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Original Article

A comparative approach to the variation of natural elements in Italian bottled waters according to the national and international standard limits

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ABSTRACT

Water is essential for life and contains minerals which play an important role in human nutrition. The market of mineral water has been growing steadily over the last few years. Italy is the country with the highest production and consumption in the world. Current international drinking water regulations are not very clear, as well as being completely absent in several countries. They also present contradictions between drinking water intended for human consumption and those to be bottled.

This work focused on mineral water due to the wide public acceptance and economic interest of this product. Bottled mineral waters (371 brands) from all the Italian regions (20) were characterized by means of the physico-chemical and chemical composition (52 parameters) reported on their label by using statistical analysis. The relationships among selected variables were examined by Durov and Piper diagrams.

A comparison between the water quality composition and the standard limits fixed for both mineral and drinking water by national and international regulations EU, Italy, USEPA, Canada, Spain, CODEX, WHO) is also discussed.

The analysis shows that Italian waters are rich in natural elements that unequivocally characterise its taste and quality. A comparison of our results against the current Italian regulations for mineral waters shows that out of 371 bottled mineral water studied, only 2 have problems in terms of Ba and Pb concentration. However, when compared to the limits established by international regulations, there appear to be several contradictions.

Only 2 Italian regions out of 20 would fulfil the drinking water regulation for all the parameters where standard limits or guidance values are defined. Some elements show a clear regional dependency. Upon studying the large natural variation in concentration of the 52 parameters, it becomes evident that we know very little about the natural variation of element concentration in water as well as the health effects of most of the elements in drinking waters.

1. Introduction

The packaged waters sector is growing steadily with a growth rate that is higher than that of all the other soft drinks sectors. The worldwide consumption of packaged waters can be estimated to be around 165 billion L in 2005, which means that the rate was 25–26 L/per capita/year. The total turnover of the bottled water industry can be estimated to be around €45 billion (Beverfood, 2006).

The increase in consumption in western countries with a high income is mainly due to the increasing awareness of the health-preserving properties of water, both in its basic, hydrating function as well as a source of precious minerals.

Data in Table 1 show how the world market of bottled water in the 2006, with Italy being the highest production (12 billion L/year) and consumption (200 L/per capita/year) (Beverfood, 2006). Italian production of bottled water has increased by of 30% over the last 5 years. In Italy, there are more than three hundred brands of Italian bottled waters recognized by the EC (OJEC, 1996, 2000).

Water is necessary for life due to its natural elements which play a central role. For example, sodium is considered to be a contributory cause of dietary cancer, whereas potassium may play a protective role (Jansson, 1996). The effect of calcium is less clear as it may depend on the concentration of both sodium and potassium (Yang et al., 1997). Mineral water may represent a good source of calcium which is necessary for the maintenance of bones (Ekmekcioglu, 2000). The consumption of water with a high fluoride–silica relationship may explain the positive effect of fluoride on patients affected by bone fracture (Fabiani et al., 1999).

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Table 1
Consumption of bottled waters in the world (Beverfood, 2006)

Continents	Population		Total consumption		Per capita	
	Billion	%	Billion	%	L	Index
Western. Europe	397	*6.1*	44.5	*27.0*	112	*448*
Eastern. Europe	410	*6.3*	11.6	*7.0*	28	*112*
Total	807	*12.4*	56.1	*34.0*	70	*280*
North America	325	*5.0*	27.2	*16.5*	84	*336*
Latin America	565	*8.7*	28.0	*17.0*	50	*200*
Total	890	*13.7*	55.2	*33.5*	62	*248*
Australia &and Asia	3.646	*56.1*	39.6	*24.0*	11	*44*
Africa &and Middle East	1.157	*17.8*	14.1	*8.5*	12	*48*
Total	4.803	*73.9*	53.7	*32.5*	11	*44*
Total world	6.500		165.0		25	

Sulphite is reported as a cause of potential adverse effects on individuals (Lester, 1995). Moreover, the number of chemical contaminants identified in drinking water has grown exponentially and includes disinfection by products (DBPs) and many other compounds (Gabrielli and Gerofi, 1984; Tsezou et al., 1996; Rondeau et al., 2000; Calderon, 2000; Rook, 1974; USEPA, 2000).

Bottled water is associated with naturalness and perceived by many to taste better, to have fewer impurities, and to confer higher social status on the consumer than tap water (Allen et al., 1989; Falahee and MacRae, 1995; Saad et al., 1998). The commercialization of processed tap water has been authorized by many countries; this may attract unscrupulous manufacturers toward illegal activities such as bottling tap water and selling it as mineral water. Worry regarding tap water concerns the mineral content (Crawford and Gardner, 1968; Gibson et al., 1987), the level of contaminants, as well as the microbiological quality. The quality of Italian mineral water was questioned and a comparative study between mineral and tap waters demonstrated the lack of significant difference in terms of quality (D'Ascenzo et al., 1997; Versari et al., 2002). Variation of natural elements in European bottled mineral waters and its health effects was investigated by Misund et al. (1999). Other interesting studies evaluate the drinking water quality from Kuwait (Al Fraij et al., 1999), Canada (Gibson et al., 1987), Turkey (Güler, 2007a, b), Nigeria (Nkono and Asubiojo, 1997) and Egypt (Saleh et al., 2001). In any case, the results of these studies were obtained from the analyses of few samples of the National sources.

