

## Fluoride levels in Mexican Foods and Beverages

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## **Abbreviations**

AI	Adequate Intake
DW	Deionized water
ENSANUT	Mexican National Health and Nutrition Survey
FFQ	Food Frequency Questionnaire
UK	United Kingdom
US	United States
USDA	United States Department of Agriculture

## **Abstract**

**Background:** Sources of fluoride exposure for Mexicans include foods, beverages, fluoridated salt, and naturally fluoridated water. There is no available database describing the fluoride content of foods and beverages consumed in Mexico.

**Objective:** To estimate the content of fluoride in foods and beverages; and, to compare their content to that of those from the United States (US) and the United Kingdom (UK).

**Methods:** 182 foods and beverages reported as part of the 2012 Mexican Health and Nutrition Survey were purchased in the largest supermarket chains and local markets in Mexico City. Samples were analyzed for fluoride, at least in duplicate, using a modification of the hexamethyldisiloxane microdiffusion method. Values were compared to those from the USDA and UK fluoride content tables.

**Results:** The food groups with the lowest and highest content were eggs (2.32 $\mu$ g/100g) and seafood (371 $\mu$ g/100g), respectively. When estimating the amount of fluoride per portion size, the lowest values corresponded to eggs and the highest to fast foods. Meats and sausages, cereals, fast food, sweets and cakes, fruits, dairy products, legumes and seafood from Mexico presented higher fluoride contents than similar foods from the US or the UK. Drinks and eggs from the US exhibited the highest contents, while this was the case for pasta, soups and vegetables from the UK.

**Conclusion:** The majority of foods and beverages analyzed in this study contained higher fluoride contents than their US and UK counterparts. The data generated in this study will be useful to facilitate the monitoring of fluoride intake in the population.

**Key words:** fluoride, foods, beverages, market-basket survey

**Highlights:**

- Sources of fluoride exposure in Mexico City include foods, beverages, fluoridated salt, and naturally fluoridated water
- The majority of foods and beverages consumed in Mexico City and analyzed in this study contained higher fluoride contents than their US and UK counterparts.
- The data generated in this study will be useful to facilitate the monitoring of fluoride intake in the population.

## Introduction

At appropriate levels, fluoride has been established as a safe and effective agent in the prevention of dental caries [1]. On the other hand, excessive intake of fluoride has been linked to detrimental effects, including the development of dental enamel and skeletal fluorosis, increased bone fractures, and more recently, neurodevelopmental deficits in children [2-5].

Monitoring the intake of fluoride to ensure its protective effects are maximized while decreasing the detrimental effects caused by excessive exposure has become a need, particularly in areas where community fluoridation programs have been implemented. In addition to fluoride naturally present in water or added as part of community fluoridation programs to water or salt, the major sources of fluoride for humans are foods, beverages, dietary supplements, and, for infants and toddlers, dental professional products and reconstituted formulae [6]. These sources must be taken into account when estimating the total fluoride exposure of an individual or populations.

The United States Institute of Medicine has published adequate intake (AI) levels for all ages which may be useful for this purpose [7]. Results of studies in the United States, Canada, the United Kingdom, and Colombia have shown that up to 70% of the total fluoride intake for children (including infants) may be derived from the diet [8-14].

In Mexico, the main sources of fluoride exposure have been reported to be drinking water (natural fluoride content) and salt [15, 16]. Salt is fluoridated as a measure to prevent dental caries in Mexico. The initial regulations established a fluoride concentration of  $250 \pm 50$  mg F/kg salt [17], but a later modification to the norm suggests a range between 200 and 250 mg F/kg salt and indicates that salt for human consumption should be iodized and fluoridated (with the

exception of municipalities where water contains >0.7 ppm fluoride) [18]. For children, dental products have also been reported as a significant source [15].

A recent study analyzed samples of juices and carbonated products in Mexico, and reported mean fluoride concentrations of 0.67 (SD 0.38) to 0.49 (SD 0.41) ppm, respectively. These findings suggest that fluoride ingested through bottled drinks may represent an important part of the total fluoride ingested by children [19]. In addition, variable fluoride concentrations were found in products like bottled water and other bottled drinks (0.08-1.42 mg F/L for juices, 0.07-1.30 mg F/L for fruit drinks, and 0.10-1.70 mg F/L for other bottled drinks) [20].

The US Department of Agriculture (USDA) coordinated the development of a National Fluoride Database of Selected 403 Beverages and Foods, to be able to estimate fluoride intake through the diet [21]. A similar effort has been completed in the United Kingdom where a fluoride database containing 518 commercially available foods and drinks was compiled recently [22].

In spite of the previous efforts to assess fluoride intake and exposure in Mexico, no comprehensive study has been conducted that includes a representative list of foods ingested by the Mexican population, as in other countries. Consequently, the aim of this study was first to estimate fluoride concentrations in the most frequently consumed foods and beverages in Mexico according to the National Health and Nutrition Survey (2012). As a second aim, the data were compared to two available databases for fluoride content: the USDA National Fluoride Database of Selected Beverages and Foods and the Fluoride Content of Selected Drinks and Foods in the UK tables, to establish the main differences between fluoride content of foods and beverages prepared with fluoridated water vs. salt.

## **Methods**

### **Selection of foods**

Using the data from the Mexican National Health and Nutrition Survey 2012 (ENSANUT), we selected 100 more frequently consumed foods and beverages, reported in the 24-hour recall [23]. The list of the 100 more consumed foods obtained by the 24-hour recall did not include all items of the Food Frequency Questionnaire (FFQ), also applied in the same survey; therefore, we included the missing ones (n=25). Finally, qualitative information collected as part of an anthropological study was taken into account to include other foods frequently consumed by Mexico City adolescents (n=57) [24]. In total, 182 different foods (n=166) and beverages (n=16) encompassed in 14 food groups were selected (1. Beverages, 2. Meats, Processed Meat and Poultry, 3. Cereals, 4. Fast food, 5. Mexican Food, 6. Sweets, Pastries, snacks, 7. Fruits, 8. Egg, 9. Dairy Products, 10. Legumes, 11. Soups, pasta, 12. Seafood, 13. Vegetables, 14. Others).

