Chemical Quality of Bottled Waters: A Review

Malwina Diduch, Żaneta Polkowska, and Jacek Namieśnik

Abstract: Bottled water has become very popular for quenching thirst and as a dietary (mineral) supplement. The plethora of natural mineral waters precludes any unequivocal system of classification, which makes it difficult for the consumer to choose a water with properties that suits him/her exactly. The ever-increasing popularity of bottled waters means that it is of the utmost importance to determine not only their mineral content, but above all, the content of possible contaminants, especially organic ones. In this respect bottled waters are a special case, because apart from organic contamination from the environment, the water may become secondarily contaminated as a result of its being improperly transported and stored. Pesticides, volatile organic compounds, and carbonyl compounds have been detected in samples of bottled water. This overview shows the available published information on levels of inorganic constituents and organic contaminants in samples of bottled water in the context of sample preparation procedures and analytical techniques.

Keywords: analytical techniques bottled water, chemical composition, classification

Introduction

Just 15 to 20 y ago, water in a plastic bottle was not a regular item on many consumers' shopping lists. Today, however,thousands of millions of liters of water are sold in all types of packaging and containers. The mineral water market is the most dynamically expanding branch of the nonalcoholic beverage sector (Bong and others 2009). There are many reasons for this ever-increasing popularity of bottled water. For example, success can be attributed to effective marketing strategies. Drinking water out of a bottle not only quenches one's thirst, but it is equated with a hygienic lifestyle, fitness, health, and good looks as well (de Beaufort 2007). The sales campaigns of food conglomerates have discouraged people from drinking municipal water, even though it is subjected to very much the same rigorous quality requirements as bottled water.

Bottled water is also frequently chosen as an alternative to municipal water for reasons of taste and smell, because in most countries of the world water cannot be disinfected by chemical means. Bottled water, in contrast, can be bought not only in every food shop but also at most service points. The demand for bottled water is completely independent of the supply of municipal water, which is frequently of identical, if not even higher, quality. Suffice it to say that sales of bottled water are greatest in highly developed countries, where tap water is of high and even very high quality. Against this, a single bottle of *Evian* water costs as much as it would to fill it with municipal water once a day for more than 10 years! On average, a liter of bottled water is from 250 to 600 times more costly than a liter of tap water.

A serious environmental problem connected with the constantly rising consumption of bottled water is the bottles in which it is sold. Because of their immense numbers, they are littering the world all over and have become the most troublesome item of rubbish at the present time (Coelho and others 2011). Most

water bottles are produced from polyethylene terephthalate (PET), which in itself is an innocuous substance and is recyclable but not biodegradable (Hansen and Pergantis 2006). However, only 23% of PET bottles are recycled in the USA, and approximately 17% in Poland (Benefits of Recycling). To produce 38 thousand million plastic containers for bottled water consumed in the USA in 2006 alone, one and a half million barrels of crude oil was needed, not to mention the fuel required for transportation around the country.

Classification of mineral waters

The very concept of "mineral water" was first defined, at the International Balneological Congress at Nauheim, Germany, in 1911, as water containing at least 1000 mg of dissolved mineral constituents per liter, and this norm was accepted by all the countries represented at the Congress. Over the next 80 y or so this definition was changed many times, resulting in waters with a lower mineral content also being labeled "mineral"; by 1990 the acceptable level had fallen to 200 mg/L [PL–BN]. Consequently, the market became flooded with pseudo-mineral waters. In spite of disclaimers in various directives playing down this reduction in mineral content, most bottled waters are still falsely labeled "mineral waters"; in fact, only about 30 of the more than 200 brands on the market in Poland deserve this name.

To a very great extent, the composition of subterranean water depends on the type and structure of the rocks with which it comes into contact. The multifarious minerals forming the Earth's crust, as well as the various hydrogeochemical processes (sorption, oxidation and reduction, leaching, weathering, hydrolysis) and physical parameters (temperature, pressure) affecting these processes, have given rise to an immense diversity of mineral waters.

This makes it impossible to draw up a uniform system of classification, even if the only criterion is the chemical composition. Analysis of the sum of all the mineral constituents of water permits a classification based on the degree of mineralization (mineral content) (Table 1). This categorization can be extended by basing it on the content of specific constituents, which are chemical elements or compounds with proven physiological or medicinal activity (Table 1). The better known among these are

MS 20110570 Submitted 5/4/2011, Accepted 7/29/2011. Authors are with Dept. of Analytical Chemistry, Chemical Faculty, Gdańsk Univ. of Technology GUT, Narutowicza Street 11/12, 80-233 Gdańsk, Poland. Direct inquiries to author Diduch (E-mail: malwina.jakubik@gmail.com).

iron, bromine, iodine, manganese, and carbon dioxide (van der Aa 2003).

Depending on the concentrations at which they are present, some of the constituents of water impart specific properties to the water. On this basis we can distinguish waters of varying hardness, salinity, or CO_2 saturation (Table 1). The temperature of the water is also a significant parameter, on the basis of which cold and thermal waters are differentiated; the latter can be further subdivided into tepid, warm, and hot waters (Table 1) (van der Aa 2003).

Natural mineral waters are classified according to geological, hydrogeological, physicochemical, and microbiological criteria. Pharmacological, physiological, and clinical criteria are also taken into account if the natural properties of the water justify this (Petraccia and others 2006). Water can be admitted for consumption only when the concentrations of its constituents do not exceed the norms specified in the table showing the various legal regulations (Table 2). When these norms are established, nutritional standards and the highest permissible levels (limiting values) in the case of harmful or potentially toxic substances have to be taken into account (Güler 2007).

The Problems and Challenges Posed by the Analysis of Bottled Waters

Subterranean waters, the main source of mineral waters, have fairly constant physicochemical properties, and their composition is the result of the interplay of numerous hydrogeochemical processes. Anthropogenic contamination is not of the same importance for such waters as it is for surface waters. A real danger for the quality of subterranean waters, however, is their overexploitation, which may increase the inflow of adjacent surface waters. It is also worth remembering that, in many countries, access to subterranean waters is very limited; there, the main source of bottled water is desalinated sea water (Al-Mudhaf and others 2009).

The challenge now facing analytical chemists is to develop a method for the qualitative and quantitative determinations of the wide range of analytes present in bottled waters. Determining the content of inorganic and organic compounds is difficult, mainly because of

- the low levels of individual compounds present in samples,
- the complex composition (high degree of mineralization),
- interactions between the constituents present in samples,

Table 1-Classifications of mineral waters

Type of water	Parameter	Unit	Reference
Criterion: mineral content			
Very low mineral content	Total content of mineral salts < 50	mg/L	(van der Aa 2003)
Low mineral content	Total content of mineral salts 50-500	0	· · · · · · · · · · · · · · · · · · ·
Medium mineral content	Total content of mineral salts 500-1500		
High mineral content	Total content of mineral salts >1500		
Criterion: content of specific co	nstituents		
Chloride	Chlorides > 200	mg/L	(van der Aa 2003)
Bicarbonate	Bicarbonates > 600	U	, , , , , , , , , , , , , , , , , , ,
Sulfate	Sulfates > 200		
Sodium	Sodium > 200		
Calcium	Calcium > 150		
Magnesium	Magnesium > 50		
Iron	Iron > 1		
Bromide	Bromide > 5		
Iodide	Iodide > 1		
Manganese	Manganese > 1		
Oxalic	$CO_2 > 250$		
Fluoride	Fluoride > 1		
Sulfide	Sulfide > 1		
Arsenic	Arsenic > 0.7		
Criterion: salinity			
Fresh	Cl < 5	mg/L	(van der Aa 2003)
Slightly saline	Cl 5–30	U	, , , , , , , , , , , , , , , , , , ,
Saline	Cl 30–150		
More saline	Cl 150–300		
Very saline	Cl 300–1000		
Mineral	Cl 1000–10000		
Criterion: hardness			
Very soft	Ca + Mg = 0.5	mEq/L	(van der Aa 2003)
Soft	Ca + Mg 0.5 - 1	-	
Medium hard	Ca + Mg 1-2		
Hard	Ca + Mg 2-4		
Very hard	Ca + Mg > 4		
Criterion: CO ₂ saturation	U		
Unsaturated	No CO ₂	mg/L	(van der Aa 2003)
Slightly saturated	$CO_2 < 1500$	0	· · · · · · · · · · · · · · · · · · ·
Medium saturated	CO ₂ 1500-4000		
Highly saturated	CO ₂ 4000–6000		
Criterion: temperature	-		
Cold	< 20	°C	(Petraccia and others 2006)
Thermal			· · · · · · · · · · · · · · · · · · ·
Tepid	20-30		
Warm	30-40		
Hot	40		

- possible changes in composition during transport and storage as a result of reactions and the potential desorption of constituents from packaging materials, and
- the interdependence between constituents present in samples (for example, the Ca:Mg ion ratio).

Method for determining the organic and inorganic constituents of bottled waters

It is frequently the case that quality control of bottled water is limited to the determination of the levels of inorganic constituents such as the anions Br⁻, BrO₃⁻, Cl⁻, ClO₃⁻, ClO₄⁻, F⁻, I⁻, $\mathrm{NO_2}^-,\,\mathrm{NO_3}^-,\,\mathrm{SO_4}^{2-},\,\mathrm{PO_4}^{3-},\,\mathrm{HCO_3}^-;$ the cations $\mathrm{Na^+},\,\mathrm{K^+},$ NH4⁺, Mg²⁺, Ca²⁺ (Azoulay and others 2001; Saleh and others 2001; Rosborg and others 2005; Morr and others 2006; Bong and

others 2009); and certain metals, Be, Cd, Cr, Cu, Hg, Fe, Mg, Mn, Ni, Se, Sr, V, Zn, Co, Hg, Pb, Th, U, Li, As, Al, Ba, Bi, Zr, Sn, Rb, Sb, Sc, Te, Tl (Al.-Saleh and Al.-Doush 1998; Saleh and others 2001; Ikem and others 2002; Costa and others 2003; Baba and others 2007; Shotyk and Krachler 2007a, 2007b; Westerhoff and others 2008; Keresztes and others 2009; Krachler and Shotyk 2009). Other elements, such as boron, are rarely determined. Table 3 provides data on the analytical techniques used for determining the inorganic constituents of bottled water.

The information available in the literature on the analytical techniques for determining the concentrations of organic compounds in bottled mineral waters is of fairly recent date, the first information on this subject having appeared in 2002. But the problem probably existed long before mineral water began to be sold in

Table 2-Regulations and standards for water intended for human consumption.