In this study, 371 Italian bottled mineral waters were characterized by a statistical analysis using the physico-chemical and chemical composition reported on their label. Attempts to differentiate the mineral waters according to their origin and composition was made. The standard limits established by Italian and main international regulations for selected parameters are reported and investigated.

2. Material and methods

The physico-chemical and chemical composition reported on the label of 371 Italian bottled mineral waters were used as data for this study. Brand name, spring, location, laboratory and the data of chemical analysis for each considered bottled water are listed in the Appendix, divided into 20 groups based on the distribution in the Italian regions. The data are representative of all Italian bottled waters. Fig. 1 shows the geographic distribution of the springs in each region, with 46% of the bottled waters (170 brands) being in Northern Italy while only 15% (57 brands) in the South.

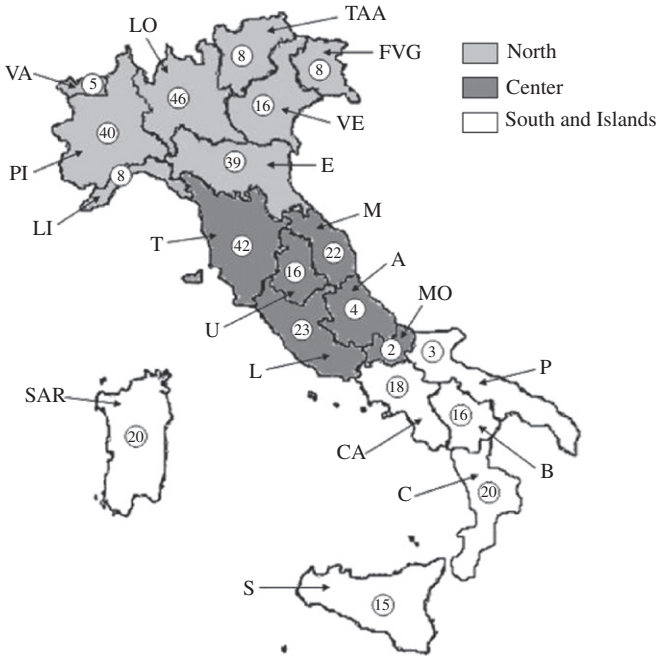

Fig. 1. Regional distribution of the Italian bottled mineral waters. A, Abruzzi; B, Basilicata; C, Calabria, CA, Campania; E, Emilia Romagna; FVG, Friuli Venezia Giulia; L, Latium; LI, Liguria; LO, Lombardy; M, Marches; MO, Molise; P, Apulia; PI, Piedmont; S, Sicily; SAR, Sardinia; T, Toscany; TAA, Trentino Alto Adige; U, Umbria; VA, Valle D'Aosta; VE, Veneto.

Fifty-two physico-chemical and chemical parameters were considered (Ag, Al, As, B, Ba, Br, Ca, Cd, Cl, CN, CO, CO_2, CO_3, conductivity, Cr, Cs, Cu, C_6H_5OH density, F, Fe, H_2S, H_3BO_3, hardness, HCO_3, Hg, I, K, La, Li, Mg, Mn, N, Na, NH_4, Ni, NO_2, NO_3, O_2, P_2O_5, Pb, pH, PO_4, S, Se, SiO_2, Sn, SO_4, Sr, TDS, temperature of spring, Zn). These determinations were carried out and certified by the official analysis laboratories, and their accuracy and precision is not questioned in this study. Routine analysis of mineral water is carried out by each company on a daily basis, whereas a complete analytical control is scheduled, at least, with annual frequency. On the other hand, the labels remain valid for a period of 5 years fixed by DL 12/12/1992 n. 54 and DL 25/01/1992 n. 96 105.

The analysis is based on an initial characterisation of the quality of the bottled waters by calculating the min, max, 75th percentile and mean values is more appropriate for each parameter. For parameters where the minimum was below the detection limit, the value of the detection limit was used for the calculation, giving a conservative estimate. The quality of the waters are discussed through Piper and Durov diagrams (Durov, 1948; Piper, 1944). A statistical analysis was carried out on the variation of the main natural elements presented in terms of concentration and spatial distribution.

The most representative regulations and guidelines in the world were also taken into consideration in order to compare the quality of Italian bottled waters. These included the Directive 2003/40/EC of the European Community (EU), the Real Decreto 140/2003 dated 7 February for Spain (E) and the National Primary and Secondary Drinking Water Regulations (USEPA, 2006) developed by the Environmental Protection Agency of the United States

of America (USEPA). The Guidelines for Canadian Drinking Water Quality and the Guideline Technical Documents (CDN) developed by the Federal–Provincial–Territorial Committee (Health Canada, 1968) were also taken into account. The limits set by the Italian regulations were also reported, including the DM 31/05/2001 for mineral waters (I-MW), DL 2/02/2001 n. 31 (I-DW) for waters intended for human consumption (not including mineral waters) and DM 12/06/2003 n. 185 (I-RW) for the reuse of waste waters for specific uses such as irrigation (and for human consumption) as well as the values for drinking waters guidelines by international organizations such as the Codex Alimentarius Commission (CODEX) and World Health Organization (WHO).