### **Purchasing of Samples**

Grocery stores and farmer markets in Mexico City were identified for the purchase of foods and beverages using the following criteria: 1) We bought fruits and vegetables in three different major markets in the city: "*La Central de Abastos Market*" and "*La Merced Market*", as they distribute food to the majority of the smaller local markets and stores; and one public market located in Mexico City (*Mi Mercado Tacubaya*). 2) We selected four large supermarket chains, the main distributors in Mexico City, with the largest geographical coverage: *Walmart* (Walmart and *Bodega Aurrera*), *Soriana*, *Comercial Mexicana* (*Comercial Mexicana* and *Mega Comercial Mexicana*) and *Chedraui*; all of them with multiple locations (North, South, Center, West and East areas). Meat and dairy products, as well as processed industrialized foods were purchased in these

supermarkets. 3) In the case of traditional prepared foods (corn based foods such as tacos, sopes, quesadillas), and natural juices, streets vendors were chosen for purchasing these items. 4) Finally, other foods were purchased in more specific stores, such as ice cream parlors for traditionally flavored waters, and creameries for milk (i.e. Liconsa milk, an item subsidized by the government).

Foods that are eaten raw or require minimal preparation were purchased in triplicate, i.e.: zucchini squash, chayote squash, eggs, lettuce, lentils, mango, apple, orange, nopales, potato, papaya, cucumber, banana, watermelon, and carrots. For processed foods, at least two brand names and different presentations were included, e.g. sliced bread, cereals, rice, soda. For most foods, three different samples were purchased, selecting a different place of collection (for fruits and vegetables), or different brands or different presentations (in the case of processed foods) to account for variability. All foods were bought between October 2014 and March 2017.

### **Fluoride Analysis**

Foods and beverages were refrigerated within 8 h if they were not processed. Foods that are usually consumed cooked, i.e.: meats, rice, pasta, legumes, were boiled without added salt using the same brand of water which contains negligible amounts of fluoride ( $< 0.01$  ppm). Beverages were thoroughly homogenized, and duplicate aliquots ( $\sim 20$  mL) were saved for fluoride analyses.

Deionized water was added to each food sample, and the resulting weight of the food plus the water was recorded. The amount of deionized water (DW) to be added was decided depending on the consistency of each food. In the case of beverages or semi-liquid foods, DW was not added.



The foods were then thoroughly homogenized for approximately two minutes, using a household blender. Homogenates were placed in 50 ml scintillation vials. These vials had been previously labeled with the food code and the date on which the sample was processed. After the sample was processed, they were frozen at a temperature of -30 °C.

Duplicate aliquots (~ 20 ml) of each food homogenate were frozen until they were analyzed. Frozen aliquots were then shipped to the Indiana University School of Dentistry Oral Health Research Institute for analysis.

Analysis of food and beverages, were conducted using a modification of the hexamethyldisiloxane (HMDS: Sigma–Aldrich) micro-diffusion method as modified by Martinez-Mier et al. as described elsewhere [25]. Briefly, known weights or volumes of samples were pipetted into a plastic petri dish (Falcon 60 × 15 mm disposable Petri dishes, Fisher Scientific/BD Falcon); a sodium hydroxide (NaOH, A.R.: Fisher Scientific) trap solution was placed on the petri dish lid, and after the addition of sulfuric acid (H<sub>2</sub>SO<sub>4</sub>: Fisher Scientific) saturated with HMDS, each dish was immediately tightly sealed. During overnight diffusion, fluoride released by acid hydrolysis was trapped in the NaOH trap. The trap was then recovered and buffered to pH 5.2 with acetic acid (CH<sub>3</sub>COOH: Fisher Scientific). The recovered solution was adjusted to a final volume of 100 µL with DW. Fluoride content of each sample was obtained by comparison of the millivolt reading of the sample to a standard curve prepared from the data for diffused fluoride standard solutions analyzed at the same time.

### **Statistical Analysis**

Our descriptive analysis included the fluoride values of every sample, and the mean and standard deviations for each food and beverage. Foods and beverages were organized in 14 different groups

according to their type and mean and standard deviations for each group were estimated in order to identify the food groups with the highest and lowest fluoride contents.

Comparisons between fluoride contents of foods and beverages in the USDA and UK tables vs. the fluoride content in the Mexican foods and beverages were performed. Each item was matched based on the Mexican foods list. A simple analysis by food and by food group was performed and also the differences in terms of food groups above or below the USDA and the UK tables. Standard portion sizes of each food were also compared between the three databases.

## **Results**

The fluoride content data ( $\mu\text{g/g}$ ,  $\mu\text{g}/100\text{ g}$ , portion size and  $\mu\text{g}/\text{portion size}$ ) of foods and beverages within food groups are shown in table 1. The compiled database shows a wide range in fluoride content between and within the different food groups (the full list of fluoride values of foods and beverages is shown in Appendix A).

