



## ORIGINALES

### Fluoride concentrations in water consumed in the Region of Murcia are not sufficient to prevent dental caries

La concentración de fluoruro en las aguas consumidas en la Región de Murcia no es suficiente para prevenir la caries dental

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#### ABSTRACT:

**Introduction:** Dental caries remains the most frequent chronic disease in childhood and is considered a public health problem. Fluoride has proven effectiveness in the prevention of caries and drinking water is the main source of fluoride intake. The objective of this study was to determine fluoride concentrations in tap water from 10 areas and in 10 bottled waters sold in the Region of Murcia.

**Materials and Methods:** The concentration of fluoride in water was determined using a fluoride ion-selective electrode with a direct technique previously calibrated with standard fluoride concentrations prepared with TISAB II.

**Results:** In tap water, fluoride concentrations from 0.09 to 0.18 mgF/L (ppm) were detected; in bottled waters the concentration of fluoride varied from 0.04 to 0.50 ppm.

**Conclusion:** Fluoride is present in the water consumed in the Region of Murcia but in concentrations that do not prevent dental caries. Fluoride supplements should be prescribed in children at high risk of caries, and for this, all external sources of fluoride intake, including water, must be accounted for.

**Key words:** Fluoride, dental caries, mineral water, tap water.

#### RESUMEN:

**Introducción:** La caries sigue siendo la enfermedad crónica más frecuente en el niño y es considerada un problema de salud pública. El flúor es la principal medida protectora contra la caries dental y el agua de consumo es la principal fuente de ingesta de flúor.

**Objetivo:** El objetivo de nuestro trabajo fue calcular la concentración de ión fluoruro en el agua de abastecimiento de 10 zonas y en 10 aguas embotelladas comercializadas en la Región de Murcia.

**Material y Métodos:** La concentración de fluoruro en las aguas se determinó con un electrodo ion-selectivo para flúor previamente calibrado con patrones de fluoruro preparados con TISAB II.

**Resultados:** En el agua de abastecimiento, se detectaron concentraciones de fluoruro entre 0.09 y 0.18 mgF/L (ppm) en las aguas embotelladas la concentración de fluoruro varió desde 0.04 a 0.50 ppm.

**Conclusiones:** El fluoruro está presente en aguas consumidas en la Región de Murcia pero en concentraciones que no alcanzan niveles preventivos para la caries dental. Es necesario prescribir suplementos de flúor en niños con alto riesgo de caries y para ello se deben contabilizar todas las fuentes externas de flúor, incluido el agua.

**Palabras clave:** Flúor, fluoruro, caries dental, agua mineral, agua de bebida.

## INTRODUCTION

The World Health Organization (WHO) states that dental caries remains the most common chronic disease in children in most countries, has a negative impact on the quality of life of children and their families, and is considered a public health problem<sup>(1,2)</sup>.

The 2015 Global Burden of Disease study found that the worldwide age-standardized prevalence rate of untreated dental caries in primary dentition was 7.8% (573 million children) and the incidence of new cases of dental caries in primary dentition was 126 million children in 2015<sup>(3)</sup>. In Spain, the latest oral health survey showed a prevalence of dental caries in the primary dentition of 31.5% at 5-6 years and in the permanent dentition of 33.3% at 12 years and 43.2% at 15 years<sup>(4)</sup>.

Water is one of the main sources of fluoride intake. In dentistry, the fluoride content in the water is relevant, as it may have beneficial or harmful consequences for the patient, depending on the concentration<sup>(5)</sup>.

The fluoridation of drinking water as a preventive, safe and efficient measure against dental caries was introduced in the last century. Within the European Union, only the United Kingdom, Ireland and Spain regulate fluoridation, which is usually done by adding sodium fluoride, hexafluorosilicic acid or fluorosilicic acid. This is a recognized method to prevent dental caries when used in concentrations suitable for each region, according to local temperature<sup>(6,7)</sup>. However, in 2014, the public water supply in 95% of Spanish cities contained < 0.7 ppm of fluoride, as the fluoridation of the public water was abandoned due to the increased consumption of bottled water<sup>(8)</sup>. In the autonomous community of the Region of Murcia, water fluoridation ceased in 2013.

The concentration of fluoride in water necessary to provide a protective effect against dental caries is 0.7 ppm according to the American Academy of Pediatric Dentistry (AAPD)<sup>(9)</sup> or between 0.6 and 0.8 ppm according to the Spanish Ministry of Health (RD 1798/2010 of December 30)<sup>(10)</sup>. In fact, children who drink water with < 0.6 ppm of fluoride and who are at high risk of dental caries should be prescribed oral fluoride supplements<sup>(9)</sup>.

Bottled mineral water is the most consumed commercial drink in Spain, which is the fourth largest producer in the European Union and the fifth in consumption, although experts claim that tap water is just as good, has the same minerals, and a much smaller environmental footprint. In the Region of Murcia, the taste of tap water varies substantially, as it depends on a mixture of water from the River Segura and the River Tagus and desalinated water from the sea, which is why 50% of people in Murcia consume bottled, mineral or mineralized water. Murcia has little rainfall and high temperatures, with more than 300 days of sunshine per year. In 1994, the absolute

maximum temperature in Spain in the twentieth century of 47.2 °C was recorded in Murcia. These reasons may explain the high consumption of tap or mineral water<sup>(11)</sup>.