Parameter	Unit	ECC ^a (1998) Drinking water (MAC) ^b	ECC ^a (2003) Bottled water (MAC) ^b	WHO ^a (2008) Drinking water (GV) ^c	EPA ^a (2009) Drinking water (MCL) ^d	IBWA ^a (2009) Bottled water (SOQ) ^e	FDA ^a (2010) Bottled water (SOQ) ^e	Polish legalization Dz. U. Nr 276, poz, 2738 ^a (2004) Bottled water (MAC) ^b
Disinfectants and disinf	ection	by products						
Bromate	mg/L	0.01	-	0.01	0.01	0.01	0.01	_
Chlorine	mg/L	_	-	5 ^f	0.1	0.1	4.0	_
Chlorite	mg/L	_	_	0.7 ^f	1	1	1	_
Haloacetic acids	mg/L	_	_	_	0.06	0.06	0.06	_
Total trihalogenometals	mg/L	0.1	_	1	0.08	0.01	0.08	_
Inorganic chemicals	0							
Aluminum	mg/L	0.2	_	_	_	0.2	0.2	_
Amonium	mg/L	0.5	_	_	_	_	_	2
Antimony	mg/L	0.005	0.005	0.02	0.006	0.006	0.006	0.005
Arsenic	mg/L	0.01	0.01	0.01 ^f	0.01	0.01	0.01	0.01
Barium	mg/L	-	-	0.7	2	1	2	1
Beryllium	mg/L	-	-	-	0.004	0.004	0.004	-
Boron	mg/L	1	1	0.5^{f}	_	_	_	5
Cadmium	mg/L	0.005	0.003	0.003	0.005	0.005	0.005	0.003
Chloride	mg/L	250	-		-	250	250	250
Chrome	$\mu g/L$	0.05	0.05		0.1	0.05	0.1	0.05
Copper	mg/L	2	1	2	1.3^{g}	1	1	1
Cyanide	mg/L	0.05	0.07	0.07	0.2	0.1	0.1	0.07
Fluoride	mg/L	1.5	5	1.5	4.0	see	see	5
Iron	mg/L	0.2	_	_	_	0.3	0.3	0.5
Lead	mg/L	0.01	0.01	0.01	0.015^{g}	0.005	0.005	0.01
Manganese	$\mu g/L$	0.05	0.5	0.4 ^f	-	0.05	0.05	0.5
Mercury	mg/L	0.001	0.001	0.006	0.002	0.001	0.002	0.001
Molybdenum	mg/L	-	-	0.07	-	-	-	-
Nickel	mg/L	0.02	0.02	0.07	-	0.1	0.1	0.02
Nitrate	mg/L	50	50	50	10^{h}	10	10	50
Nitrite	mg/L	0.5	0.1	0.2^{f}	1 ^h	1	1	0.1
Selenium	mg/L	0.01	0.01	0.01	0.05	0.01	0.05	0.01
Silver	mg/L	-	-	-	-	0.025	0.1	-
Sodium	mg/L	200	-	-	-	-	-	200
Sulfate	mg/L	250	_	-	-	250	250	250
Thallium	mg/L	_	_	-	0.002	0.002	0.002	_
Uranium	mg/L	-	-	0.015 ^f	0.03	0.03	0.03	-
Zinc	mg/L	-	-	-	-	5	5	1
Organic chemicals	U							
Acrylamide	mg/L	0.0001	_	0.0005	_	_	_	_
Benzene	mg/L	0.001	_	0.01	0.005	0.001	0.005	_
Total pesticides	$\mu g/L$	0.5	_	_	_	_	_	0.5
PAHs	$\mu g/L$	0.1	_	_	_	_	_	0.1
Phenolics	mg/L	-	-	-	-	0.001	0.001	0.002

^a Sources (see References): EEC = European Economic Community; WHO = World Health Organization; EPA = US Environmental Protection Agency; IWBA = International Bottled Water Association; FDA = U.S. Food and Drug Administration; Dz. U. Nr 276, poz. 2738 (Official acts of Polish Government).

Maximum admissible concentration. Guideline value.

^d Maximum contaminant level.

Standard of quality.

f Provisional guideline value Action level.

h Measured as nitrogen.

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plastic bottles, as evidenced by the ubiquity of organic compounds in the various compartments of the environment. The following groups of organic compounds have been determined in samples of bottled water: pesticides, volatile organic compounds, perfluorinated carbon compounds, and carbonyl compounds (Nawrocki and others 2002; Ericson and others 2008; Greulich and Alder 2008; Al-Mudhaf and others 2009; Diaz and others 2009). Table 4 gives data on the analytical procedures for determining organic compounds in bottled waters.

Levels of Target Inorganic and Organic Constituents of Bottled Waters

Inorganic constituents (natural and contaminants) of bottled waters

The analytical results given in the literature (Table 5) show the breadth of the range of parameters determined in bottled waters. The differences in the compositions of particular waters are very evident. This is the direct result of the geology of the region from which the water is drawn, and also of the legislation in force in a particular country. The differences in mineral content directly affect the taste and odor of the water. Bottled waters are perceived by many to taste better, have fewer impurities, and to confer higher social status on the consumer than does tap water (Saad and others 1998). Mineral water is also often used as a replacement for tap water, which is always chemically disinfected (Nawrocki and others 2002).

The main dangers to the quality of subterranean water that are sources of bottled water stem from area pollution caused by the application of agricultural chemicals, the lack or malfunction of sewage disposal systems, negligently planned landfill sites, and the insufficient number and poor efficiency of sewage treatment plants, effluent basins, sewage ponds, and poorly designed and executed

petrol stations. Line-level sources can also include leaking pipes, gas mains, and sewers (Polkowska 2003).

Organic contaminants in bottled waters

Bottled mineral waters are a special case as far as the analysis of organic contaminants is concerned. Apart from substances derived from various compartments of the environment, like pesticides (Greulich and Alder 2008; Diaz and others 2009;) and perfluoro derivatives (Ericson and others 2008), as well as those that can form during the treatment of water (Al-Mudhaf and others 2009), the material from which the bottle or container is made can also constitute a source of contamination (Nawrocki and others 2002). Table 6 lists the levels of organic contaminants determined in bottled waters.

PET is the usual material from which bottles for mineral water are made. Studies of the possible migration of PET degradation products have shown that if bottled water is stored at elevated temperatures or exposed to sunlight, the aldehyde content in the water increases (Nawrocki and others 2002). Moreover, the size of the bottle is of greater concern. Water stored in small-capacity bottles (0.2 to 0.25 L) contains more contaminants than that in bottles of larger capacity (1.5 L). It has also been demonstrated that the bottle material degrades faster if the water is carbonated (Azoulay and others 2001; Burlingame 2003; Bong and others 2009).

Studies of the possible degradation of the polymers from which bottles are made is of major importance, because in developing countries a process known as solar disinfection is frequently used to rid the water of microorganisms. This is a simple, cheap, and effective method: the bottle is filled with water, capped, then exposed to solar radiation for 15 to 18 h (Schmid and others 2008).

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Parameter	Type of water	Analytical technique	Validation parameters	Reference
Be, Cd, Cr, Cu, Hg, Fe, Mg, Mn, Ni, Se, Sr, V, Zn	Bottled	ICP-PED	Detection limit (μ g/mL)	(Al-Saleh and Al Doush 1998)
Ag, Al., As, Ca, Cd, Co, Cr, Cu, Fe, Hg, Mg, Mn, Mo, Na, Pb, Th, U, Zn Ca, K, Mg, Na	Bottled	ICP-OES	-0.000098-0.018	(Ikem and others 2002) (Rosborg and others 2005)
Sb Ag, Al, As, B, Ba, Be, Bi, Br, Ca, Ce, Cd, Co, Cu, Cr, Cs, Fe, Ge, Hg, I, Li, Mg, Mn, Mo, Na, Pb, Rb, Se, Sb, Sc, Sr, Te, Ti, Tl, Th, U, V,W, Zn, Zr	Bottled	ICP-MS	Detection limit (μg/L) 0.004–0.028 – Detection limit (μg/L) 0.01–10 Recovery (%) 91.6–111 Detection limit (μg/L) 0.001–26	(Westerhoff and others 2008) (Krachler and Shotyk 2009) (Saleh and others 2001) (Rosborg and others 2005)
Al, B, Ba, Bi, Ca, Cd, Co, Cr, Cu, Fe, La, Mn, Ni, Pb, Sb, Sn, Sr, Ti, U, Zn, Zr	Bottled (c, nc)	ICP-AES	-	(Baba and others 2007)
Ca, K, Mg, Na	Bottled		-	(Bong and others 2009)
Sb	Bottled (c, nc)	ICP-SF-MS	Detection limit (pg/mL) 0.7	(Keresztes and others 2009)
NO ₃ -N	Bottled	FIA	Detection limit (μ g/L) 60	(Rosborg and others 2005)
F, Cl, SO ₄ –S Br, BrO ₃ ⁻ , Cl, ClO ₃ ⁻ , F, I, NO ₂ ⁻ , NO ₃ ⁻ , SO ₄ ²⁻ , PO ₄ ³⁻ Cl, NO ₃ ⁻ , SO ₄ ²⁻ , HCO ₃ ⁻	Bottled	IC-CD	Detection limit (µg/L) 100–190 –	(Rosborg and others 2005) (Saleh and others 2001, Liu and Mou 2004) (Bong and others 2009)
Ba, Ca, Cr, Cu, Ge, K, Mn, Ni, Pb, Rb, Sr, Ti, Zn	Bottled (c, nc)	STR-XRF	Detection limit (μ g/L) 0.02–22.2	(Costa and others 2003)
As, Ca, Cd, Cu, K, Mg, Na, P, Se, Zn	Bottled	MIP-MS	_	(Chiba and others 2006)
ClO ₄ ⁻	Bottled	ESI-MS-MS	-	(Shi and others 2007)

c = carbonated, nc = noncarbonated.

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Table 4-Analytical techniques for determining organic constituents.