3. Results and discussions

3.1. General water chemistry

Table 2 shows the variation of natural elements in Italian bottled mineral waters. The main components are followed by a small group of elements with median concentrations between trace and 2 mg/L (e.g., B, Mn, Fe, Cr, Al, Sr and F). The median concentration for most of these elements is below 0.5 mg/L. We are used to thinking in 'averages' and tend to forget that there can be a large variation surrounding these averages. Expressed as observed maximum concentrations, a lot of elements already reach levels of 1 mg/L and more. The lowest maximum concentrations detected, below 0.01 mg/L, were observed for Cr, Cd and As. There are also traces of many other elements.

In total, the maximum concentrations range from the lowest minimum value detected (0.002 mg/L of H_3BO_3) to 8055 mg/L for the Cl, with a difference of six orders of magnitude. The differences in concentration for the single elements range from one to seven orders of magnitude (e.g., Al, Fe, F, As, Cd, Cr, Ba and Ni show the lowest variation, Cl, I, HCO_3 and Na show the largest variation). This difference is clearly highlighted in Table 2.

The major composition of water is shown in Fig. 2 through a Durov diagram (Durov, 1948) and in Fig. 3 through a Piper diagram (Piper, 1944). The figures show that there is a tendency for especially 'strong' mineral waters (with high TDS concentration) in the central regions of Italy. The northern regions have a tradition for mineral waters with a relatively high mineralisation total. The majority of the waters are considered to be of the more desirable Ca–HCO_3-type (for general drinking water purposes). Several waters are rather high in Mg.

3.2. Comparison with standards

The Italian and international regulations have rather restrictive and contradictory limits in relation to the quality of water intended for human consumption, while the quality standard limits of bottled mineral water still do not protect the final consumer and present notable contradictions.

The question is whether all these elements can have a health effect at the reported concentrations. This question is very difficult to answer. It is generally recognised that in addition to the major elements, e.g., Ca, K, Mg, Na, P and S, there are a number of elements, e.g., Co, Cr, Cu, Fe, I, Mn, Mo, Se, V and Zn that are essential for many life functions (Edmunds and Smedley, 1996). Drinking water is an important source for the daily intake of many of these elements. It is recognised that for many of these elements, there exists a characteristic dose-response curve.

The concentration of the natural elements was then compared in relation to the Italian and international regulations. Table 3 shows the comparison between the Italian and international guidelines and regulations considered.

We find limits for elements that are essential and non-toxic according to Table 3, but there are no limits or guideline in all countries for elements where no biological role is known or which are extremely toxic (e.g., Br, Mo, Cr(VI) and U). We also find widely different values for the same element in different countries

Table 2
Variation of main natural elements and parameters in Italian bottled mineral waters

Element or parameter	Min	Max	75th percentile	Mean	No. of label with element	Element	Min	Max	75th percentile	Mean	No. of label with element
Ag^+ (mg/L)	Trace	Trace	Trace	Trace	1	I^- (mg/L)	Trace	207.40	0.021	6.83	32
Al^{3+} (mg/L)	Trace	2.60	0.08	0.254	30	K^+ (mg/L)	0.09	300	4.15	10.42	340
As (mg/L)	Trace	0.007	0.0053	0.0035	2	La (mg/L)	Trace	Trace	Trace	Trace	1
B (mg/L)	Trace	13.6	0.225	0.9	6	Li^+ (mg/L)	Trace	5.02	0.14	0.27	89
Ba^{2+} (mg/L)	Trace	1.2	0.06	0.1146	13	Mg^{2+} (mg/L)	Trace	328.4	29.4	26.02	360
Br (mg/L)	Trace	5.2	0.3	0.4924	29	Mn^{2+} (mg/L)	Trace	9.8	0.5	0.6273	38
Ca^{2+} (mg/L)	0.8	864	107.43	97.53	359	N (mg/L)	Trace	37.20	20.5	14.35	38
Cd (mg/L)	Trace	0.002	0.0005	0.00038	8	Na^+ (mg/L)	Trace	5051.43	35.23	76.53	354
Cl^- (mg/L)	0.15	8055.80	34.72	96.95	324	NH_4^+ (mg/L)	Trace	4.5	0.01	0.16	131
CN^- (mg/L)	Trace	Trace	Trace	Trace	1	Ni (mg/L)	Trace	Trace	Trace	Trace	1
CO (mg/L)	Trace	Trace	Trace	Trace	1	NO_2^- (mg/L)	Trace	3.0	0.00001	0.04	127
CO_2 (mg/L)	Trace	2800	48.13	209.90	296	NO_3^- (mg/L)	Trace	47.49	6.1	5.51	288
CO_3^{2-} (mg/L)	Trace	108	75.05	34.74	6	O_2 (mg/L)	Trace	13.10	8.8	5.95	98
Conductivity (μS/cm)	35	24,200	779.5	1208.87	49	P_2O_5 (mg/L)	Trace	0.27	0.1	0.08	22
Cr^{3+} (mg/L)	Trace	0.002	0.002	0.0001	15	Pb^{2+} (mg/L)	Trace	3.5	0.002	0.35	12
Cs^{2+} (mg/L)	0.7	0.7	0.7	0.7	1	PH	5.2	9.4	7.65	7.20	343
Cu^{2+} (mg/L)	Trace	Trace	Trace	Trace	6	PO_4^{3-} (mg/L)	Trace	0.95	0.00001	0.08	34
C_6H_5OH	Trace	Trace	Trace	Trace	3	S^{2-} (mg/L)	0.001	12.4	9.30	6.20	2
F^- (mg/L)	Trace	8.40	0.61	0.5663	194	Se (mg/L)	Trace	Trace	Trace	Trace	1
Fe^{2+} (mg/L)	Trace	4	0.053	0.1823	69	SiO_2 (mg/L)	Trace	122	19.05	18.93	297
H_2S (mg/L)	Trace	178	10.55	21.54	19	Sn (mg/L)	Trace	Trace	Trace	Trace	1
H_3BO_3 (mg/L)	0.002	9.7	6	4	3	SO_4^{2-} (mg/L)	0.30	1918	60.68	113.82	330
Hardness (°F)	0.4	250	23.58	21.98	149	Sr^{2+} (mg/L)	Trace	14.7	1.2	1.30	125
HCO_3^- (mg/L)	4	3245.20	386.53	362.31	334	TDS (mg/L)	17	15,627	583.1	622.09	356
Hg (mg/L)	Trace	Trace	Trace	Trace	2	Zn^{2+} (mg/L)	Trace	0.18	0.045	0.045	4