The lowest F contents were observed for: vegetable shortening ( $0.24\ \mu\text{g}/100\text{ g}$ ), animal lard ( $0.28\ \mu\text{g}/100\text{ g}$ ), natural juice ( $0.50\ \mu\text{g}/100\text{ mL}$ ), sandwich ( $0.64\ \mu\text{g}/100\text{ g}$ ), canola oil ( $0.65\ \mu\text{g}/100\text{ mL}$ ), cabbage ( $0.67\ \mu\text{g}/100\text{ g}$ ), papaya ( $0.74\ \mu\text{g}/100\text{ g}$ ) and lemon ( $0.87\ \mu\text{g}/100\text{ g}$ ). Foods with the highest F content were: jelly ( $366.79\ \mu\text{g}/100\text{ g}$ ), pre-cooked rice ( $434.38\ \mu\text{g}/100\text{ g}$ ), hot chocolate mix ( $521.16\ \mu\text{g}/100\text{ g}$ ), wholegrain bread/toast ( $588.44\ \mu\text{g}/100\text{ g}$ ), oysters ( $1461.58\ \mu\text{g}/100\text{ g}$ ) and fried/baked pork rinds ( $1465.40\ \mu\text{g}/100\text{ g}$ ). For the food groups, the ones with the highest median

were seafood (371.29  $\mu\text{g}/100\text{ g}$ ), meats and poultry (191.47  $\mu\text{g}/100\text{ g}$ ), fast food (118.02  $\mu\text{g}/100\text{ g}$ ) and legumes (84.91  $\mu\text{g}/100\text{ g}$ ).

Once the fluoride content per portion size of food was calculated, fast foods were found to contain the highest concentration of fluoride (209.61  $\pm$  182.30  $\mu\text{g}/\text{portion}$ ), followed by seafood (191.99  $\pm$  305.57  $\mu\text{g}/\text{portion}$ ). Foods with the lowest fluoride content were eggs (1.27  $\pm$  0.49  $\mu\text{g}/\text{portion}$ ) and fruits (5.08  $\pm$  6.06  $\mu\text{g}/\text{portion}$ ).

When comparing fluoride levels from foods or beverages among countries, differences in fluoride content were found for more than 40% (62 out of 150) of equivalent items. When comparing the fluoride content of Mexican foods with USDA and UK data (by 100 g), some important differences by group were found (Table 2). In the case of meats and sausages, cereals, fast foods, candies and pastries, fruits, dairy products, legumes, and seafood, Mexican foods were found to contain more fluoride than their US and UK counterparts. In comparison, US beverages and eggs contained the most fluoride, whereas pasta, soups and vegetables from the UK presented the highest fluoride content.

## **Discussion**

The present study aimed to develop a comprehensive fluoride database including 182 different foods and beverages, which is the first of its kind in Mexico. The creation of such a database will enable researchers and public health professionals to estimate the dietary fluoride intake in the Mexican population. Previous studies have evaluated fluoride intake from foods (18,19), albeit on a limited scale not comparable to the present, comprehensive study. The present study

included the most representative foods and beverages consumed at the national level, with the fluoride content of a total of 166 foods and 16 beverages being determined.

This effort is the first step in understanding the contribution of diet to the total fluoride intake of a Mexican sample. The complexity of understanding the diet's contribution to the total exposure implies taking into account both, the fluoride content in foods and the portion eaten. For this reason, it is important to highlight that, per portion size; fast food appears as the principal source of fluoride. This finding is quite important in a country like Mexico where discretionary foods represent more than a quarter of total energy intake [26].

The comparison of the fluoride values between countries showed multiple differences, which can be explained by previously documented factors that influence fluoride content such as: water, soil, and pesticides [6]. USDA tables show the highest fluoride content in beverages, which was expected as water is the vehicle for fluoridation programs in the US. In Mexico, however, the food fluoride concentration is mostly associated with the content of salt. In UK, vegetables are particularly high in relation to the other two countries; this may be explained by high fluoride concentrations reported for soil in the UK (ranging between 200-400 mg F/kg [27]).

One of the strengths of our study is that samples for each item were obtained in duplicate or triplicate, in attempt to capture the natural variability in fluoride content. This effort also included: the selection of different forms of preparations, presentations of the same food, different brands in the case of industrialized foods, gives a better explanation of an independent variability represents.

Even though the list of foods selected for this study represents the national intake; one of its limitations is that all the samples were purchased in Mexico City, thereby limiting the generalizability to the entire Mexican population. For example, fluoride concentrations in natural water in the north-central part of Mexico can be as high as 4.5 mg/L, which is considerably higher than what has been recommended [28]. This can affect the fluoride concentration of vegetables grown and beverages produced in this region .

Another limitation is that when comparing the different databases from the three countries, some foods lack an equivalent and were therefore not included in the analysis. Thus, the averages calculated by food group had different numbers of items.

Finally, the information generated in this study has the potential to become a tool to facilitate the monitoring of dietary intake, especially in vulnerable populations like children and pregnant women. Its use in combination with estimates of intake from other sources like salt and toothpaste, could give public health authorities a better picture of the total fluoride exposure in the population.

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Table 1. Fluoride content data ( $\mu\text{g/g}$ ,  $\mu\text{g}/100\text{ gr}$ , portion size and  $\mu\text{g}/\text{portion}$  size) of foods and beverages within food groups most consumed in Mexico

