluoride content in products widely consumed by the population, such as bottled mineral water and industrialized soft drinks. Recently, the preference for healthful beverages may be one of the factors responsible for the increase in mineral water consumption observed in Brazil and other countries (5,6, 11-13). There is a large variety of mineral waters coming from other regions and sold in the Manaus metropolitan area, which requires the evaluation of their fluoride content to ensure a protective effect against dental caries and minimize the adverse effect of dental fluorosis.

In the present study, the samples of mineral water sold in the Amazon region showed significant variation of ion fluoride concentration (0.03 to 1.09 ppmF), which was also reported in other Brazilian regions (14-16). Only one commercial brand of mineral water (PRA) exceeded the maximum limit

Tabela 1. Concentração média de Fluoreto relatada pelo fabricante e encontrada nas marcas de águas minerais analisadas.

Place of origin (State/Country)	Mineral water codes	N	Fluoride concentration ($\mu\text{gF/mL}$)		
			Reported by the manufacturer	Maximum - minimum value	Mean concentration
São Paulo/Brazil	PR	6	0.23	0.22 - 0.23	0.23
Milan/Italy	PEL	6	NE*	0.45 - 0.48	0.47
Florence/Italy	PA	6	NE*	0.05 - 0.09	0.07
São Paulo/Brazil	PRA	6	1.59	0.93 - 1.09 [†]	1.02 [†]
São Paulo/Brazil	SC	6	0.05	0.06 - 0.08	0.07
São Paulo/Brazil	SCG	6	0.05	0.06 - 0.06	0.06
Vergeze/Italy	PER	6	NE**	0.11 - 0.15	0.13
Amazonas/Brazil	SAC	6	0.03	0.09 - 0.11	0.10
Amazonas/Brazil	SACG	6	0.03	0.10 - 0.11	0.10
Amazonas/Brazil	AC	6	0.14	0.11 - 0.13	0.12
Amazonas/Brazil	ACG	6	0.14	0.09 - 0.11	0.10
Maranhão/Brazil	BL	6	0.02	0.03 - 0.05	0.04
Amazonas/Brazil	YA	6	0.02	0.05 - 0.09	0.06
Amazonas/Brazil	YAG	6	0.02	0.06 - 0.09	0.08
Rio de Janeiro/Brazil	AQ	6	0.02	0.03 - 0.04	0.04

* NE – Concentration not specified by the manufacturer; [†] Values in bold: exceed the recommended value.

Table 2. Mean concentration of fluoride ion reported by the manufacturer and measured in the brands of Amazon guaraná-based soft drinks analyzed.

Soft drink codes	n	Fluoride concentration ($\mu\text{gF/mL}$)		
		Reported by the manufacturer	Maximum - minimum value	Mean concentration
REG	6	NE*	0.04 - 0.10	0.06
RE	6	NE*	0.07 - 0.11	0.10
MA	6	NE*	0.03 - 0.09	0.05
TC	6	NE*	0.05 - 0.09	0.07
TA	6	NE*	0.09 - 0.14	0.10
GA	6	NE*	0.04 - 0.09	0.06
KT	6	NE*	0.03 - 0.06	0.04

* NE – Concentration not specified by the manufacturer

of 0.8 ppm F, which is not in compliance with the Ministry of Health Resolution No. 635, 1975 (4). In 1996, Villena et al. (14) reported that 11 (10.6%) brands of mineral water sold in Brazil had fluoride ion concentrations higher than 0.7 ppmF. In 2004, Ramires et al. (17) analyzed samples from Bauru city and found that 9% showed values higher than 0.8 ppmF. In 2008, Grec et al. (16) found values higher than 0.8 ppmF in 19% of the samples in São Paulo. Although the present findings showed lower levels than these previous studies, Manaus should be monitored by the sanitary agencies because many products coming from other regions are sold in the local market and may increase the risk for dental fluorosis. In the municipality of Manaus the consumption of bottled mineral water is high due to its use as drinking water and to prepare food and drinks.

The Resolution No. 274 of September 22th, 2005 (7), of the Brazilian sanitary agency (ANVISA) (18) establishes that: “It is mandatory that the following warnings should be clearly stated in bold print: a) “Contains Fluoride”, when the product contains over 1 mg/L of fluoride; b) “The product is not recommended for nursing infants and children up to 7-year-old”, when it contains over 2 mg/L of fluoride;

c) “Daily consumption of this product is not recommended: Contains over 2 mg/L of fluoride”, when the product contains over 2 mg/L of fluoride. In the present study it was found that mineral water products with a very low mean concentration of fluoride had labels bearing the title “Fluoridated Mineral Water”, which might induce the population to consume the product to obtain some benefits for dental caries control. Regarding the mineral water composition reported by the manufacturers on the bottle labels, only three commercial products (PEL, PA, PER) did not specify the presence of fluoride ion. Grec et al. (16) also found that the labels of five brands out 35 (2%) did not specify the presence of fluoride in their composition. Villena et al. (14) alerted for the need to know the level of fluoride in bottled mineral water because these products are often used by children, and they highlighted the lack of precise information on the labels of 10 brands (9.6%) out of 104 brands of mineral water consumed in Brazil. Therefore, it is necessary to have a more strict control of fluoride content in industrialized beverages by the governmental agencies, so that the manufacturers would provide correct and complete composition information on the labels of bottled mineral water and soft drinks.

Besides mineral water, Amazon guaraná-based soft drinks also are a possible source of fluoride intake due to their composition and geochemical factors. However, the present soft drink samples showed no significant variation in the fluoride concentration (0.03 to 0.12 ppm). When assessing the fluoride levels measured and the risk/benefit of using fluoride, the Amazon guaraná-based soft drinks did not show fluoride content values that could have a beneficial anti-caries effect. On the other hand, Heintze and Bastos (18) showed that soft drinks showed concentrations of fluoride ranging from 0.05 to 0.79 ppm in a national evaluation; and Heilman et al. (19) found

a variation from 0.02 to 1.28 ppm of fluoride in North America.

In summary, the fluoride ion concentration in 95% of the brands of mineral water and soft drinks analyzed in the present study is negligible for any positive effect on caries control, although some labels bring the statement “fluoridated mineral water”. Only one brand of mineral water showed a higher concentration than the value recommended for human consumption in Brazil. These data suggest that the Brazilian standards that classify water as being fluoridated should be revised considering the risk/benefit binomial of this measure for caries control.

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