Parameter	Type of water	Sample preparation	Analytical technique	Reference
Pesticides α -HCH β -HCH β -HCH δ -HCH Aldrin DDD DDE DDT Dieldrin Endosulfan I Endosulfan II Endosulfan sulfate Endrin	Bottled 1.5-19L	A 500 mL aliquot of each bottled water sample was transferred to a separating funnel, then extracted by shaking with 75 mL of ether–hexane (25%, v/v). Separately another 500 mL aliquot was extracted with 75 mL of hexane and the two extracts combined so that 1 L of sample was extracted in total. The organic phase was passed through anhydrous sodium sulfate to remove remnants of water then the samples evaporated in a rotary evaporator to 5 mL.	GC-ECD	(Diaz and others 2009)
Volatile organic compounds 1,2,4-Trimethylobenzene 1,2-Dichloropropanne 1,3,5-Trimethylobenzene 1,3-Dichlorobenzene Bromodichloromethane Bromoform Chloroform Dibromochloromethane Dibromomethane Ethylbenzene <i>iso</i> -Propylbenzene Xylene Naphthalene Styrene Toluene Trichloroethene Chloral-hydrate Trichloropropanone	Bottled	In this method, VOCs and surrogates with low water solubility are extracted (purged) from the sample matrix by bubbling helium gas through the aqueous sample. Purged sample components are trapped in a tube containing suitable sorbent materials. When purging is complete, the sorbent tube is heated and backflushed with helium to desorb the trapped sample components into a capillary GC column interfaced to the MS. Bottled water was directly analyzed without the addition of sodium thiosulfate. The US Environmental Protection Agency (EPA) method 52.2 with some modifications was employed for purge and trap extraction of THMs and analysis by gas chromatography/mass spectrometry.	GC-MS	(Leivadara and others 2008, Al-Mudhaf and others 2009, Ahmad and Bajahlan 2009, Ikem 2002, Saleh and others 2001)
Dichloroacetonitrile Haloacetic acid Formic acid Dichloroacetic acid Ethanedioic acid	Bottled (purified, mineral, natural)	Samples were filtered with 0.45 μ m filters. One hundred-milliliter polytetrafluoroethylene (PTFE) beakers were used for sample concentration. The beakers were cleaned a 150 W AS3120A sonicator	IC-ED	(Liu and Mou 2003)
Antioxidant Butylated hydroxytoluene	Bottled 0.5–2L	Solid-phase micro extraction (SPME) was implemented and applied for the extraction of BHT 2.2 from water samples and further determination by capillary gas chromatography-mass spectrometry. Used an SPME manual holder and fiber assembly with a 100 mm polydimethylsiloxane film, and an amber screw-top vial with white PTFE-silicone septa. The fiber was exposed to 15 mL aliquots (maximum capacity). Extractions were performed at room temperature (20 to 25 °C). The expon time was 30 min	GC-MS	(Tombesi and Freije 2002)
4-Nonylphenol bisphenol A triclosan	Bottled (mineral, pure)	Was 50 mm. Before extraction, the pH value of each water sample was adjusted to 3 using 4 M H ₂ SO ₄ and 50 mL of HPLC-grade methanol was added into the water to increase extraction efficiency. And 100 μ L each of 1 mg/L of 4-n-NP, BPA-d16 and 13C-TCS were spiked into each sample as internal standards. The cartridges were conditioned by 10 mL of methanol and 10 mL of Milli-Q water. Then water samples passed through the SPE cartridges at a flow rate of 10 mL/min. After loading of the samples, the cartridges were dried under vacuum for 2 h. The analytes were eluted from the cartridges using 8 mL ethyl acetate. The eluates were concentrated to dryness under a gentle stream of nitrogen, and then redissolved in methanol to a final volume of 1 mL. Each final extract was filtered through a 0.45 μ m membrane filter into a 2 mL amber glass vial and kept at -18 °C until analysis. First, 100 μ L of the final extract in methanol was transferred to the test	GC-MS-NCI	(Li and others 2010)

Table 4–Continued				
Parameter	Type of water	Sample preparation	Analytical technique	Reference
		tube and the solvent was dried under a gentle nitrogen stream. Secondly, 2 mL of 1 M NaHCO ₃ and 1 mL of 1 M NaOH were added. After shaking for 30 s, 2 mL of n-hexane, 50 μ L of 10% pyridine in toluene and 50 μ L of 2% PFBOCI in toluene were added. The tube was tightly capped and handshaken violently for 1 min. After the organic phase and aqueous phase were separated thoroughly, the organic phase was transferred to a 5 mL glass centrifuge tube using a glass pipette. Third, 2 mL of n-hexane was added to the 10 mL tube for a second extraction. The tube was handshaken for 1 min, and the other procedures were the same as in the second step. After separated, the supernatant was transferred to the aforementioned 5 mL glass centrifugal tube. Then the combined n-hexane mixture was dried under a gentle nitrogen stream. Finally, the extract was redissolved in 100 μ L of n-hexane, and then transferred to a 2 mL amber glass vial with a 250 μ L flat-bottomed insert, which was ready for		
Perfluorochemicals PFBuS PFDA PFDoDA PFDS PFHpA PFHxA PFHxS PFNA PFOA PFOS PFOSA PFTDA PFUnDA THPFOS	Bottled	GC-NCI-MS analysis. Samples were filtered with glass microfiber filters. Samples were concentrated using solid-phase extraction. Briefly, 500 mL of water were used for extraction after adjusting the pH to 4 using an HCl solution. Extraction standards, 13C4-PFOS and 13C4-PFOA, and 10 mL of methanol (MeOH) were added. After 10 min, water samples were loaded onto Waters Oasis WAX single use cartridges (6 cm ³ /150 mg) previously conditioned with 4 mL MeOH and 4 mL water. Vacuum was used to speed up the concentrations of water samples. After drying, SPE cartridges were eluted with 4 mL acetate buffer solution (discarded) and 2 mL 2% NH4 in MeOH (target fraction). This fraction was filtered (2 μ m mylon filter) and evaporated under nitrogen. The final volume was set to 500 μ L including 13C5-labeled PFNA added as performance standard and 300 μ L of 2 mM sodium acetate in water.	HPLC-MS	(Ericsson and others 2008)
Formaldehyde Acetaldehyde Acetone	0.5–1.5 L; c, nc	20 mL of water. 20 mL of water samples were collected in glass vials with glass caps. One milliliter of 1 mg/mL aqueous PFBOA solution was added to the sample and kept at room temperature for 1 h, then 2 drops of concentrated sulfuric acid were added to complete the derivatization reaction. The extract was then purified with 3 mL of 0.2 N sulfuric acid solution. The hexane layer was separated and transferred to vials containing approximately 50 mg of sodium sulfate to dry the extract	GC-ECD	(Nawrocki and others 2002)

Summary

Bottled water is a product that is purchased by annually increasing numbers of people of all age groups. The quality control of mineral waters tends to concentrate on the determination of anion and cation levels, since it is these that govern the taste, odor, and possible nutraceutical properties of the water. The diversity of mineral waters causes problems in drawing up a uniform classification system that would make it easier for the consumer to choose a water suitable for his/her individual needs. In addition, the broad spectrum of inorganic constituents in mineral waters precludes the application of any one particular analytical technique. Ion chromatography remains the most popular method of determining the levels of ions in such waters.

The constantly rising sales of mineral waters bring with them ever-increasing exploitation of their sources. The consequences of this include deterioration in the quality of subterranean wa-

ters, for example, as a result of the inflow of adjacent ground waters, which are often exposed to anthropogenic contamination. The implication is that not only the mineral content but also the levels of possible organic contaminants must be subjected to constant quality control measures. If bottled water is not stored under the right conditions, that is to say, if it is exposed to high temperatures and/or sunlight, it can become contaminated by the degradation products of the material from which the bottle was made. This is a fairly new problem. Techniques such as GC-ECD, GC-MS, and HPLC-MS are used to determine organic contaminants in samples of bottled water. Emptied bottles are a serious danger to the environment. They are constantly increasing in number, yet no system for their reuse has met with approval. It is still the case that only a small fraction of them is recycled, which makes them one of the most troublesome items of refuse.

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Table 5-Levels of inorganic constituents in bottled waters (literature information).

	Brand	water	Parameter	Range	Unit	References
Europe						
England	Abbey Well	lm	Ca	39–114	mg/L	(Azoulay and others 2001)
	Aqua-Pura		Mg	1-36		
	Buyton		INa	6-46		
	Chiltern					
	Highland Spring					
	Strathmore					
Austria	Montes	с	Ca	8157	μ g/L	(Bong and others 2009)
			Cl	1059		
			HCO ₃ -	28331		
			K	443		
			Mg	4056		
			INA NO -	4309		
			SO_{2}^{2-}	407		
	Bomerquelle	mm	Ca	146	mg/L	(Azoulay and others 2001)
			Mg	65		()
			Na	13		
	Voslauer	lm	Ca	57		
			Mg	37		
			Na	5		
Belgium	Bru	lm	Ca	23	mg/L	(Azoulay and others 2001,
U			Mg	23	U	Morr and others 2006)
			Na	10		
	Chaudfontaine	m	Ca	65		
			Mg	18		
	D I		Na	44		
	Duke	S	Ca	10-112		
	Leberg		Ng	0-47 5 10		
	Valvert	lm	INa Ca	67.7-68		
	varvere		Mo	2		
			Na	1.9-2		
inland	Vichi original	mm	Ca	100	mg/L	(Azoulay and others 2001)
	c		Mg	110	0	
			Na	220		
	Vichy Nouvelle	lm	Ca	70		
			Mg	110		
	Airs las Davis		INa Ci	1		(Salah and adams 2001
rance	Aix les Dalles	111	Ca Ma	72	mg/L	Bong and others 2001,
			Na	14		Azoulay and others 2003,
			INd	14		Morr and others 2006)
	Badoit	mm	Ca	200-467		,
	Contrex		Mg	84-100		
			Na	7-160		
	Eau de Source-Oliviers	m	Ca	157		
			Mg	21		
			Na	14		
	Evian	s. plastic	Al	0.006	μ g/L	
			Ca	0.05	mg/L	
			Cd	< 0.2	μ g/L	
			Cl	18	mg/L	
			Co	1	μ g/L	
			Cr	< 0.2		
			Ee	< 0.2		
			Ha	51		
			K	27.3	mø/L	
			Mg	1-24	<i>o</i> [,] –	
			Mn	5	μ g/L	
			Na	5-6.38	mg/L	
			SO_4^{2-}	2.29		
			U	4	$\mu g/L$	
			-	~		
			Zn	8		
	Derrier	lm no	Zn Ca	8 78 4538–147000	mg/L	