Food Group	Food/Beverage	$\mu\text{g}/100\text{ g}$	Portion size (gr or mL)	$\mu\text{g}/\text{portion}$
Beverages	Water, Bottled	14.2440	240	34.1855
	Water, tap	16.8160	240	40.3583
	Water, EVIAN	4.4959	240	10.7902
	Sugar Flavored beverage, LA MICHOACANA	13.8791	240	33.3098
	Corn-based beverage	15.1541	240	36.3698
	Beer, 4% alcohol, CORONITA EXTRA	74.8357	240	179.6058
	Sugar beverage, orange flavore, FRUTSI	15.6332	240	37.5198
	Coffee with sugar, americano, ANDATTI	17.8887	240	42.9329
	Natural Juice, orange flavor, home made	0.5043	240	1.2104
	Sugar beverage, apple flavore, BOING	29.1712	240	70.0109
	Concentrated comercial juice, apple flavore, JUMEX	22.0311	240	52.8746
	Concentrated comercial juice, apple flavore, DEL VALLE	13.1329	240	31.5189
	Soda, Coca Cola	70.5247	240	169.2593
	Soda, Pepsi	31.6193	240	75.8864
	Soda, orange flavor, FANTA	20.8726	240	50.0943
	Chamomile Tea, LAGG's	10.8731	240	26.0955
		<b>Mean</b>	<b>23.2297</b>	
	<b>SD</b>	<b>20.8094</b>		<b>49.9426</b>
Meats, Processed Meat and Poultry	Chicken leg or thigh or breast, COMERSA	55.6524	90	50.0872
	Chicken leg or thigh or breast, BACHOCO	27.1071	90	24.3964
	Pork ribs	38.0461	55	20.9254
	Pork ribs, COMERSA	100.1858	55	55.1022
	Beef, lean meat	15.0616	55	8.2839
	Beef, lean meat, RANCHO DON FRANCISCO	23.4469	55	12.8958
	Beef lean meat, COMERSA	17.5302	55	9.6416
	Pork rind	1465.4056	30	439.6217
	Turkey ham, ZWAN	39.3966	30	11.8190
	Turkey ham, FUD	125.8863	30	37.7659
	Mexican style longaniza sausage	191.4689	30	57.4407
	Turkey sausage, ZWAN	176.3699	30	52.9110
	Pork sausage, FUD	295.9576	30	88.7873
	Pork sausage, KIR	109.0558	30	32.7167
		<b>Mean</b>	<b>191.4693</b>	
	<b>SD</b>	<b>375.7267</b>		<b>110.4627</b>
Cereals	Amaranto cereal, bars	37.8555	25	9.4639

	Rice precooked, VERDE VALLE	434.3866	100	434.3866
	Rice, cooked , LA MERCED	14.8462	100	14.8462
	Rice, cooked	45.7077	100	45.7077
	Cereal bar, CHOCO KRISPIS KELLOGG'S	45.7790	25	11.4447
	Cereal bar, ZUCARITAS KELLOGG'S	94.4872	25	23.6218
	Cereal Bar, BRAND FRUIT, BIMBO	82.3370	25	20.5843
	Barley, fluor	51.0909	100	51.0909
	Rye, fluor	42.2924	100	42.2924
	Cereal, Corn Flakes, KELLOG´S	54.9474	30	16.4842
	Cereal, Frosted Flakes, KELLOG´S	49.0997	30	14.7299
	Cereal, chocolate, KELLOG´S	74.2373	30	22.2712
	Crackers, SALADITAS GAMESA	63.4962	20	12.6992
	Crackers, HABNERAS GAMESA	9.1440	20	1.8288
	Crackers, RITZ	15.6325	20	3.1265
	Corn flour, MASECA	59.2372	100	59.2372
	Corn tortilla	43.0123	25	10.7531
	Bread, white, BIMBO	90.2060	70	63.1442
	Bread, white, bakery	44.9442	70	31.4609
	Bread, white, bakery	6.2292	70	4.3605
	Sweet bread, TIA ROSA	49.5836	70	34.7085
	Sweet bread, TIA ROSA	18.0721	70	12.6505
	Sweet bread, with nuts, TIA ROSA	32.2893	70	22.6025
	Bread, whole wheat, BIMBO	84.1922	70	58.9345
	Bread, whole wheat, bakery	49.4836	70	34.6385
	Bread, whole wheat, toast	588.4410	70	411.9087
	Bread crumbs, BIMBO	81.2350	50	40.6175
	Potatoe, white	3.8297	40	1.5319
	Potatoe, french fried	165.7370	40	66.2948
	Potatoe, fried, home made	12.1351	40	4.8541
	Potatoe, precooked	99.9706	40	39.9883
	Flour tortilla	64.2652	30	19.2796
	Flour tortilla, whole wheat	22.7624	100	22.7624
	Flour tortilla, LA MODERNA	14.6661	100	14.6661
	<b>Mean</b>	<b>77.8127</b>		<b>49.3815</b>
	<b>SD</b>	<b>116.5597</b>		<b>96.6820</b>
Fast Food	Bcheese burger, home made	199.9384	240	479.8522
	Hot Dog, home made	138.5327	110	152.3859
	Pizza, DOMINO´S PIZZA	132.9694	92	122.3319
	Sandwich, LUNCHIBON	64.5218	130	83.8784
	<b>Mean</b>	<b>133.9906</b>		<b>209.6121</b>
	<b>SD</b>	<b>55.3675</b>		<b>182.3288</b>
	Cheese taco, home made	62.6610	100	62.6610



Mexican Food	Traditional corn-based dish	102.9415	100	102.9415
	Tamal	11.4053	200	22.8106
	Traditonal corn-based dish	94.3880	100	94.3880
	<b>Mean</b>	<b>67.8490</b>		<b>70.7003</b>
	<b>SD</b>	<b>41.4271</b>		<b>36.3256</b>
Sweets, Pastries, Snacks	Peanut,salty, GOLDEN NUTS, BARCEL	24.7579	35	8.6653
	Peanut, raw	28.5482	35	9.9919
	Powder chocolate, CHOCO MILK	521.1624	10	52.1162
	Bar Chocolate, CARLOS V	56.9590	10	5.6959
	Ice stick, BON ICE	23.1985	60	13.9191
	Penaut candy, DE LA ROSA	18.3311	30	5.4993
	Chilli candy, MICKEY CHAMOY	23.9155	30	7.1746
	Chilli Candy, PELON PELO RICO	2.6027	30	0.7808
	Lolly pop, TUTSI CHUPA POP	9.9815	30	2.9945
	Corn snacks, TOTIS	135.8429	35	47.5450
	Sweet Cookie, MARIAS GAMESA	144.1042	32	46.1134
	Sweet Cookie, with marshmallow, MINI MAMUT	18.3054	32	5.8577
	Jelly powder, D´GARI	366.7965	125	458.4956
	Chewing gum, BUBALOO	5.3641	30	1.6092
	Ice cream, lemon, HOLANDA	62.5192	50	31.2596
	Chips, SABRITAS	94.7702	35	33.1696
	Chips, BARCEL		35	5.5663
	Chips, home made	49.4911	35	17.3219
	Snack type, chocolate cup cake, cream filled	36.3590	70	25.4513
	Snack type, chocolate cup cake, cream filled	29.4039	70	20.5827
Lemon pie, frozen, KIRKLAND	14.3569	125	17.9461	
Pumkin seed, toasted, salted	164.6264	35	57.6192	
	<b>Mean</b>	<b>87.2094</b>		<b>39.7898</b>
	<b>SD</b>	<b>129.8224</b>		<b>95.1544</b>
Fruits	Strawberries, raw	2.7779	140	3.8891
	Guaba, raw	1.9407	75	1.4555
	Mango, raw	12.3304	185	22.8113
	Mango, raw	3.5198	185	6.5116
	Apple, raw, with peel	7.1534	100	7.1534
	Cantaloupe, raw	1.9690	100	1.9690
	Orange, raw	1.1045	145	1.6016
	Papaya, raw	0.7432	100	0.7432
	Pineapple, raw	2.7268	75	2.0451
	Banana, raw	1.3372	176	2.3534
	Watermelop, raw	7.7308	100	7.7308
	Grapefruit, raw	2.0297	135	2.7400
		<b>Mean</b>	<b>3.7803</b>	