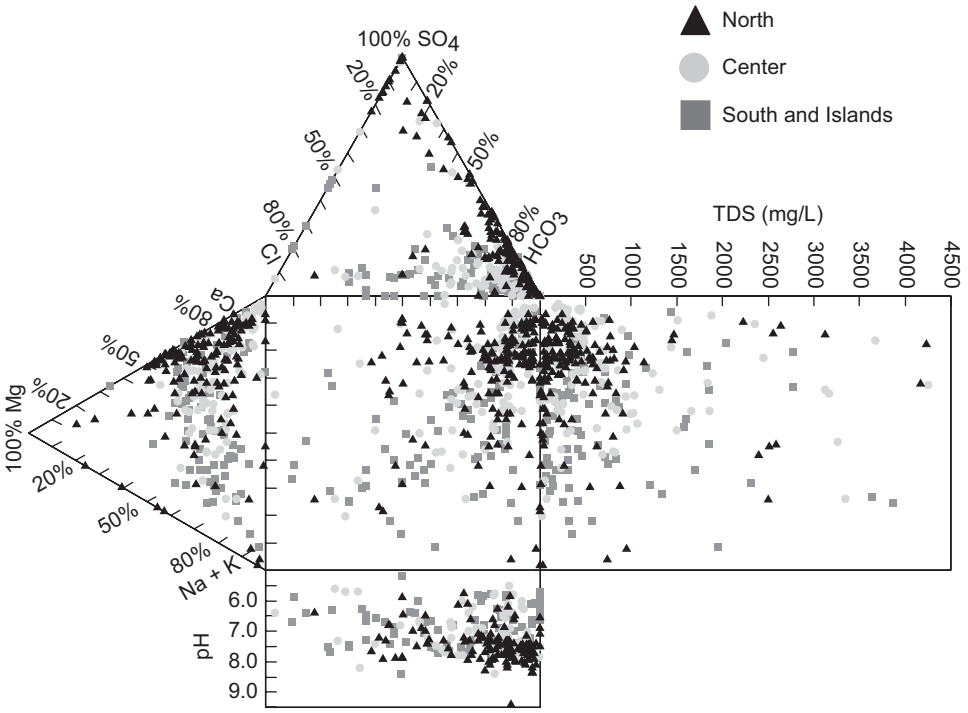

Fig. 2. Durov diagram of the Italian bottled mineral waters.