The objective of this study was to analyze fluoride concentrations in the bottled and tap water consumed in the Region of Murcia.

## MATERIAL AND METHODS

### Samples

#### Bottled water

Ten brands of mineralized and mineralized water frequently found in the shops of the Region of Murcia (Spain) were selected. All were packaged in plastic bottles, except for Vichy Catalan, which was packaged in a glass bottle, and were stored at room temperature, and protected from sunlight and humidity until analysis. One brand contained water from two natural sources. The origins of the bottled water were Alicante, Badajoz, Cuenca, Girona, Granada, Murcia, Pontevedra, and Valencia. The composition on the labels is shown in table 1.

**Table 1:** Composition in the labelling of mineral and mineralized waters consumed in the Region of Murcia.

	Brand	Lot	Composition (mg/L or ppm)								
			Chloride	Bicarbonate	Calcium	Sodium	Sulfate	Magnesium	Potassium	Lithium	Fluoride
Mineralized	Aquarel Nestlé- Els Avets, Girona	L803679411	6.8	131	36.2	10.1	8.9	7.2	-	-	
	Aquarel- Las Jaras, Badajoz	L802379411	6.8	13.2	2.2	4.7	3.7	2.3	-	-	
	Cortés de Arenoso with gas- Alicante	L06/08/18	-	267.1	86.8	7.7	16.0	7.8	<1	-	< 0.01
	Fuente Liviana- Cuenca	L296307	-	273	67.4	0.8	-	18.5	-	-	
	Fuente Primavera - Valencia	L7205C1318	37	303	86	20	-	23	-	-	

	Lanjarón - Granada	L12-02-20	-	131	26.6	5.5	-	12.9	-	-
	Solán de Cabras - Cuenca	L0380391821	-	284	60.0	4.8	-	26.7	1.0	-
	Vichy Catalan- Girona	L3	584.0	2081.0	-	1097.0	49.6	-	50.7	1.3
<b>Mineral</b>	Neval- Moratalla, Murcia	L:08022004	147	243	56.9	91.8	122	44.3	-	-
	Mondariz- Pontevedra	02101A	14.7	-	6.6	47.7	-	5.2	-	-

### Drinking water

50 ml of tap water was collected from 10 different sites in the Region of Murcia: Alcantarilla, Barrio La Merced (Murcia center), Barrio Vista Alegre (Murcia center), Cartagena, Churra (Murcia), El Palmar (Murcia), Espinardo (Murcia), Urbanization La Alcayna (Molina de Segura), Llano de Brujas (Murcia) and Lorca.

The water was stored in polyethylene tubes with screw caps at room temperature and protected from sunlight and humidity until analysis.

Ultrapure water obtained using Milli-Q® IQ 7000 (Merck KGaA, Darmstadt, Germany) was used as a control. All samples were collected and labeled by a researcher who did not intervene in the determinations, to carry out the study blind.

### Determination of fluoride concentrations

Fluoride concentrations were determined using an ion-specific electrode (Orion 9609 BNWP, Thermo Fisher Scientific Inc., Waltham, USA), connected to an ion analyzer (Orion EA-940, Thermo Fisher Scientific Inc. Waltham, USA). The electrode was previously calibrated with standard solutions from 0.10 to 1.0 ppm F<sup>-</sup>, mixing 1 ml of each standard solution with 1 milliliter of TISAB II (Hanna Instruments, Woonsocket, Rhode Island, USA) [1.0 M acetate buffer pH 5.0, 1.0 M NaCl and 0.4% CDTA]. Water samples were buffered with a TISAB II solution (1:1, v/v). Before each reading, the samples were stirred with a vibrator (Classic Vortex Mixer, Velp Scientifica, Italy). The results of the reading were collected in millivolts (mV) and converted to mgF/L (ppm F) using a calibration curve.

## RESULTS

Fluoride concentrations in bottled water ranged from 0.04 to 0.50 ppm (Table 2). Except for Vichy Catalan, the rest of mineralized waters had less fluoride than natural mineral waters.

**Table 2.** Concentration of fluoride in mineral and mineralized bottled water consumed in the Region of Murcia (mg/L or ppm).

	Brand	F <sup>-</sup>
Mineralized	Aquarel Nestlé (Els Avets, Girona)	0.10
	Aquarel (Las Jaras, Badajoz)	0.04
	Cortés de Arenoso with gas (Alicante)	0.08
	Fuente Liviana (Cuenca)	0.1
	Fuente Primavera (Valencia)	0.15
	Lanjarón (Granada)	0.16
	Solán de Cabras (Cuenca)	0.10
	Vichy Catalan (Girona)	0.50
Mineral	Neval (Moratalla, Murcia)	0.21
	Mondariz (Pontevedra)	0.43

Of all the bottled waters, only Cortés de Arenoso mineral water with gas from Alicante and Mondariz from Pontevedra indicated the concentration of fluoride in their labelling.