	<b>SD</b>	<b>3.4949</b>		<b>6.0681</b>
Egg	Egg, cooked, white, BACHOCO	2.2242	55	1.2233
	Egg, cooked, white, GENA	1.4794	55	0.8137
	Egg, cooked, red, SAN JUAN	3.2678	55	1.7973
	<b>Mean</b>	<b>2.3238</b>		<b>1.2781</b>
	<b>SD</b>	<b>0.8983</b>		<b>0.4941</b>
Dairy Products	Cream, fluid, half and half, LALA	4.7835	10	0.4784
	Cream, fluid, LALA	5.9621	10	0.5962
	Cream, fluid, ALPURA	4.2150	10	0.4215
	Cream, fluid	11.3783	10	1.1378
	Petite swiss cheese, strawberry flavor, DANONINO	29.6281	45	13.3326
	Powder milk, whole milk, NIDO	142.3928	240	341.7428
	Milk, skim, ALPURA 2000	11.1449	240	26.7478
	Milk, whole milk, NUTRILECHE	16.9727	240	40.7346
	Milk, whole, LALA	5.1051	240	12.2522
	Milk, Skim, Fortified, LICONSA	11.0335	240	26.4805
	Milk, fresh	2.4509	240	5.8823
	Cheese, fresh, AGUASCALIENTES	98.3093	30	29.4928
	Cheese, manchego, NESTLÉ	44.9490	30	13.4847
	Cheese, panela, LOS VOLCANES	45.2670	30	13.5801
	Cheese, Oaxaca, LALA	18.8579	30	5.6574
	Fermented skimmed milk drink - YAKULT	22.9782	80	18.3825
	Fermented skimmed milk drink, low in sugar - LALA	32.2082	80	25.7665
	Yogurt, natural, ALPURA	3.3508	150	5.0262
	Yogurt, natural, LALA	5.3380	150	8.0069
		<b>Mean</b>	<b>27.1750</b>	
	<b>SD</b>	<b>36.2009</b>		<b>76.1272</b>
Legumes	Spanish alubia beans, VERDE VALLE	303.9590	50	151.9795
	Beans, fried, LA COSTEÑA	56.3649	50	28.1825
	Beans, boiled, home made	237.2508	50	118.6254
	Beans, boiled, VALLE VERDE	50.4446	50	25.2223
	Chic peas, LA MERCED	22.1167	50	11.0584
	Lima beans, boiled, LA MERCED	21.6804	50	10.8402
	Lentils, Boiled, LA MERCED	25.7501	50	12.8751
	Lentils, Boiled, VALLE VERDE	21.8468	50	10.9234
	Lentils, Soup, Knorr	24.8116	50	12.4058
	<b>Mean</b>	<b>84.9139</b>		<b>42.4569</b>
	<b>SD</b>	<b>107.3676</b>		<b>53.6838</b>
Soups , pasta	Soup, chicken broth	16.2194	120	19.4633
	Vegetable broad, canned, CAMPBELL's	24.2024	78	18.8778
	Mushroom soup, home made	22.1404	78	17.2695
	Pasta, soup, preccoked, KNORR	20.0426	50	10.0213

	Pasta, soup, home made, LA MORENA	14.6511	50	7.3256
	Spaguetti, home made	178.6394	50	89.3197
	Vegetables, soup, home made	12.7249	120	15.2698
	<b>Mean</b>	<b>41.2315</b>		<b>25.3639</b>
	<b>SD</b>	<b>60.7304</b>		<b>28.5640</b>
Seafood	Clam, cooked	1461.5870	50	730.7935
	Tunna, canned, DOLORES	17.8687	40	7.1475
	Dried Cod, Norwegian, cooked	114.3219	80	91.4575
	Shrimp, cooked	247.2479	50	123.6239
	Sunfish, cooked	15.4316	45	6.9442
	<b>Mean</b>	<b>371.2914</b>		<b>191.9933</b>
	<b>SD</b>	<b>616.7877</b>		<b>305.5727</b>
Vegetables	Collard greens, boiled	193.1117	85	164.1449
	Avocado, raw	6.8195	33	2.2504
	Broccoli, boiled	7.6994	35	2.6948
	Squash, cooked	3.9087	50	1.9544
	Onion, raw	1.5078	10	0.1508
	Chayote squash, cooked	5.1566	50	2.5783
	Ancho chile, dried, cooked	30.0077	10	3.0008
	De Arbol chile, dried, cooked	2.7830	10	0.2783
	Guajillo chile, dried cooked	32.9668	10	3.2967
	Jalapeño Chilli, LA COSTEÑA	4.4090	10	0.4409
	Cabbage, boiled	5.2256	35	1.8290
	Cauliflower, boiled	0.6758	35	0.2365
	Spinach, cooked	44.7400	85	38.0290
	fresh beans, cooked	12.7046	30	3.8114
	Corn , cooked	7.6777	50	3.8388
	Tomatoes, cooked	1.7824	30	0.5347
	Lettuce, raw	15.5267	30	4.6580
	Jicama, raw	2.7701	163	4.5152
	Lemon, raw	0.8752	5	0.0438
	Cactus, cooked	8.0121	70	5.6085
	Cucumber, raw	14.8598	150	22.2896
	Fat hen, cooked	39.5299	85	33.6004
Carrots, cooked	13.7210	50	6.8605	
	<b>Mean</b>	<b>19.8466</b>		<b>13.3324</b>
	<b>SD</b>	<b>39.8494</b>		<b>34.4593</b>
Other	Sugar, granulated	15.2300	10	1.5230
	Vegetable oil, corn	0.6549	14	0.0917
	Chicken stock, granulated, SAN JORGE	81.2233	6	4.8734
	Chicken stock, granulated, KNORR	198.4767	6	11.9086
	Margarine	7.5911	10	0.7591