Country	Brand	Type of water	Parameter	Range	Unit	References
	Diana	Water	HCO	1171	Cint	
			K K	27.4		
			Mg	254-4000		
			Na	535-14000		
			NO_3^-	103		
	Drings Main		SO_4^2	424	ma/I	
	Prince Noir	m	Ca Ma	528 78	mg/L	
			Na	9		
	SaintYorre	hm	Ca	100-176		
	Vichy Celestins		Mg	9-160		
			Na	900-1200		
	Vittel Bonne Sources	lm	Са	91		
			Mg	20		
	Vittel Grande Source	mm	Ca	202-575		
	Vittel Hepar		Mg	36-118		
	I II I		Na	3-13		
	Volvic	lm	Ca	299-10000	$\mu { m g/L}$	
			Cl	438-442		
			HCO ₃ -	1323-1352		
			K Ma	13/-145		
			Ng	502-9400		
			NO_3^-	119-120		
			SO4 ²⁻	88.5-89.6		
Spain	Font Vella	lm	Ca	26-35	mg/L	(Azoulay and others 2001)
-1	Fonter		Mg	5-7	8	(
			Na	11-12		
	Salus Vidago	mm	Ca	78		
			Mg	10		
		,	Na	660		
	San Narciso Viabre Catalan	hm	Ca	33-53		
	vicny Catalan		Mg	0-9 1120-1133		
	Viladru	lm	Ca	16		
			Mg	2		
			Na	9		
Ireland	Ballygowan	lm	Ca	37-114	mg/L	(Azoulay and others 2001)
	Glenpatrick Spring		Mg	15-23		
	Tipperary		Na	12-25		
Iceland	Thorspring	lm	Ca	6	mg/L	(Azoulay and others 2001)
			Mg	1		
			Na	8		
Germany	Apollinaris	mm, c	Ca	2.7-89	mg/L	(Azoulay and others 2001,
			Cl	3660	$\mu { m g/L}$	Morr and others 2006)
			HCO ₃ -	31778		
			K Ma	893 5 9–104	mg/I	
			Na	23-425	ing/ L	
			NO ₃ ⁻	78.1	$\mu g/L$	
			SO4 ²⁻	1023		
	Azur	m	Ca	177	mg/L	
			Mg	29.9		
	E. diam.		Na	1/6		
	Fachingen	111111	Ca Ma	62		
			Na	500		
	Gerolsteiner	С	Ca	2610-2991	$\mu g/L$	
			Cl	127-135		
			HCO ₃ ⁻	7262-7353		
			K	10.5-11.6		
			Mg	1319-1447		
			INA NO	144-161		
			SQ4 ²⁻	167-184		
	Gerolsteiner Sprudel	mm	Ca	176-364	mg/L	
	Hassia Sprudel		Mg	36-113	3	
			Na	119-232		

(Continued)

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Country	Brand	Type of water	Parameter	Range	Unit	References
	Hella	lm	Ca	51		
			Mg	4		
		1	Na	8		
	Kaiser Friedrich	hm	Ca Ma	5		
			Na	1419		
	Peterstaler	mm	Ca	216-256		
	Rippoldsauer		Mg	37-128		
	Robacher		Na	40-215		
	St. Michaelis	lm	Ca	43		
			Mg	4		
	Liberkinger	hm	Na	21		
	Oberkinger	11111	Ca Mo	20		
			Na	1180		
Doland	Venetroleo	hm	Ca	176	ma/l	(A rouley and others 2001)
rolaliu	Kiystylika	11111	Ma	60	mg/1	(Azotiay and others 2001)
			Na	900		
	Nałęczowianka	mm	Ca	119		
	C C		Mg	21		
			Na	24		
Portugal	Pedras Saldagas	mm	Ca	132	mg/L	(Azoulay and others 2001)
0	8		Mg	9	0	
			Na	550		
Słovenia	Radenska	mm	Ca	217	mg/L	(Azoulay and others 2001)
			Mg	97	0	
			Na	470		
Switzerland	Aproz	mm	Ca	454	mg/L	(Azoulay and others 2001,
	1		Mg	67	U	Bong and others 2009)
			Na	8		
	Cristalp	lm	Ca	115	mg/L	
			Mg	40		
	I I ai dilam d		Na Ca	20	11 ~ /T	
	Heidiland	С	Cl	2941 42.3	µg/L	
			HCO ₂ ⁻	1405		
			K	14.2		
			Mg	1642		
			Na	189		
			NO ₃ ⁻	33.4		
			SO4 ²⁻	2682		
	Henniez	lm	Ca	111	mg/L	
			Mg	19		
	Dessurger		INa Ca	9 286_136		
	Valser		Mo	24-54		
	valser		Na	11-46		
Italy	Aqua di Nepi	lm	Ca	72-124	mg/L	(Bong and others 2009,
	Aqua Fabia		Mg	5-26	C C	Azoulay and others 2001,
			Na	15-32		Morr and others 2006)
	Aqua Panna	lm, nc	Ca	912-15000		
			CI	241		
			NCO3	19/5		
			Μσ	302-5000		
			Na	355-3000		
			NO ₃ ⁻	69.7		
			SO_4^{2-}	229		
	Boario	lm	Ca	60-124		
	Claudia		Mg	2-41		
	Crodo Lisiel		Na	6-56		
	Crodo Valle d'Oro	mm	Ca	408-510		
	rerrarelle		No.	25-51		
	Finagi	lm	ina Ca	∠−50 15–18		
	Levissima	1111	Mø	1-5		
			Na	1-6		
	Maxim's	s	Ca	20.2		
			Mg	1.6		

$\begin{tabular}{ c c c c c c c c c c c c c c c c c c c$	
$ \begin{split} & \mbox{S. Pellegrino} & \mbox{nm, c} & \begin{tabular}{lllllllllllllllllllllllllllllllllll$	
S. Pellegrino mm, c C_{a} 4701–208000 $\mu g/L$ Cl 1810 HCO ₅ 3495 K 74.5 Mg 2361–55900 Na 1596–43600 No ₃ 50.6 San Bendetto lm Ca 43 mg/L Mg 25 Na 8 San Bernardo lm, c Ca 1334–12000 $\mu g/L$ Cl 91.3 HCO ₅ 4815 K 26.6 Mg 1000–1313 Na 322–1000 NO ₃ 139 SO4 ² 49.6 San Pellegrino m Ca 204–414 mg/L Sanfaustino Mg 17–57 Na 17–47 Sangemini mm Ca 322 Mg 19 Na 21 Solé nc Cl 298 HCO ₃ 1740 K 2359 Mg 8,47 Na 77.9 No ₃ 16.7 SO4 ² 5.85 Mg 34.47 Na 77.9 ND ₃ 16.7 SO4 5.85 Mg 34.47 NA 7 NA	
S. Pellegrino mm, c Ca 4701–208000 $\mu g/L$ Cl 1810 HCO ₃ ⁻ 3495 K 74.5 Mg 2361–55900 Na 1596–43600 NO ₃ ⁻ 50.6 San Bendetto Im Ca 43 mg/L Mg 25 Na 8 San Bernardo Im, c Ca 1334–12000 $\mu g/L$ Cl 91.3 HCO ₃ ⁻ 4815 K 26.6 Mg 1000–1313 Na 325–1000 NO ₃ ⁻ 139 SO ₄ ²⁻ 49.6 San Pellegrino m Ca 204–414 mg/L Sanfaustino Mg 17–57 Na 17–47 Sangemini mm Ca 322 Mg 19 Na 21 Solé nc Ca 10.8 $\mu g/L$ Cl 298 HCO ₃ ⁻ 1740 K 2359 Mg 8.47 Na 77.9 Na 77.9 Na 77.9 Na 77.9 Na 77.9 No ₃ ⁻ 16.7 SO ₄ ²⁻ 5.85 Mg 8.47 Na 77.9 No ₃ ⁻ 16.7 SO ₄ ²⁻ 5.85 Mg 12 Na 71.4 Mg 12 Na 71.4 K 2359 Mg 8.47 Na 77.9 NO ₃ ⁻ 16.7 SO ₄ ²⁻ 5.85 Mg 12 Na 2 Mg 12 Na 2	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	
$ \begin{split} & \text{NO}_3^{-7} & 50.6 \\ & \text{San Bendetto} & \text{Im} & \text{Ca} & 43 & \text{mg/L} \\ & \text{Mg} & 25 \\ & \text{Na} & 8 \\ \\ & \text{San Bernardo} & \text{Im, c} & \text{Ca} & 1334-12000 & \mu g/L \\ & \text{Cl} & 91.3 \\ & \text{HCO}_3^{-} & 4815 \\ & \text{K} & 26.6 \\ & \text{Mg} & 1000-1313 \\ & \text{Na} & 325-1000 \\ & \text{No}_3^{-7} & 139 \\ & \text{Sol}^{2^-} & 49.6 \\ & \text{San Pellegrino} & \text{m} & \text{Ca} & 204-414 & \text{mg/L} \\ & \text{San faustino} & & \text{Mg} & 17-57 \\ & \text{Na} & 17-47 \\ & \text{Sangemini} & \text{mm} & \text{Ca} & 322 \\ & \text{Mg} & 19 \\ & \text{Na} & 21 \\ & \text{Mg} & 19 \\ & \text{Na} & 21 \\ & \text{Mg} & 19 \\ & \text{Na} & 21 \\ & \text{Cl} & 298 \\ & \text{HCO}_3^{-7} & 1740 \\ & \text{K} & 2359 \\ & \text{HCO}_3^{-7} & 1740 \\ & \text{K} & 2359 \\ & \text{Mg} & 8.47 \\ & \text{Na} & 77.9 \\ & \text{Na} & 71.9 \\$	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	
Na8San BernardoIm, cCa1334–12000 $\mu g/L$ Cl91.3HCO3 4815K26.6Mg1000–1313Na325–1000NO3 139SQ4 ² 49.6San PellegrinomCaSan PellegrinomCa204-414mg/LSanfaustinoMg17–57Na17–47SangeminimmCa322MgSoléncCa322MgSoléncCa10.8 $\mu g/L$ Cl298HCO3 1740KMg8.47Na77.9No3 Na77.9NO3 16.7NO3 VeraImCa34mg/LMg12Na22AsiaMg12Na2	
San Bernardo im, c Cl 134-1200 $\mu g/L$ Cl 91.3 HCO3 4815 K 26.6 Mg 1000-1313 Na 325-1000 NO3 139 SO4 ² 49.6 90.2 49.6 San Pellegrino m Ca 204-414 mg/L Sanfaustino Mg 17-57 Na 17-47 Sangemini mm Ca 322 100 Na 17-47 139 100 100 100 Solé nc Ca 322 100 100 100 Solé nc Ca 322 100 </td <td></td>	
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San Pellegrino m Ca $204-414$ mg/L Sanfaustino Mg 17-57 Na 17-47 Sangemini mm Ca 322 Mg 19 Solé nc Ca 10.8 $\mu g/L$ Solé nc Ca 10.8 $\mu g/L$ K 2359 Mg 8.47 Na 77.9 Na 77.9 Na 77.9 NO3 ⁻⁷ 16.7 SO4 ²⁻² 5.85 mg/L Mg Vera Im Ca 34 mg/L Mg 12 Na 2 2	
Santaustino Mg $1/-5/$ Na $1/-47$ Sangemini mm Ca Mg 19 Na 21 Mg 19 Na 21 Cl 298 HCO ₃ 1740 K 2359 Mg 8.47 Na 77.9 NO ₃ 16.7 SO(4 ²) 5.85 Vera Im Ca 34 mg/L Mg 12 Na 2	
Sangemini mm Ca 322 Mg 19 Na 21 Na 21 Cl 298 HCO ₃ 1740 K 2359 Mg 8.47 Na 77.9 Na 77.9 NO ₃ 16.7 SO4 ² 5.85 mg/L 20 Vera Im Ca 34 mg/L Mg 12 Na 2	
Saligninin Inim Ca 322 Mg 19 Na 21 Na 21 Cl 298 HCO ₃ 1740 K 2359 Mg 8.47 Na 77.9 NO ₃ 16.7 SO4 ² 5.85 Vera Im Ca 34 mg/L Mg 12 Na 2	
Solé nc C_a 10.8 $\mu g/L$ Cl $298HCO_3^ 1740K$ $2359Mg$ $8.47Na$ $77.9NO_3^ 16.7SO_4^{2-} 5.85Vera lm Ca 34 mg/LMg$ $12Na$ $2Asia$	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	
$\begin{array}{cccc} Cl & 298 \\ HCO_3^{-} & 1740 \\ K & 2359 \\ Mg & 8.47 \\ Na & 77.9 \\ NO_3^{-} & 16.7 \\ SO_4^{2-} & 5.85 \\ \end{array}$ Vera $\begin{array}{cccc} Mg & 238 \\ Mg & 8.47 \\ Na & 77.9 \\ NO_3^{-} & 16.7 \\ SO_4^{2-} & 5.85 \\ Na & 2 \\ Na & 2 \end{array}$	
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Vera Im 10.7 16.7 SO ₄ ²⁻ 5.85 16.7 Vera Im Ca 34 mg/L Mg 12 Na 2 Asia 12 12 12	
Vera Im SO $_4^{2-}$ 5.85 Vera Im Ca 34 mg/L Mg 12 Na 2	
Vera lm Ca 34 mg/L Mg 12 Na 2 Asia	
Mg 12 Na 2	
Na 2	
Asia	
	(D. 1.1. 2000)
Korea Bongpyong nc Ca $380 \mu g/L$	(Bong and others 2009)
HCO_2^- 1011	
K 15.2	
Mg 124	
Na 291	
NO ₃ ⁻ 120	
$SO_4^{2^-}$ 38.5	
Cl 480	
HCO 1488	
K 35.9	
Mg 220	
Na 938	
NO ₃ ⁻ 225	
SO_4^{2-} 127	
Dongwon nc Ca 783 μ g/L	
LCO - 130 HCO - 1318	
K 301	
Mg 156	
Na 274	
NO ₃ ⁻ 47.2	
SO_4^{2-} 358	
Elumgol c Ca 194–262 μ g/L	
CI = 1/0-184	
нсо ₃ 985–1096 К 16 1–18 3	
Mg 29.4–39.3	
Na 1006–1017	
NO ₃ ⁻ 90.2–100	
SO4 ²⁻ 128-137	