In Mondariz water, which was stated to contain 0.49 ppm, were found 0.43 ppm; and in Cortés de Arenoso 0.08 ppm was found with the label indicating < 0.1. The other bottled water brands did not indicate the presence of fluoride or whether they contained it.

In tap water, fluoride concentrations ranged from < 0.04 ppm in Cartagena to 0.28 ppm in Vista Alegre (Murcia city center) or in the Urbanization La Alcayna in Molina de Segura (Table 3).

**Table 3.** Concentration of fluoride in the tap waters of the Region of Murcia (mg/L or ppm).

Source of drinking water	Fluoride
Alcantarilla	0.17
Barrio La Merced (Murcia city center)	0.26
Barrio Vista Alegre (Murcia city center)	0.28
Cartagena	< 0.04
Churra (Murcia)	0.18
El Palmar (Murcia)	0.10
Espinardo (Murcia)	0.09
Llano de Bruges (Murcia)	0.23
Lorca	0.18
Urbanization La Alcayna (Molina de Segura)	0.28
Ultrapure water (control)	0.01

## DISCUSSION

Fluoride intervenes in tooth demineralization and remineralization, preventing dental caries. To reduce mineral loss, it must be present in the oral cavity at low and constant concentrations <sup>(12)</sup>. Water is one of the main sources of fluoride intake. Dentistry professionals need to know the contribution of water sources in order to prescribe the fluoride supplements necessary for the correct prevention of dental caries, especially in growing children.

Our results show that the concentration of fluoride contained in the water consumed in Murcia, both bottled and tap, are < 0.6 ppm, a concentration the AAPD considers beneficial for the prevention of dental caries without the risk of fluorosis <sup>(9)</sup>.

In 2014, the tap water in 95% of Spanish cities contained a fluoride concentration of < 0.7 ppm <sup>(8)</sup>. In the Region of Murcia, fluoride has not been added to the public supply since 2013, due to the widespread use of dental products containing fluoride and the consumption of bottled water by 50% of the population, who may know the amount of fluoride it consumes per day, but the remaining 50% has no information on the amount of fluoride they consumes <sup>(11)</sup> as they does not know the amount of fluoride contained in tap water. Although tap water is not fluoridated, a fluoride concentration of > 0.2 ppm was detected in four locations: the two neighborhoods in Murcia city center, the urbanization of Alcayna, and Llano de Brujas. Although La Alcayna and the Barrio de Vista Alegre are 9.1 km distant, the concentration of fluoride was the same - 0.28 ppm.

Spanish regulations do not require mineral and mineralized waters to indicate the amount of fluoride they contain on their labelling when the concentration is < 1.5 mg/L. However, when the concentration is > 1.5 mg/L, they should include the indication "contains more than 1.5 mg/L fluoride: not suitable for regular consumption by infants and children under seven years of age" (RD 140/2003 of February 7<sup>th</sup>) on their labelling, immediately next to the brand name in clearly visible letters<sup>(13)</sup>. According to Real Decreto 1798/2010 of December 30<sup>th</sup> <sup>(10)</sup>, water with >1 ppm should be named "fluoridated or containing fluoride", although it is not mandatory to specify the fluoride concentration on the label. However, the United Nations Food and Agriculture Organization (FAO) stated that, if the product contains more than 1 mg/L of fluoride, the words "contains fluoride" <sup>(14)</sup> should appear on the label as part of the brand name.

Companies marketing bottled water should specify its fluoride content and allow the consumer to decide on whether to purchase it, based on truthful information regarding the consumption of fluoridated drinking water versus "non-fluoridated" water <sup>(15-17)</sup>. The presence of fluoride is stated only on the labels of two of the bottled waters analyzed in our study. The label of Cortés de Arenoso with gas (Alicante) states it contains <0.1 ppm of fluoride, coinciding with the concentration detected in this study (0.08 ppm of fluoride) and the water of Mondariz (Pontevedra) states it contains 0.49 ppm compared with the 0.43 ppm detected in this study.

All bottled water analyzed had a fluoride concentration that was safe for consumption and without risk of dental fluorosis, since the maximum concentration of fluoride found was 0.50 ppm in Vichy Catalan mineralized water (Gerona). However, these concentrations found are also not useful in preventing dental caries. The Spanish Ministry of Health states that, in order to have a protective effect against dental caries,

the fluoride content in water must range from 0.6 to 0.8 ppm for cities such as Murcia, with temperatures between 26.4°C and 32.5°C<sup>(10)</sup>. The need for fluoride supplements in children who drink water with > 0.6 ppm of fluoride and who are at high risk of dental caries should be considered<sup>(9)</sup>. However, before prescribing fluoride supplements it is necessary to analyze the total daily consumption of fluoride of the child, which may come from different sources, such as water (at home, at school, tap and bottled), food and other beverages, infant milk formula, toothpaste, etc.

## CONCLUSIONS

Drinking water, whether tap or bottled, in the Region of Murcia does not contain fluoride in sufficient quantities to prevent dental caries. However, it should be taken into account when prescribing fluoride supplements in children.

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