Butter	1.0315	10	0.1031
Mayonnaise	1.2988	10	0.1299
Lard	0.2815	30	0.0845
Lard, vegetable, INCA	0.2446	30	0.0734
Spicy souce, VALENTINA	2.3861	5	0.1193
<b>Mean</b>	<b>30.8419</b>		<b>1.9666</b>
<b>SD</b>	<b>63.9241</b>		<b>3.7984</b>

Table 2. Fluoride content from foods or beverages among composition tables of different countries

Food Group	Food/Beverage	MEXICO	USDA	UK	$\mu\text{g}/100\text{ g}$
		$\mu\text{g}/100\text{ g}$	$\mu\text{g}/100\text{ g}$		
Beverages	Water, Bottled	14.2440	16.0000	NA	
	Water, tap	16.8160	71.0000	NA	
	Water, EVIAN	4.4959	10.0000	NA	
	Sugar Flavored beverage, LA MICHOACANA	13.8791	NA	NA	
	Corn-based beverage	15.1541	NA	NA	
	Beer, 4% alcohol, CORONITA EXTRA	74.8357	44.0000	NA	
	Sugar beverage, orange flavore, FRUTSI	15.6332	54.0000	NA	
	Coffee with sugar, americano, ANDATTI	17.8887	91.0000	40.0000	
	Natural Juice, orange flavor, home made	0.5043	55.0000	2.3000	
	Sugar beverage, apple flavore, BOING	29.1712	104.0000	10.2000	
	Concentrated comercial juice, apple flavore, JUMEX	22.0311	104.0000	10.2000	
	Concentrated comercial juice, apple flavore, DEL VALLE	13.1329	104.0000	10.2000	
	Soda, Coca Cola	70.5247	49.0000	0.0900	
	Soda, Pepsi	31.6193	32.0000	0.0900	
	Soda, orange flavor, FANTA	20.8726	84.0000	10.5000	
	Chamomile Tea, LAGG's	10.8731	373.0000	44.4300	
<b>Mean</b>	<b>23.2297</b>	<b>85.0714</b>	<b>14.2233</b>		
<b>SD</b>	<b>20.8094</b>	<b>88.7056</b>	<b>16.5113</b>		
Meats, Processed Meat and Poultry	Chicken leg or thigh or breast, COMERSA	55.6524	15.0000	54.9000	
	Chicken leg or thigh or breast, BACHOCO	27.1071	15.0000	54.9000	
	Pork ribs	38.0461	38.0000	3.1800	
	Pork ribs, COMERSA	100.1858	38.0000	3.1800	
	Beef, lean meat	15.0616	22.0000	5.8000	
	Beef, lean meat, RANCHO DON FRANCISCO	23.4469	22.0000	5.8000	
	Beef lean meat, COMERSA	17.5302	22.0000	5.8000	
	Pork rind	1465.4056	NA	NA	
	Turkey ham, ZWAN	39.3966	NA	6.9300	

	Turkey ham, FUD	125.8863	NA	6.9300
	Mexican style longaniza sausage	191.4689	NA	NA
	Turkey sausage, ZWAN	176.3699	41.0000	1.6000
	Pork sausage, FUD	295.9576	18.0000	1.6000
	Pork sausage, KIR	109.0558	18.0000	1.6000
	<b>Mean</b>	<b>191.4693</b>	<b>24.9000</b>	<b>12.6850</b>
	<b>SD</b>	<b>375.7267</b>	<b>10.1045</b>	<b>19.8219</b>
	Amaranto cereal, bars	37.8555	NA	NA
	Rice precooked, VERDE VALLE	434.3866	41.0000	175.2000
	Rice, cooked , LA MERCED	14.8462	41.0000	NA
	Rice, cooked	45.7077	41.0000	NA
	Cereal bar, CHOCO KRISPIS KELLOGG'S	45.7790	NA	8.0000
	Cereal bar, ZUCARITAS KELLOGG'S	94.4872	NA	NA
	Cereal Bar, BRAND FRUIT, BIMBO	82.3370	NA	NA
	Barley, fluor	51.0909	NA	NA
	Rye, fluor	42.2924	51.0000	NA
	Cereal, Corn Flakes, KELLOG'S	54.9474	17.0000	7.9500
	Cereal, Frosted Flakes, KELLOG'S	49.0997	24.0000	13.2000
	Cereal, chocolate, KELLOG'S	74.2373	31.0000	17.4000
	Crackers, SALADITAS GAMESA	63.4962	24.0000	13.1300
	Crackers, HABNERAS GAMESA	9.1440	24.0000	13.1300
	Crackers, RITZ	15.6325	24.0000	13.1300
	Corn flour, MASECA	59.2372	NA	NA
Cereals	Corn tortilla	43.0123	50.0000	NA
	Bread, white, BIMBO	90.2060	39.0000	56.1000
	Bread, white, bakery	44.9442	39.0000	56.1000
	Bread, white, bakery	6.2292	39.0000	56.1000
	Sweet bread, TIA ROSA	49.5836	NA	NA
	Sweet bread, TIA ROSA	18.0721	NA	NA
	Sweet bread, with nuts, TIA ROSA	32.2893	NA	NA
	Bread, whole wheat, BIMBO	84.1922	39.0000	22.2000
	Bread, whole wheat, bakery	49.4836	39.0000	22.2000
	Bread, whole wheat, toast	588.4410	39.0000	9.7000
	Bread crumbs, BIMBO	81.2350	39.0000	22.2000
	Potatoe, white	3.8297	49.0000	44.6700
	Potatoe, french fried	165.7370	26.0000	23.8000
	Potatoe, fried, home made	12.1351	44.0000	11.2000
	Potatoe, precooked	99.9706	44.0000	11.2000
	Flour tortilla	64.2652	33.0000	55.3000
	Flour tortilla, whole wheat	22.7624	NA	NA
	Flour tortilla, LA MODERNA	14.6661	NA	NA
	<b>Mean</b>	<b>77.8127</b>	<b>36.3913</b>	<b>32.5955</b>