(Continued)

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Control Data Nume Nume Longe Data Description Control 1 Control 0<	Country	Brand	Type of water	Parameter	Range	Unit	References
$\begin{tabular}{ c c c } & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & $		L	water	C	(7.5%)		References
$\begin{tabular}{ c c c c } \hline $ CO_1^- & 4 -2706 \\ CO_1^- & 2280 \\ Subleck S$		ICIS Keumaanasoob	nc	Cl	0.7-380	µg/L	
$\begin{tabular}{ c c c c } \hline Normool & Na & 64.5 - 92.9 \\ Summool & Na & 64.5 - 92.9 \\ Solve & Solve$		Odaesan		HCO ₃ ⁻	41-2705		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		Power O2		K	7-2359		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		Samdasoo		Mg	7.6-553		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		Sammool		Na	64.5-929		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		Seoksu		NO_3^-	16.7-131		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		Siana		SO_4^{2-}	5.8-304		
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		Soo					
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		Soonsoo					
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		1 ynant Timont	<i>c</i>	Ca	601	11 m/I	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		Tynant	L	Cl	390	μg/L	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		Tau		HCO ₂ -	2033		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				K	21.7		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				Mg	551		
				Na	948		
$\begin{array}{cccccccccccccccccccccccccccccccccccc$				SO_4^{2-}	75.2		
Valsam Cl 105-115 1570-1664 K 920-211 200-211 Na 105-115 1570-1664 North Auserica 80,0_1 667-32. 100-120. North Auserica 80,0_1 667-32. 100-120. North Auserica 900-211. Nag 110-100. 100-120. Status S Ca 17 mg/L (Mor and others 2000). Canada Aberfoyle s. plastic Al 4 \mug/L Bong and others 2002). Canada Aberfoyle s. plastic Al 4 \mug/L (Mor and others 2002). Canada Aberfoyle s. plastic Al 4 \mug/L (Mor and others 2002). Canada Solar 1 \mug/L (Mor and others 2002). Cl 0.2 \mug/L Kanaa 0.05 0.05 0.05 0.05 0.02 \mug/L Kanaa 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.05 0.0		Waterline	nc	Ca	573-617	μ g/L	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		Yaksan		Cl	105-115		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $				HCO ₃ -	1570-1661		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $				K	23.2-24.3		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $				Mg	200-211		
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $				Na	187–228		
$\begin{tabular}{ c c c c c } \hline North America & Fig & Fig & S & Ca & 17 & ng/L & (Morr and others 2006) \\ \hline Fig & Fig & S & Ca & 17 & ng/L & (Aroulay and others 2001), \\ Ca & 0.05 & mg/L & Dong and others 2009, \\ Cd & 0.2 & \mug/L & Dong and others 2009, \\ Cd & 0.2 & \mug/L & Dong and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & 14 & Bg/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and others 2009, \\ Cd & 0.2 & \mug/L & Borg and Borg a$				NO_3^-	66.6-76.2		
North America Figi Fig Fig $= 13$ Canada Aberfoyle s . plastic A A 4 4 g/L (Aroulay and others 2000). Canada Aberfoyle C A A 4 4 g/L (Aroulay and others 2001). Canada A A A A g/L B $and others 2002). Canada A A A A g/L B and others 2002). Canada A A A A g/L B and others 2002). Canada A A A A g/L B and others 2002). Canada A A A A g/L B and others 2002). Canada A A A A g/L B and others 2002). Canada A A A A B g/L B and others 2002). Canada A A A A A A B g/L B and A A A A A A A A A A$				5042	108-129		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	North Ame	rica		0	47	17	
Canada Aberfoyle s. plastic Al 4 $\mu g/L$ (Azouhy and others 2001, Ga 0.05 mg/L Bong and others 2009, Id 49.77 mg/L Bong and others 2002) Gl 49.77 mg/L Ikem and others 2002) Gl 49.77 mg/L Cr <0.2 Cr <0.2 Hig 14 Fe 0.0001 Hig 14 K 1.82 mg/L Mag 24.5 Ma <0.1 $\mu g/L$ Na 2.3 mg/L Canada Geese m Ca 282 mg/L Na 36 Canadia Spring s Ca 11-20 Claival Na 36 Canadia Spring s, plastic Ag 0.3 ± 0.6 $\mu g/L$ Na 2-13 Dannon s. plastic Ag 0.3 ± 0.6 $\mu g/L$ Cr 0.3 ± 0.5 mg/L Canada Geese m Ca 282 mg/L Na 2-13 Dannon s. plastic Ag 0.3 ± 0.6 $\mu g/L$ Canadia Spring s Ca 11-20 Claival Mg 3-7- Na 2-13 Dannon s. plastic Ag 0.3 ± 0.6 $\mu g/L$ Ca 2.195 ± 22.45 mg/L Cr 0.3 ± 0.5 mg/L Cr 0.3 ± 0.5 $\mu g/L$ Cr 0.3 ± 0.5 mg/L Cr 0.3 ± 0.5 $\mu g/L$ Cr 0.3 ± 0.5 $\mu g/L$ Ng 0.5 ± 0.5 $\mu g/L$ Canadia 0.5 ± 0.5 $\mu g/L$ Ng 0.5 ± 0.5 $\mu g/L$ Canadia 0.5 ± 0.5 $\mu g/L$ Canadia 0.5 ± 0.5 $\mu g/L$ Can	Fiji	Fiji	S	Ca Ma	1/	mg/L	(Morr and others 2006)
Canada Aberfoyle s. plastic Al 4 $\mu g/L$ (Azoulay and others 2001, Ga 0.05 mg/L Bong and others 2002) Cd 0.2 $\mu g/L$ Item and others 2002) Cd 49.77 mg/L Go 1 $\mu g/L$ Go 1 $\mu g/L$ Gr <0.2 Cu 1 Fe 0.001 Hg 14 K 1.82 mg/L Mg 24.5 Mn <0.1 $\mu g/L$ Canada Geese m Ca 282 mg/L Na 36 Canadian Spring s Ca 11-20 Clairval Mg 3-7 Clairval Mg 3-7 Clairval Na 2-13 Dannon s. plastic Ag 0.3 ± 0.6 $\mu g/L$ Ca 2.15 $\mu g/L$ Ca 2.12 $\mu g/L$ Ca 2.13 $\mu g/L$ Ca 2.13 $\mu g/L$ Ca 2.13 $\mu g/L$ Ca 2.14 $1-20$ Ca 2.15 ± 2.245 mg/L Ca 2.195 ± 2.245 mg/L Ca 2.100 ± 7.245 Ca 2.100 ± 1.255 Ca 2.100 ± 7.245 Ca 2.100 ± 1.255 Ca 2.100 ± 1.2455 Ca 3.24 ± 1.823 Pb 0.340.01 $\mu g/L$ Mg 7.10 ± 2.84 Na 2.352 ± 1.823 Pb 0.340.5 $\mu g/L$ Mg 7.10 ± 2.84 Na 2.352 ± 1.823 Pb 0.340.5 $\mu g/L$ Mg 7.10 ± 2.84 Na 2.352 ± 1.823 Pb 0.340.475	~ .			Nig	15	-	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Canada	Abertoyle	s. plastic	Al	4	$\mu g/L$	(Azoulay and others 2001,
$\begin{array}{cccccccccccccccccccccccccccccccccccc$				Ca	0.05	mg/L	Bong and others 2009,
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				Ca	0.2	$\mu g/L$	Ikem and others 2002)
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				Ci	49.77	mg/L	