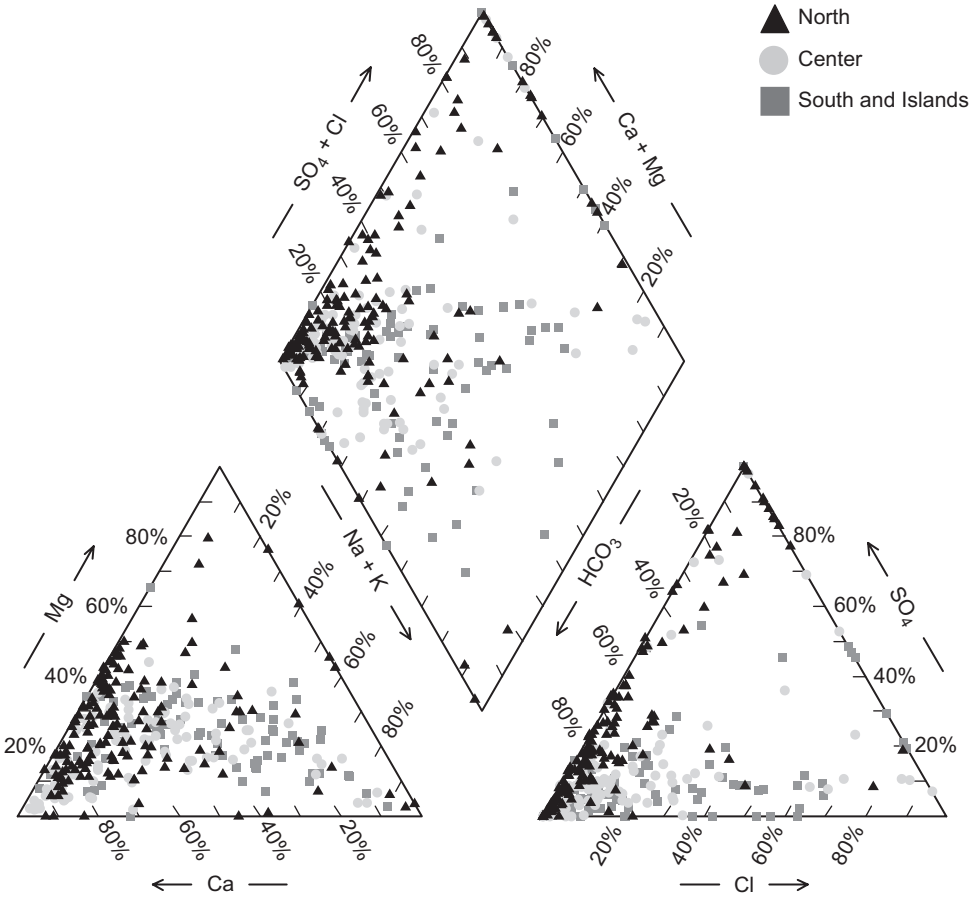

Fig. 3. Piper diagram of the Italian bottled mineral waters.

Table 3
Comparison of the national and international standards for the natural elements

Element	USEPA (mg/L)	CDN (mg/L)	E (mg/L)	EU (mg/L)	I			Codex (mg/L)	WHO (mg/L)
					(MW) (mg/L)	(DW) (mg/L)	(RW) (mg/L)		
Ag	(0.10)	–	–	1	–	–	–	–	–
Al	(0.05–2)	0.1–0.2	[0.200]	–	–	[0.200]	1	–	0.2
As	0.010	0.005	0.010	0.010	0.05	0.010	0.02	0.01	0.01
B	–	[5]	1	1	5	1	1	5	0.5
Ba	2	1	–	1.0	1	–	10	0.7	0.7
Be	**0.004**	**–**	**0.001**	–	–	–	**0.1**	–	**–**
Br	**–**	–	0.025	–	–	–	1	–	–
Cd	0.005	0.005	0.0050	0.003	0.003	0.0050	0.005	0.003	0.003
Cl^-	(250)	[250]	[250]	–	–	[250]	250	–	–
ClO^-	–	–	–	–	**–**	**0.700**	–	–	–
CO	–	–	–	0.070	–	–	0.05	0.07	–
Cr	0.1	0.05	0.050	0.050	0.05	0.050	0.1	0.05	0.05
Cr (VI)	**–**	**–**	**–**	–	**–**	**–**	**0.005**	**–**	**–**
Cu	1.3, (1)	[1]	–	1.0	1	1,0	1	1	2
F	4, (2)	1.5	1.5	5	–	1.50	1.5	[1]	1.5
Fe	(0.3)	[0.3]	[0.200]	–	–	[0.200]	2	–	–
Hg	0.002	0.001	0.0010	0.0010	0.001	0.0010	0.001	0.001	0.006
Mo	**–**	**0.07**	**–**	**–**	**–**	**–**	**–**	**–**	**0.07**
Mn	(0.05)	[0.05]	[0.050]	0.50	2	[0.050]	0.2	0.5	0.4
N	–	–	–	–	–	–	15	–	–
Na	–	[200]	[200]	–	–	[200]	–	–	200
NH_4	–	–	[0.50]	–	–	[0.50]	2	–	–
Ni	–	–	0.020	0.020	–	0.020	0.2	0.02	0.07
NO_3	44	45	50	50	45	50	–	50	50
NO_2	3.3	–	0.5/0.1c	0.1	–	0.50	–	0.02	3
Pb	0.015	0.01	[0.025]	0.010	0.01	0.010	0.1	0.01	0.01
P	**–**	**–**	**–**	**–**	**–**	**–**	**2**	**–**	**–**
Sb	**0.006**	**0.006**	**0.0050**	**0.0050**	–	**0.0050**	–	**0.005**	**0.02**
Se	0.05	0.01	0.010	0.010	0.01	0.010	0.01	0.01	0.01
Sn	–	–	–	–	–	–	3	–	–
SO_3	–	–	–	–	–	–	**0.5**	–	–
SO_4	(250)	[500]	[250]	–	–	[250]	500	–	500
Tl	**0.2**	**–**	**–**	**–**	**–**	**–**	**0.001**	**–**	**–**
U	**0.030**	**0.02**	**–**	**–**	**–**	**–**	**–**	**–**	**0.015**
V	**–**	**–**	**–**	**–**	**–**	**0.050**	**0.1**	**–**	**–**
Zn	(5)	[5]	–	–	–	–	0.5	–	3