	<b>SD</b>	<b>116.5597</b>	<b>9.3504</b>	<b>38.0112</b>
Fast Food	Bcheese burger, home made	199.9384	28.0000	13.9000
	Hot Dog, home made	138.5327	NA	NA
	Pizza, DOMINO'S PIZZA	132.9694	31.0000	31.4000
	Sandwich, LUNCHIBON	0.6452	37.0000	NA
	<b>Mean</b>	<b>118.0214</b>	<b>32.0000</b>	<b>22.6500</b>
	<b>SD</b>	<b>83.9280</b>	<b>4.5826</b>	<b>12.3744</b>
Mexican Food	Cheese taco, home made	62.6610	NA	NA
	Traditional corn-based dish	102.9415	NA	NA
	Tamal	11.4053	NA	NA
	Traditonal corn-based dish	94.3880	NA	NA
	<b>Mean</b>	<b>67.8490</b>		
	<b>SD</b>	<b>41.4271</b>		
Sweets, Pastries, Snacks	Peanut,salty, GOLDEN NUTS, BARCEL	24.7579	16.0000	NA
	Peanut, raw	28.5482	NA	NA
	Powder chocolate, CHOCO MILK	521.1624	NA	NA
	Bar Chocolate, CARLOS V	56.9590	NA	NA
	Ice stick, BON ICE	23.1985	74.0000	NA
	Penaut candy, DE LA ROSA	18.3311	NA	NA
	Chilli candy, MICKEY CHAMOY	23.9155	NA	NA
	Chilli Candy, PELON PELO RICO	2.6027	NA	NA
	Lolly pop, TUTSI CHUPA POP	9.9815	27.0000	NA
	Corn snacks, TOTIS	135.8429	NA	NA
	Sweet Cookie, MARIAS GAMESA	144.1042	16.0000	NA
	Sweet Cookie, with marshmallow, MINI MAMUT	18.3054	16.0000	7.3000
	Jelly powder, D'GARI	366.7965	73.0000	22.0000
	Chewing gum, BUBALOO	5.3641	5.0000	NA
	Ice cream, lemon, HOLANDA	62.5192	74.0000	NA
	Chips, SABRITAS	94.7702	65.0000	11.2000
	Chips, BARCEL	15.9037	65.0000	11.2000
	Chips, home made	49.4911	65.0000	11.2000
	Snack type, chocolate cup cake, cream filled	36.3590	38.0000	NA
	Snack type, chocolate cup cake, cream filled	29.4039	38.0000	NA
Lemon pie, frozen, KIRKLAND	14.3569	22.5000	NA	
Pumkin seed, toasted, salted	164.6264	NA	NA	
	<b>Mean</b>	<b>83.9682</b>	<b>42.4643</b>	<b>12.5800</b>
	<b>SD</b>	<b>127.6025</b>	<b>25.7611</b>	<b>5.5301</b>
Fruits	Strawberries, raw	2.7779	4.0000	1.9500
	Guaba, raw	1.9407	NA	NA
	Mango, raw	12.3304	NA	NA
	Mango, raw	3.5198	NA	NA
	Apple, raw, with peel	7.1534	3.0000	1.9000