$\begin{array}{cccccc} Cu & 1 & & & & & & & \\ Cu & 1 & & & & & & \\ Fe & 0.001 & & & & & & \\ Hg & 14 & & & & & & & \\ K & 1.82 & mg/L & & & & & \\ Mg & 24.5 & & & & & & & \\ Mn & <0.1 & \mu g/L & & & & & \\ Mo & <0.7 & & & & & & & & \\ Na & 23 & mg/L & & & & & \\ SOa^{2-} & 79.69 & & & & & & & \\ SOa^{2-} & 79.69 & & & & & & & & \\ Na & 23 & mg/L & & & & & & \\ SOa^{2-} & 79.69 & & & & & & & & \\ Na & 36 & & & & & & & & & \\ Canadia Geese & m & Ca & 282 & mg/L & & & & \\ Mg & 10 & & & & & & & & \\ Na & 36 & & & & & & & & \\ Canadia Spring & s & Ca & 11-20 & & & & & & \\ Canadia Spring & s & Ca & 11-20 & & & & & & \\ Clairval & & Mg & 3-7 & & & & & \\ Cairval & & Mg & 3-7 & & & & & & \\ Dannon & s. plastic & Ag & 0.3 \pm 0.6 & & & & & & & & \\ Al & 2.7 \pm 2.5 & & & & & & & & & \\ Ca & 21.95 \pm 22.45 & mg/L & & & & & & \\ C1 & 48.76 \pm 35.27 & & & & & & & & \\ Ca & 21.95 \pm 22.45 & mg/L & & & & & \\ C1 & 48.76 \pm 35.27 & & & & & & & \\ Ca & 21.95 \pm 22.45 & mg/L & & & & & \\ C1 & 48.76 \pm 35.27 & & & & & & & \\ Ca & 21.95 \pm 22.45 & mg/L & & & & & \\ C1 & 48.76 \pm 35.27 & & & & & & & \\ Ca & 21.95 \pm 22.45 & mg/L & & & & & \\ C1 & 48.76 \pm 35.27 & & & & & & & \\ Ca & 21.95 \pm 22.45 & mg/L & & & & & \\ C1 & 48.76 \pm 35.27 & & & & & & & \\ Ca & 21.95 \pm 22.45 & mg/L & & & & & \\ C1 & 48.76 \pm 35.27 & & & & & & & \\ Ca & 0.7 \pm 1.5 & \mu g/L & & & & & \\ Cr & 0.3 \pm 0.5 & & & & & & \\ Rg & 7.10 \pm 2.84 & & & & & & \\ Na & 23.52 \pm 18.23 & & & & & \\ Pb & 0.3 \pm 0.5 & & & & & & & \\ Na & 23.52 \pm 18.23 & & & & & & \\ Na & 23.52 \pm 18.23 & & & & & & \\ Na & 23.52 \pm 18.23 & & & & & & \\ Na & 23.52 \pm 18.23 & & & & & & \\ Na & 23.52 \pm 18.23 & & & & & & \\ Na & 23.52 \pm 18.23 & & & & & \\ Na & 23.52 \pm 18.23 & & & & & & \\ Na & 23.52 \pm 18.23 & & & & & & \\ Na & 23.52 \pm 18.23 & & & & & & \\ Na & 23.52 \pm 18.23 & & & & & & \\ Na & 23.52 \pm 18.23 & & & & & & & \\ Na & 23.52 \pm 18.23 & & & & & & & \\ Na & 23.52 \pm 18.23 & & & & & & & & \\ Na & 23.52 \pm 18.23 & & & & & & & & & & \\ Na & 23.52 \pm 18.23 & & & & & & & & & & \\ Na & 23.52 \pm 18.23 & & & & & & & & & & & & & & & \\ Na & 23.52 \pm 18.23 & & & & & & & & & & & & & & & & & $				Ct Cr	< 0.2	μg/L	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$				Cu	1		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				Fe	0.001		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				Hg	14		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				К	1.82	mg/L	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				Mg	24.5		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				Mn	< 0.1	$\mu { m g/L}$	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$				Mo	< 0.7		
$\begin{array}{cccccccccccccccccccccccccccccccccccc$				Na	23	mg/L	
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$				SO4 ²	79.69		
$ \begin{array}{cccc} Canadian Greese & m & Ca & 282 & mg/L \\ Mg & 10 \\ Na & 36 \\ Canadian Spring & s & Ca & 11-20 \\ Clairval & Mg & 3-7 \\ Na & 2-13 \\ Dannon & s. plastic & Ag & 0.3 \pm 0.6 & \mu g/L \\ Al & 2.7 \pm 2.5 & ca & 21.95 \pm 22.45 & mg/L \\ Cl & 48.76 \pm 35.27 & Ca & 1.7 \pm 1.5 & \mu g/L \\ Cl & 48.76 \pm 35.27 & Co & 1.7 \pm 1.5 & \mu g/L \\ Cl & 0.7 \pm 0.6 & Fe & 0.001 \pm 0.001 \\ Hg & 12 \pm 16.5 & K & 1.09 \pm 0.91 & mg/L \\ Mg & 7.10 \pm 2.84 & Na & 23.52 \pm 18.23 \\ Pb & 0.3 \pm 0.5 & \mu g/L \\ SO_4^{2-} & 20.40 \pm 7.24 & mg/L \\ U & 0.7 \pm 1.1 & \mu g/L \\ Zn & 8 \pm 8.7 & Montclair & m & Ca & 3-8 & mg/L \\ Montclair & m & Ca & 3-8 & mg/L \\ Mg & 3-12 \\ Na & 340-475 & \\ \end{array} $		Canada Casas		Zn	27	$\mu g/L$	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		Canada Geese	III	Ca Ma	202	ing/ L	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$				Na	36		
Clairval Mg $3-7$ Na $2-13$ Dannon S. plastic Ag 0.3 ± 0.6 $\mu g/L$ Al 2.7 ± 2.5 Ca 21.95 ± 22.45 mg/L Cl 48.76 ± 35.27 Co 1.7 ± 1.5 $\mu g/L$ Cr 0.3 ± 0.5 Cu 0.7 ± 0.6 Fe 0.001 ± 0.001 Hg 12 ± 16.5 K 1.09 ± 0.91 mg/L Mg 7.10 ± 2.84 Na 23.52 ± 18.23 Pb 0.3 ± 0.5 $\mu g/L$ SO $_4^{2-}$ 20.40 ± 7.24 mg/L SO_4^{2-} 20.40 ± 7.24 mg/L U 0.7 ± 1.1 $\mu g/L$ Zn 8 ± 8.7 Montclair m Ca $3-8$ mg/L Mg $3-12$ Na $340-475$		Canadian Spring	s	Ca	11-20		
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		Clairval	0	Mg	3-7		
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				Na	2-13		
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		Dannon	s. plastic	Ag	0.3 ± 0.6	μ g/L	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			-	Al	2.7 ± 2.5	-	
$\begin{array}{cccccccc} Cl & 48.76 \pm 35.27 \\ Co & 1.7 \pm 1.5 & \mu g/L \\ Cr & 0.3 \pm 0.5 \\ Cu & 0.7 \pm 0.6 \\ Fe & 0.001 \pm 0.001 \\ Hg & 12 \pm 16.5 \\ K & 1.09 \pm 0.91 & mg/L \\ Mg & 7.10 \pm 2.84 \\ Na & 23.52 \pm 18.23 \\ Pb & 0.3 \pm 0.5 & \mu g/L \\ SO_4^{2-} & 20.40 \pm 7.24 & mg/L \\ U & 0.7 \pm 1.1 & \mu g/L \\ Zn & 8 \pm 8.7 \\ Montclair & m & Ca & 3-8 & mg/L \\ Mg & 3-12 \\ Na & 340-475 \end{array}$				Ca	21.95 ± 22.45	mg/L	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				Cl	48.76 ± 35.27		
$\begin{array}{cccccccccccccccccccccccccccccccccccc$				Со	1.7 ± 1.5	$\mu { m g/L}$	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$				Cr	0.3 ± 0.5		
$\begin{array}{cccccccccccccccccccccccccccccccccccc$				Cu	0.7 ± 0.6		
$\begin{array}{cccccccccccccccccccccccccccccccccccc$				ге	0.001 ± 0.001		
$\begin{array}{cccccccccccccccccccccccccccccccccccc$				K	12 ± 10.3 1.09 ± 0.91	ma/I	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$				Mø	7.10 ± 2.84	<u>8</u> / L	
$\begin{array}{ccccccc} Pb & 0.3 \pm 0.5 & \mu g/L \\ SO_4{}^{2-} & 20.40 \pm 7.24 & mg/L \\ U & 0.7 \pm 1.1 & \mu g/L \\ Zn & 8 \pm 8.7 \\ Montellier & Mc & 3-8 & mg/L \\ Montellier & Mg & 3-12 \\ Na & 340-475 \end{array}$				Na	23.52 ± 18.23		
$\begin{array}{cccccccccccccccccccccccccccccccccccc$				Pb	0.3 ± 0.5	$\mu g/L$	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$				SO4 ²⁻	20.40 ± 7.24	mg/L	
$\begin{array}{ccccccc} & Zn & 8 \pm 8.7 \\ Montclair & m & Ca & 3-8 & mg/L \\ Montellier & Mg & 3-12 \\ & & Na & 340-475 \end{array}$				U	0.7 ± 1.1	$\mu g/L$	
Montclair m Ca 3–8 mg/L Montellier Mg 3–12 Na 340–475				Zn	8 ± 8.7		
Montellier Mg 3–12 Na 340–475		Montclair	m	Ca	3-8	mg/L	
1Na 340-473		Montellier		Mg No	3-12		
				INa	340-473		