USEPA, US Environmental Protection Agency; CDN, Canada; E, Spain; EU, European Union; I(MW) = Italian mineral water standards; I(DW), Italian drinking water standards; I(RW), Italian reuse water standards; [] = GL, guidance level; () = NSDWS, USEPA national secondary drinking water standards; "bold characters" = not present of only brands.

(e.g., Ag, Al, Hg, Pb, V, etc.). Standard limits have been set with the serious misconception that natural water is clean and does not show a large variation in element concentration if there is no contamination (it is worth noting that most of these drinking water limits are valid for 'spring water' and not for mineral waters!).

Table 3 highlights how several of the elements reported on the labels are not even considered by any regulation or guideline (Ca, Li, Mg and Sr), while other elements as Be, ClO, Cr(VI), Mo, P, Sb, SO_3, Tl, U and V, where a maximum concentration limits is fixed, are not reported on any of the 371 labels.

Table 4 shows the comparison between the concentration of the natural elements in Italian mineral waters (Table 2) with the more restrictive standard limits and guidance concentrations for different governmental regulations (Table 3).

The most restrictive among the maximum concentration limits and guideline values established by the regulations were used for the comparison, with exception of those set by the CODEX and the WHO (2006). Results of this comparison are shown in Table 5, with the number of samples above the standards for each element. The relative regulation as well as the region of origin of the water was also indicated. The percentage of the number of samples above the standards was also calculated in relation to both the total number of waters as well as those that reported the element to be present on the label.

A comparison of our results from against the current Italian regulations for mineral waters shows that out of 371 bottles only 2 do not pass all the drinking water standards. These have an above standard concentration of both Ba as well as Pb and are sold in the pharmacy, due to having particular curative properties.

Cl is the natural element that has the most number of samples above the limit (98 out of the 371 sampled), approximately 1/3 of the bottle of Italian mineral waters reporting this parameter on their label. This comparison is in relation to the guideline value of 250 mg/L fixed for the waters intended for human consumption and therefore drinkable, but these waters cannot be used, in Italy, for irrigation, because they exceed the maximum concentration limit set by DM 185/2003!

More than one out of two bottles that includes at least one of Br, Mn and N on their label, exceed the standard limits defined by different governmental regulation (Table 4).

Table 5 shows the regional distribution of the excess concentrations for every single element in are in relation to the standard limits reported in Table 4. It is shows that out of 20 Italian regions only 2 (Molise, MO and Abruzzo, A) pass all the drinking water standards set by the international agencies or governments considered. However, these regions represent only 1.7% of the Italian mineral waters (6 out of 371). The bottled waters from the central regions are richer in natural elements and

Table 4
Comparison of the natural elements reported on Italian bottled mineral water and the standards defined by different international authorities

Element	Mean (mg/L)	Max (mg/L)	Water standards (mg/L)	No. of samples above standard	% samples total above standard	% samples or number of label with elements above standard	Regions
Ag	Trace	Trace	0.1 (USEPA*)	0	0	0	
Al	0.2454	2.6	0.05 (USEPA)	9	2.43	30.00	E, LO, VE, PI, T, M, B
As	0.0035	0.0070	0.005 (E)	1	0.27	50.00	L
B	0.9	13.6	1 (S, EU, I(DW), I(RW))	1	0.27	16.67	LO
Ba	0.1146	1.2	1 (CON, EU, I(MW))	1	0.27	7.69	T
Br	0.4924	5.2	0.025 (E)	20	5.39	68.97	LO, T, M, L, SAR, P, B, C
Cd	0.000381	0.0020	0.003 (EU, I(MW))	0	0	0	
Cl	96.85	8056.80	250 (USEPA*, CON*, E*, I(DW)*, I(RW))	98	26.42	30.25	E, LO, VA, PI, T, U, M, L, SAR, P, S, CA, B, C
CO	Trace	Trace	0,05 (I(RW))	0	0	0	
Cr	0.0001	0.002	0.05 (CON, E, EU, I(MW), I(DW))	0	0	0	
Cu	Trace	Trace	1 (USEPA*, CON*, I(MW), I(DW), I(RW))	0	0	0	
F	0.5663	8.4	1.5 (CON, E, I(DW), I(RW))	12	3.23	6.19	LO, TAA, T, L, SAR, S, CA
Fe	0.1823	4	0.2 (E, I(DW))	8	2.16	11.59	E, LO, VA, PI, T, L, SAR, CA
Hg	Trace	Trace	0.001 (CON, E, EU, I(MW), I(DW), I(RW))	0	0	0	
Mn	0.6273	9.8	0.05 (USEPA*, CON*, E, I(DW))	22	5.93	57.89	PI, T, U, L, CA
N	14.35	37.2	15 (I(RW))	19	5.12	50.00	E, LO, VE, PI, FVG, LI, T, U, M, L
Na	76.53	5051.43	200 (CON*, E*, I(DW)*)	18	4.85	5.08	E, LO, VE, PI, T, L, SAR, S, B
NH_4	0.16	4.5	0.5 (S*, ITDW*)	9	2.43	6.87	E, LO, T, M, L
Ni	Trace	Trace	0.02 (E, EU, I(DW))	0	0	0	
NO_3	5.51	47.49	44 (USEPA)	12	3.23	4.17	E, LO, PI, T, U, M, L, SAR, P, S, B
NO_2	0.0405	3.0	0.1 (E*, EU)	4	1.08	3.15	VE, T, S
Pb	0.35	3.5	0.01 (CON, EU, I(MW), I(DW))	2	0.54	16.67	E, M
Se	Trace	Trace	0.01 (CON, E, EU, I(MW), I(DW), I(RW))	0	0	0	
Sn	Trace	Trace	3 (I(RW))	0	0	0	
SO_4	113.82	1918	250 (USEPA*, E, I(DW))	30	8.09	9.09	E, LO, TAA, VE, VA, PI, T, M, L, SAR, S, CA
Zn	0.045	0.18	5 (USEPA*, CON)	0	0	0	