	Cantaloupe, raw	1.9690	1.0000	0.6000
	Orange, raw	1.1045	NA	2.3000
	Papaya, raw	0.7432	NA	NA
	Pineapple, raw	2.7268	NA	NA
	Banana, raw	1.3372	2.0000	0.7700
	Watermelon, raw	7.7308	1.0000	NA
	Grapefruit, raw	2.0297	1.0000	NA
	<b>Mean</b>	<b>3.7803</b>	<b>2.0000</b>	<b>1.5040</b>
	<b>SD</b>	<b>3.4949</b>	<b>1.2649</b>	<b>0.7657</b>
Egg	Egg, cooked, white, BACHOCO	2.2242	5.0000	0.8800
	Egg, cooked, white, GENA	1.4794	5.0000	0.8800
	Egg, cooked, red, SAN JUAN	3.2678	5.0000	0.8800
		<b>2.3238</b>	<b>5.0000</b>	<b>0.8800</b>
		<b>0.8983</b>	<b>0.0000</b>	<b>0.0000</b>
Dairy Products	Cream, fluid, half and half, LALA	4.7835	3.0000	2.1667
	Cream, fluid, LALA	5.9621	3.0000	2.1667
	Cream, fluid, ALPURA	4.2150	3.0000	2.1667
	Cream, fluid	11.3783	3.0000	2.1667
	Petite swiss cheese, strawberry flavor, DANONINO	29.6281	NA	NA
	Powder milk, whole milk, NIDO	142.3928	3.0000	0.8000
	Milk, skim, ALPURA 2000	11.1449	3.0000	0.8000
	Milk, whole milk, NUTRILECHE	16.9727	3.0000	0.8000
	Milk, whole, LALA	5.1051	3.0000	0.8000
	Milk, Skim, Fortified, LICONSA	11.0335	3.0000	0.8000
	Milk, fresh	2.4509	3.0000	0.8000
	Cheese, fresh, AGUASCALIENTES	98.3093	34.0000	20.1700
	Cheese, manchego, NESTLÉ	44.9490	34.0000	20.1700
	Cheese, panela, LOS VOLCANES	45.2670	34.0000	20.1700
	Cheese, Oaxaca, LALA	18.8579	34.0000	20.1700
	Fermented skimmed milk drink - YAKULT	22.9782	NA	NA
	Fermented skimmed milk drink, low in sugar - LALA	32.2082	NA	NA
	Yogurt, natural, ALPURA	3.3508	12.0000	2.8000
	Yogurt, natural, LALA	5.3380	12.0000	2.8000
		<b>Mean</b>	<b>27.1750</b>	<b>11.8750</b>
	<b>SD</b>	<b>36.2009</b>	<b>13.5296</b>	<b>8.3418</b>
Legumes	Spanish alubia beans, VERDE VALLE	303.9590	2.000	23.150
	Beans, fried, LA COSTEÑA	56.3649	19.000	NA
	Beans, boiled, home made	237.2508	2.000	NA
	Beans, boiled, VALLE VERDE	50.4446	2.000	NA
	Chic peas, LA MERCED	22.1167	NA	NA
	Lima beans, boiled, LA MERCED	21.6804	7.000	NA
	Lentils, Boiled, LA MERCED	25.7501	NA	NA

	Lentils, Boiled, VALLE VERDE	21.8468	NA	NA
	Lentils, Soup, Knorr	24.8116	NA	NA
	<b>Mean</b>	<b>84.9139</b>	<b>6.4000</b>	<b>23.1500</b>
	<b>SD</b>	<b>107.3676</b>	<b>7.3689</b>	
Soups , Pasta	Soup, chicken broth	16.2194	61.0000	NA
	Vegetable broad, canned, CAMPBELL's	24.2024	NA	42.4000
	Mushroom soup, home made	22.1404	NA	NA
	Pasta, soup, preccoked, KNORR	20.0426	6.0000	NA
	Pasta, soup, home made, LA MORENA	14.6511	6.0000	23.2500
	Spaguetti, home made	178.6394	24.0000	154.7000
	Vegetables, soup, home made	12.7249	NA	NA
	<b>Mean</b>	<b>41.2315</b>	<b>24.2500</b>	<b>73.4500</b>
	<b>SD</b>	<b>60.7304</b>	<b>25.9278</b>	<b>71.0130</b>
Seafood	Clam, cooked	1461.5870	61.0000	NA
	Tunna, canned, DOLORES	17.8687	31.0000	12.5500
	Dried Cod, Norwegian, cooked	114.3219	NA	358.4000
	Shrimp, cooked	247.2479	183.5000	NA
	Sunfish, cooked	15.4316	18.0000	NA
	<b>Mean</b>	<b>371.2914</b>	<b>73.3750</b>	<b>185.4750</b>
	<b>SD</b>	<b>616.7877</b>	<b>75.5925</b>	<b>244.5529</b>
Vegetables	Collard greens, boiled	193.1117	27.0000	NA
	Avocado, raw	6.8195	7.0000	6.8000
	Broccoli, boiled	7.6994	4.0000	63.2700
	Squash, cooked	3.9087	2.0000	NA
	Onion, raw	1.5078	1.0000	NA
	Chayote squash, cooked	5.1566	NA	NA
	Ancho chile, dried, cooked	30.0077	NA	NA
	De Arbol chile, dried, cooked	2.7830	NA	2.0700
	Guajillo chile, dried cooked	32.9668	NA	NA
	Jalapeño Chilli, LA COSTEÑA	4.4090	NA	NA
	Cabbage, boiled	5.2256	1.0000	30.9000
	Cauliflower, boiled	0.6758	1.0000	37.3800
	Spinach, cooked	44.7400	38.0000	NA
	fresh beans, cooked	12.7046	NA	20.9200
	Corn , cooked	7.6777	16.5000	17.8500
	Tomatoes, cooked	1.7824	4.0000	1.0500
	Lettuce, raw	15.5267	5.0000	5.4500
	Jicama, raw	2.7701	NA	NA
	Lemon, raw	0.8752	NA	NA
	Cactus, cooked	8.0121	NA	NA
Cucumber, raw	14.8598	1.0000	1.0000	
Fat hen, cooked	39.5299	NA	NA	



	Carrots, cooked	13.7210	47.0000	60.8000
	<b>Mean</b>	<b>19.8466</b>	<b>11.8846</b>	<b>22.4991</b>
	<b>SD</b>	<b>39.8494</b>	<b>15.6314</b>	<b>23.0697</b>
	Sugar, granulated	15.2300	1.0000	1.2000
	Vegetable oil, corn	0.6549	1.0000	0.0000
	Chicken stock, granulated, SAN JORGE	81.2233	NA	NA
	Chicken stock, granulated, KNORR	198.4767	NA	NA
Other	Margarine	7.5911	5.0000	0.0000
	Butter	1.0315	3.0000	0.0500
	Mayonnaise	1.2988	9.0000	3.6000
	Lard	0.2815	NA	NA
	Lard, vegetable, INCA	0.2446	NA	NA
	Spicy souce, VALENTINA	2.3861	NA	NA
	<b>Mean</b>	<b>30.8419</b>	<b>3.8000</b>	<b>0.9700</b>
	<b>SD</b>	<b>63.9241</b>	<b>3.3466</b>	<b>1.5571</b>

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