Country	Brand	Type of water	Parameter	Range	Unit	References
	Nava	S	Ca	38		
			Mg	20		
			Na	6		
	Whistler	nc	Ca	311	$\mu { m g/L}$	
			Cl	166		
			HCO_3^-	556		
			K	14.7		
			Mg	53.8		
			Na	109		
			NO_3^-	13.6		
			SO ₄ 2-	73		
USA	A Sante	m	Ca	4	mg/L	(Bong and others 2009,
			Mg	1		Azoulay and others 2001,
			Na	160		Morr and others 2006
	Adobe Springs	S	Ca	1–3		Ikem and others 2002)
	Alhambra		Mg	1-96		
			Na	4-5		
	Aquafina	p. plastic	Ag	1.1 ± 1.9	μ g/L	
			Al	1.3 ± 2.9		
			As	11.9 ± 9.1	/T	
			Ca	0.06 ± 0.04	mg/L	
			Ca	1 ± 1.9	$\mu g/L$	
			Cr	3.9 ± 1.110 2 ± 1.5	mg/L	
			Co Cr	2 ± 1.3	µg/L	
			Cu	< 0.2		
			Fe	0.0 ± 0.0 0.1 ± 0.4		
			На	3 ± 51		
			K	0.05 ± 0.05	mg/L	
			Mo	0.03 ± 0.03 0.02 ± 0.03	ing, E	
			Mo	2.3 ± 4.7	$\mu g/L$	
			Na	4.28 ± 8.62	mg/L	
			Pb	0.3 ± 0.7	$\mu g/L$	
			SO_4^{2-}	0.24 ± 0.21	mg/L	
			Th	2.3 ± 2.9	$\mu g/L$	
			U	0.7 ± 0.8	. 0	
			Zn	0.9 ± 0.7		
	Arrowhead	S	Ca	20-36	mg/L	(Bong and others 2009,
	Black Mountain		Mg	1-5		Azoulay and others 2001,
	Caddo Valley		Na	2-12		Morr and others 2006,
						Ikem and others 2002)
	Calistoga	m	Ca	7	mg/L	
			Mg	1		
			Na	150		
	Canterbury	s. plastic	Ca	0.05	mg/L	
			Cd	< 0.2	$\mu g/L$	
			CI	5.7	mg/L	
			Co	< 0.4	μ g/L	
			Cr	< 0.2		
			Ea	0.001		
			Ha	0.001		
			K	1 79	mg/I	
			Mo	16	ing/ L	
			Mn	1	$\mu g/L$	
			Mo	1	P-8/ -	
			Na	1.61	mg/L	
			SO_4^{2-}	5.84	0	
	Carolina mountain	s	Ca	5-6	mg/L	
	Cobb mountain		Mg	2	U	
			Na	4-5		
	Crystal geyser	s. plastic	Ag	1-57	$\mu { m g/L}$	
	Crystal springs		Al	0.2–3		
			As	12		
			Ca	4-26.7	mg/L	
			Cd	2–3	μ g/L	
			Cl	6.8-49.77	mg/L	
			Co	0.8-1	$\mu { m g/L}$	
			Cr	< 0.2		
			Cu	< 0.2		
			Fe	0.001-0.8		
			нg	3-14		

(Continued)

sdm

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ountry	Brand	Type of water	Parameter	Range	Unit	References
			К	0.5-1.13	mg/L	
			Mg	3.75-24.5		
			Mn	0.1-5.5	$\mu { m g/L}$	
			Mo	0.7-8		
			Na	1.2-160	mg/L	
			Pb	0.5	$\mu { m g/L}$	
			SO_4^{2-}	2.58-79.69	mg/L	
			Zn	27	$\mu g/L$	
	Dasani	p. plastic	Ag	0.2 ± 0.4	$\mu g/L$	(Bong and others 2009,
		1 1	Al	2.6 ± 4.2	10	Azoulay and others 2001
			As	6.5 ± 6.3		Morr and others 2006:
			Ca	0.08-10	mg/L	Ikem and others 2002)
			Cd	0.7 ± 1.6	$\mu \sigma / L$	
			Cl	8.38 ± 0.68	mg/I	
			Co	15 ± 14	μ_{α}/I	
			Cr	1.5 ± 1.4 0.4 ± 0.9	μg/L	
			Cr	0.7 ± 0.7		
			Cu E.	0.5 ± 0.6		
			Fe	0.4 ± 0.6		
			Hg	20 ± 29.8	-	
			K	12.89	mg/L	
			Mg	3.10 ± 0.77		
			Mn	2 ± 7	$\mu { m g/L}$	
			Mo	2.7 ± 3.5		
			Na	12.89 ± 31.21	mg/L	
			Pb	0.3 ± 0.5	$\mu \tilde{g}/L$	
			SO_4^{2-}	14.29 ± 0.99	mg/L	
			Th	3.0 ± 6.5	$\mu g/L$	
			U	2.5 ± 6.5	1.9	
			Zn	3.8 ± 10.7		
	Deep Bock	s	Ca	0.5-26.5	mg/I	
	Deer Park	5	Ma	1-2.6	g, 2	
			No	1_60		
	Ecumtainhaad	م ساممین	I Na A co	1-00	$u \sim T$	
	Fountainnead	s. plastic	Al	$0/.0 \pm 101.3$	μg/L	
			Al	4.7 ± 5.0		
			As	9.7 ± 11.4	/T	
			Ca	$3.1 \pm 4./4$	mg/L	
			Cd	1.3 ± 2.2	$\mu g/L$	
			Cl	4.7 ± 0.92	mg/L	
			Co	1 ± 0.8	$\mu { m g/L}$	
			Cr	< 0.2		
			Cu	0.5 ± 0.8		
			Fe	0.001 ± 0.0006		
			Hg	24.7 ± 28		
			ĸ	1.3 ± 0.19	mg/L	
			Mg	0.34 ± 0.04	0	
			Mo	2.8 ± 3.1	$\mu g/L$	
			Na	5.33 ± 0.45	mo/I	
			Ph	0.2 ± 0.4	ug/L	
			SO 2-	0.4 ± 0.4 14 56 \pm 1 52	$\mu g/L$	
			304 Th	14.50 ± 1.55	ing/L	
			In	2.2 ± 3.0	µg∕L	
			U	2.3 ± 2.7		
			Zn	2.2 ± 1.0		
	Georgia Mountain Water	S	Ca	2	mg/L	(Bong and others 2009,
	Goldemb	s. plastic	Ag	0.12	$\mu { m g/L}$	Azoulay and others 200
			As	4		Morr and others 2006,
			Ca	0.05	mg/L	Ikem and others 2002)
			Cd	5	$\mu g/L$	
			Cl	6.13	mg/L	
			Cr	< 0.2	$\mu g/L$	
			Cu	< 0.2	1.9	
			Fe	0.001		
			На	75		
			K K	0.258	ma/I	
			Ma	0.230	iiig/ L	
			ivig Ma	3.2 1	11.0 /T	
			Mn	1	μ g/L	
			Mo	2		
			Na	2.06	mg/L	
			SO4 ²⁻	12.94		
			Th	2	$\mu g/L$	
					-	
			U	1	_	

Country	Brand	Type of water	Parameter	Range	Unit	References
	Great Bear	s	Ca	1-1.3	mg/L	
			Mg	1	U	
	Harrison	o ulostio	Na A ~	1.7-3		
	nawallall	s. plastic	лд Са	0.04	$\mu g/L$ mg/L	
			Cd	< 0.2	$\mu g/L$	
			Cl	7.17	mg/L	
			Cr	< 0.2	μ g/L	
			Cu	1		
			K	2.35	mg/L	
			Mg	3.47	0	
			Mn	1	$\mu { m g/L}$	
			Mo	2		
			SO_{4}^{2-}	5.98	mg/L	
			Th	5	$\mu g/L$	
			U	1	, 0	
			Zn	15		
	Hawaiian Springs	S	Ca	6-37	mg/L	
	La Croix		Mg Na	3-22 4-6		
	Lithia Springs	m	Ca	120	mg/L	
	1 0		Mg	7	0	
			Na	680	-	
	Melwood	s. plastic	Ag	3 ± 28	μ g/L	
			As	0.4 ± 9.2 2 + 2 8		
			Ca	1.53 ± 2.0	mg/L	
			Cl	7.17	U U	
			Со	1 ± 1.4	$\mu { m g/L}$	
			Cr	< 0.2		
			Fe	0.001		
			K	10.2 ± 8.77	mg/L	
			Mg	1.06 ± 0.92	C C	
			Mn	0.5 ± 0.7	μ g/L	
			Mo Na	3 ± 4.2 5.98	mg/I	
			SO4 ²⁻	5.63	nig/ L	
			Th	5	μ g/L	
			U	1		
	Mandaaina		Zn	15		(Paug and others 2000
	Mendocino	III	Ca Mo	130	mg/ L	Azoulay and others 2009,
			Na	240		Morr and others 2006,
						Ikem and others 2002)
	Mount Olympus	S	Са	8-68	mg/L	
	Mountain Valley		Mg Na	2-8		
	Mountainvallev	s. plastic	Ca	0.05	mg/L	
	Oasis	1	Cd	< 0.2	$\mu g/L$	
			Cl	10-23	mg/L	
			Cr	0.2	μ g/L	
			Ee	0.003		
			K	0.58-1.22	mg/L	
			Mg	4.4-8	-	
			Mn	1	μ g/L	
			Mo Na	2-10	mg/I	
			SO ₄ ²⁻	8-16	ilig/ L	
			Th	2-11	$\mu { m g/L}$	
			U	18		
	Orarla		Zn	6-11	m c /T	
	Ozarka	s	Ca Mo	18 1	mg/L	
			Na	5		
	Pleasantspring	s. plastic	Ag	1	$\mu g/L$	
			Ca	0.05	mg/L	
			Cd Cl	1 16	$\mu g/L$	
			CI	10	mg/ L	