No further comment on the action level: USEPA, US Environmental Protection Agency; CDN, Canada; E, Spain; EU, European Union; I(MW), Italian mineral water standards; I(DW), Italian drinking water standards; I(RW), Italian reuse water standards; * = GL, guidance level. The number of bottles that would fail these drinking water action levels is given, the percentage of failure per parameter and the district of origin for the bottles failing. A, Abruzzi; B, Basilicata; C, Calabria, CA, Campania; E, Emilia Romagna; FVG, Friuli Venezia Giulia; L, Latium; LI, Liguria; LO, Lombardy; M, Marches; MO, Molise; P, Apulia; PI, Piedmont; S, Sicily; SAR, Sardinia; T, Toscany; TAA, Trentino Alto Adige; U, Umbria; VA, Valle D'Aosta; VE, Veneto.

in more situations exceed the concentrations used for the comparison, these include Tuscany (T), presenting the greatest number of elements above the standards, with one of the reasons being the concentrated number of springs with thermal properties present in this region.

4. Conclusions

Italy is the nation with highest production and consumption of mineral waters in the world. Analyses of 371 bottled mineral waters from Italy for 52 elements show a widespread composition for most of these elements. Italian mineral waters are rich in natural elements and when compared to the international standard limit or guidelines, they present a number of samples above the most restrictive MCL, especially waters from the central regions of Italy. In Italy, one out of three bottles presents at least one parameter above the most restrictive limit or guideline set by considered international regulation.

Concentrations observed for single elements can cover between one and seven orders of magnitude. For most of the elements, the difference between the lowest and the highest measured concentration is three to five orders of magnitude. It is very important that the public authorities realise that there is such a widespread natural water composition for many elements, without any source of pollution.

The natural concentrations of a number of elements known to be extremely toxic, for which not even maximum allowable concentration levels for drinking water have been set in the EU, can reach surprisingly high levels. At present, these insufficient regulation for drinking water do not even apply for all mineral waters because these come, by definition, from a protected source!

The results of this study suggest that it is worth bothering to analyse for a wide range of elements and that it might actually be high time to create good and comparable databases on water chemistry over the whole of Italy. Quite different concentration ranges for many elements are to be expected for the different aquifer types. Based on such a database, meaningful standard limits, probably for a rather small set of elements that are really critical for public health, could be set based on a toxicological evaluation.

The study has highlighted how there are bottled waters that respect all the main international regulations but do not respect those set out by the Italian regulation for waters intended for irrigation. This highlights the effective inequality of the regulations for drinking waters. Further studies are needed in order to set a univocal and more effective standard limits of the natural

Table 5
Spatial distribution of the number of samples above standards identified in Italian bottled mineral waters