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Country	Brand	Type of water	Parameter	Range	Unit	References
			Cr	< 0.2	μg/L	
			Cu	1		
			ге На	0.001		
			K	52.8	mg/L	
			Mg	1.27	U	
			Mn	5	μ g/L	
			Mo	1	m o /I	
			SO_4^{2-}	1.82	mg/L	
			Th	3	μ g/L	
	Poland Spring	s	Ca	4.1	mg/L	(Bong and others 2009,
			Mg	0.2-1		Azoulay and others 2001,
			INa	1.5-3		Morr and others 2006, Ikem and others 2002)
	Prestige	s. plastic	Al	1 ± 1.4	μg/L	ikem and others 2002)
		··· 1	Ca	12.82 ± 18.07	mg/L	
			Cd	2.5 ± 3.5	$\mu m g/L$	
			Co	0.5 ± 0.7		
			Cu Fe	< 0.2 0.002 + 0.001		
			K	0.49 ± 0.08	mg/L	
			Mg	8.166 ± 1.15	8, 2	
			Mo	12.4 ± 15.1	$\mu g/L$	
			Na	6.17 ± 0.28	mg/L	
			504² U	9.42 ± 0.33 1 + 1 4	μσ/T	
			Zn	3.5 ± 0.7	μg/ L	
	Pure Spring Water	S	Ca	49	mg/L	
			Mg	4	-	
	Sams	p. plastic	Ag	1	μ g/L	
			As Ca	0.005	mg/I	
			Cd	5	μg/L	
			Cl	5.55	mg/L	
			Cr	< 0.2	$\mu g/L$	
			Cu	< 0.2		
			Fe La	0.002		
			K	0.13	mg/L	
			Mg	0.09		
			Mn	0.002	$\mu { m g/L}$	
			Mo	1	/T	
			Na Ph	2.64	mg/L	
			SO_4^{2-}	2.64	$\mu g/L$ mg/L	
			Th	4	μg/L	
			U	2	-	
	C:1	. 1 .	Zn	< 0.1	/ T	
	Suverspring	s. plastic	Ag Al	0.5-8.3	µg∕L	
	Southermonie		Ca	0.04	mg/L	
			Cd	2.8–3	μg/L	
			Cl	14.6-26.05	mg/L	
			Co	0.5-0.7	μ g/L	
			re Ho	0.002-1.3		
			K	0.53-0.66	mg/L	
			Mg	6.3-8.72	<i>o</i> [,] –	
			Мо	0.5-20.6	μ g/L	
			Na	2.17-6.44	mg/L	
			504- Th	9.42 - 10.24 0.7 - 2.3	$\mu g/\Gamma$	
			U	1.3-5.3	MB/ L	
			Zn	3 - 4		
	Sparkletts	s	Ca	5	mg/L	
			Mg	5		
	Springtime	e plastic	INA A a	15	$\mu \alpha / I$	
	Sweetwater	5. Plastic	Al	0.3	μg/ L	
			As	1		
			Ca	0.05-5.7	mg/L	
			Cl	6.7-17		

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Country	Brand	Type of water	Parameter	Range	Unit	References
			Со	1-2.5	μg/L	
			Cu	0.5-0.7	10	
			Fe	0.5-0.7		
			Hg	7.7		
			K Ma	0.57-3	mg/L	
			Mo	1.7	$\mu g/L$	
			Na	8–143	mg/L	
			SO_4^{2-}	1.7-8.9	-	
			Th	7	$\mu { m g/L}$	
			0	2.5-4.7		
	Talawanda Spring	c	Zn Ca	2-3 2-76	mg/I	
	Talking Rain	3	Mg	2-17	nig/ L	
	Utopia		Na	3–8		
	Vichy Springs	m	Ca	157	mg/L	
			Mg	48		
	7 1 1 11	1	Na	1095		(D 1 1 2000
	Zephyrhills	s. plastic	Ag	11.4 ± 25.5	µg∕L	(Bong and others 2009,
			As	0.0 ± 0.9 0.8 ± 1.8		Morr and others 2001;
			Ca	10.52 - 58	mg/L	Ikem and others 2002)
			Cd	2 ± 2.3	$\mu g/L$	· · · · · · · ,
			Cl	15.13 ± 1.24	mg/L	
			Co	0.8 ± 1.0	$\mu { m g/L}$	
			Cr	0.2 ± 0.4		
			Cu Fe	0.6 ± 0.9 0.6 ± 0.5		
			Ho	16.6 ± 22		
			K	0.37 ± 0.08	mg/L	
			Mg	0.9 - 3	8	
			Mo	5.8 ± 3.8		
			Na	4 - 6.69	mg/L	
			Pb	0.4 ± 0.5	$\mu g/L$	
			SO4- Th	14.32 ± 0.54	mg/L	
			U	54 ± 59	μg/L	
			Zn	5.4 ± 2.6		
Africa						
Egypt	Baraka	1.5 L	Al	2.71	mg/L	(Saleh and others 2001)
			Ba	59.7		
			Ca	20.7		
			Cr	8.92		
			Cu	4.63		
			Fe	79		
			Hg	0.01		
			K	21.2		
			Mg Ma	23.3		
			Na	67.2		
			Ni	0.53		
			Pb	0.02		
			Sb	0.28		
			Si	17.2		
			Ti V	60.8		
			V Zn	2.51		
	Delta	Plastic 1.5 L	Al	3.51	mg/L	
			Ba	11.5	8	
			Be	0.02		
			Ca	27.2		
			Cd	0.02		
			Cr	0.04		
			Cu	2.65		
			Fe	40.1		
			Hg	0.01		
			К	4.06		
			Mg	11.5		
			Mn	0.33		

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(Continued)

Chemical quality of bottled waters...

Country	Brand	Type of water	Parameter	Range	Unit	References
			Мо	0.88		
			Na	34.5		
			Ni	0.88		
			Р	20.7		
			Pb	0.06		
			Sb	0.1		
			Si	17.1		
			Ti	80.4		
			V	7		
м		151	Zn	9.26		(Salah
IVI	ineral	1.5 L	Ag	0.12	mg/L	(Salen and others 2001
			Al Ba	13.5		
			Be	0.02		
			Ca	44.8		
			Cd	0.01		
			Co	0.04		
			Cr	14.9		
			Cu	10.5		
			Fe	121		
			Hg	0.03		
			К	4.88		
			Mg	1.54		
			Mn	0.05		
			Mo	0.35		
			Na	169		
			Ni	2.24		
			Pb	0.08		
			SD S:	0.19		
			31 Ti	11.5		
			V	4 59		
Sa	fi	15 I	Al	11.9	mg/I	
04		1.5 E	Ba	262	ing/ L	
			Ca	7.88		
			Cr	5.45		
			Cu	2.92		
			Fe	60.9		
			Hg	0.01		
			K	21.2		
Siwa			Mg	8.15		
			Mn	1.41		
			Mo	0.29		
			Na	32.9		
			IN1 DL	0.55		
			PD Sh	0.04		
			SU Si	0.18		
			Ti	12.3 23.4		
			V	20. 1 1 51		
			Zn	58.8		
	wa	1.5 L	Al	11	mg/L	
			Ba	222	8,	
			Be	0.01		
			Ca	6.02		
			Cd	0.01		
			Co	0.01		
			Cr	5.4		
			Cu	4.14		
			Fe	99.3		
			Hg	0.03		
			K	18.5		
			Mg	0.85		
			NIO No	0.36		
			ina Ni	43.8 1.24		
			INI P	1.24		
			Pb	0.2		
			Sb	0.2		
			Si	11.6		
			~-			

Country	Brand	Type of water	Parameter	Range	Unit	References
			V	1.49		
			Zn	64.1		
	Spa Reine	lm	Mg	1	mg/L	
	-		Na	3	-	

M = mineral; lm = low mineral content; mm = medium mineral content; hm = high mineral content; s = source; p = purified; c = carbonated; nc = noncarbonated; plastic = bottle made from synthetic material; glass = glass bottle.

Tuble o Develo of ofgame containmants in cottieta natero (interature interination

Parameter	Range	Type of water	Reference
Pesticides			
α-HCH	0.045 - 0.098 mg/L	Bottled 1 5–19 L	(Diaz and others 2009)
B-HCH	0.048 - 0.152 mg/L	Dotaled HS T/ E	(Bhile and Odifers 2005)
B-HCH	0.019–0.033 mg/L		
δ-HCH	0.012-0.046 mg/L		
Aldrin	0.012-0.027 mg/L		
DDD	0.003-0.009 mg/L		
DDF	0.009 0.009 mg/L		
DDT	0.003-0.009 mg/L		
Dieldrin	nd		
Endosulfan I	nd=0.005 mg/I		
Endosulfan II	nd 0.005 mg/ L		
Endosulfan sulfate	nd=0.033 mg/I		
Endrin	nd=0.008 mg/L		
Endrin aldebyde	0.001-0.007 mg/L		
Volatile organic compounds	0.001 0.007 mg/ E		
1.2.4-Trimethylobenzene	0.11 - 0.13 mg/I	Bottled	(Al-Mudhaf and others 2009, Ahmad and Baiahlan 2009
1.2-Dichloropropanne	0.12 - 0.4 mg/I	Bottled	[kem 2010]
1.3.5_Trimethylohenzene	0.41 mg/L		IRCHI 2010)
1 3-Dichlorobenzene	0.1 mg/L		
Bromodichloromethane	0.1 - 0.58 mg/I		
Bromoform	0.11-37.55 mg/I		
Chloroform	0.1-1.85 mg/I		
Dibromochloromethane	0.1-1.76 mg/L		
Dibromomethane	0.1-0.74 mg/L		
Ethylbenzene	0.1-0.17 mg/L		
iso-Propylbenzene	0.11 mg/L		
Xylene	0.2-0.77 mg/L		
Naphthalene	0.1-0.75 mg/L		
Styrene	0.5-46.4 mg/L		
Toluene	0.1-1.18 mg/L		
Trichloroethene	0.13 mg/L		
Chloral-hydrate	$0.4-0.9 \ \mu g/L$		
Trichloropropanone	$0.4-0.7 \ \mu g/L$		
Dichloroacetonitrile	$0.12 - 0.22 \mu g/L$		
Haloacetic Acids			
Formic acid	33.2–58.1 µg/L	Bottled (purified, mineral, natural)	(Liu and Mou 2003)
Dichloroacetic acid	na $-0.6 \ \mu g/L$	ų / / / /	
msp;Toluene	0.1-1.18 mg/L		
Ethanedioic acid	23-44 μ g/L		
Antioxidant	10		
Butylated hydroxytoluene	nd–38 μ g/L	Bottled 0.5-2 L	(Tombesi and Freije 2002)
4-Nonylphenol	108-298 ng/L	Bottled (mineral, pure)	(Li and others 2010)
Bisphenol A	17,6-324 ng/L		·
Triclosan	0.6-9.7 ng/L		
Perfluorochemicals			
PFBuS	< 0.27 ng/L	Bottled	(Ericson and others 2008)
PFDA	0.63-0.82 ng/L		
PFDoDA	< 0.34 ng/L		
PFDS	< 0.1 ng/L		
PFHpA	0.4-0.61 ng/L		
PFHxA	0.87–0.102 ng/L		
PFHxS	< 0.18 ng/L		
PFNA	0.13-0.42 ng/L		
PFOA	0.16-0.67 ng/L		
PFOS	< 0.24 ng/L		
PFOSA	0.19 ng/L		
PFTDA	< 0.90 ng/L		
PFUnDA	< 0.43 ng/L		
THPFOS	< 0.1 ng/L		
Carbonyl compounds			
Formaldehyde	0.8–96.1 μg/L	0.5–1.5 L, Bottled (c, nc)	(Nawrocki and others 2002)
Acetaldehyde	0.6–317.8 μg/L		
Acetone	5.1–125.6 μg/L		

c = carbonated; nc = noncarbonated.

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