Regions	Element and no. of samples above standard																Total
	Al	As	B	Ba	Br	Cl	F	Fe	Mn	N	Na	NH_4	NO_3	NO_2	Pb	SO_4	
North																	
E	1	0	0	0	0	6	0	1	0	2	1	2	2	0	1	2	*18*
LO	1	0	1	0	2	5	1	1	0	3	1	1	2	0	0	7	*25*
TAA	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	*3*
VE	1	0	0	0	0	0	0	0	0	1	2	0	0	1	0	1	*6*
VA	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	*3*
PI	2	0	0	0	0	3	0	1	6	3	2	0	1	0	0	3	*21*
FVG	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	*1*
LI	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	*1*
Total	*5*	*0*	*1*	*0*	*2*	*15*	*2*	*4*	*6*	*11*	*6*	*3*	*5*	*1*	*1*	*16*	*78*
Center																	
MO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	*0*
T	2	0	0	1	5	25	1	1	7	3	6	4	5	2	0	8	*70*
U	0	0	0	0	0	1	0	0	2	1	0	0	3	0	0	0	*7*
M	1	0	0	0	1	5	0	0	0	3	0	1	4	0	1	1	*17*
L	0	1	0	0	3	10	3	1	5	1	1	1	7	0	0	1	*34*
Total	*3*	*1*	*0*	*1*	*9*	*41*	*4*	*2*	*14*	*8*	*7*	*6*	*19*	*2*	*1*	*10*	*128*
South and Islands																	
CA	0	0	0	0	0	5	3	1	2	0	0	0	0	0	0	1	*12*
B	1	0	0	0	2	6	0	0	0	0	1	0	5	0	0	0	*15*
C	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	*4*
P	0	0	0	0	1	3	0	0	0	0	0	0	2	0	0	0	*6*
SAR	0	0	0	0	4	17	2	1	0	0	3	0	3	0	0	1	*31*
S	0	0	0	0	0	9	1	0	0	0	1	0	4	1	0	2	*18*
Total	*1*	*0*	*0*	*0*	*9*	*42*	*6*	*2*	*2*	*0*	*5*	*0*	*14*	*1*	*0*	*4*	86
Total	*9*	1	*1*	*1*	*20*	*98*	*12*	*8*	*22*	*19*	*18*	*9*	*38*	*4*	*2*	*30*	292

A, Abruzzi; B, Basilicata; C, Calabria, CA, Campania; E, Emilia Romagna; FVG, Friuli Venezia Giulia; L, Latium; LI, Liguria; LO, Lombardy; M, Marches; MO, Molise; P, Apulia; PI, Piedmont; S, Sicily; SAR, Sardinia; T, Toscany; TAA, Trentino Alto Adige; U, Umbria; VA, Valle D'Aosta; VE, Veneto.

elements present in waters intended for human consumption, without effective differences between bottled mineral water and drinking waters.

Further studies on the analytical characterization of Italian mineral water are needed in order to protect the consumers and to draw up guidelines for the quality control and the regulation.

Appendix. Italian bottled mineral waters (commercial name, spring name, location, laboratory and date of chemical analysis)

A, Abruzzi

Acqua del Cardinale (Tagliacozzo, l'Aquila; Camerino, 28/06/1998); Fonte Primavera di Popoli (Popoli, Pescara; l'Aquila, 20/02/2001); Santa Croce Sponga (Canistro Terme, l'Aquila; Roma, 17/07/2003); Valle Reale Fonte Popoli (Popoli, Pescara; l'Aquila, 17/06/2003)

B, Basilicata

Chiarissima Fonte Itala (Atella, Basilicata; Napoli, 25/07/2003); Cutolo Rionero (Rionero in Vulture, Potenza; Potenza, 14/11/1988); Felicia (Rionero in Vulture, Potenza; Napoli, 10/12/2003); Gaudianello Monticchio (Rionero in Vulture, Potenza; Bari, 24/05/2002); Fonte Itala (Atella, Potenza; Potenza, 25/07/2003); La Francesca (Rionero in Vulture, Potenza; Potenza, 22/04/1999); Leggera Fonte Ninfa (Monticchio Bagni, Potenza; Bari, 29/01/2002); Lilia (Rionero in Vulture, Potenza; Roma, 31/03/2003); Ninfa (Rionero in Vulture, Potenza; Bari, 17/02/1998); Santa Maria degli Angeli (Atella, Potenza; Napoli, 07/01/2004); Solaria (Rionero in Vulture, Potenza; Napoli, 03/06/2004); Sveva (Rionero in Vulture, Potenza; Napoli, 22/03/2004); Toka (Rionero in Vulture, Potenza; Roma, 31/03/2003); Sorgente Trafficante (Rionero in Vulture, Potenza; Matera, 28/10/1994); Vivien (Rionero in Vulture, Potenza; Roma, 31/03/2003); Visciolo (Rionero in Vulture, Potenza; Potenza, 22/04/1999)

C, Calabria

Sorgente dell'Amore (Grimaldi, Cosenza; Cosenza, 04/05/2000); AcquaSí Fonte Leo (Carlopoli, Catanzaro; Catanzaro, 17/09/2002); Fonte della Madonnina della Calabria (Grifalco, Catanzaro; Catanzaro, 21/10/1998); Certosa Fonte Camarda (Polia, Vibo Valentia; Cosenza, 03/06/1997); Certosa Fonte Perna (Polia, Vibo Valentia; Cosenza, 13/03/1999); Sorgente Dipodi (Feroleto Antico, Catanzaro; Messina, 11/10/1993); Fabrizia Passo dell'Abate (Fabrizia, Vibo Valentia; Cosenza, 09/09/1998); Fontedoro Sorgente Nunzio III (Oppido Mamertina, Reggio Calabria Messina, 05/08/1999); Fontenoce (Parenti, Cosenza; Messina, 14/11/2003); Futura (Feroleto Antico, Catanzaro; Messina, 12/06/2003); Leo (Carlopoli, Catanzaro; Catanzaro, 17/09/2002); Limpida (Feroleto Antico, Catanzaro; Messina, 16/10/2002); Mangiatorella (Stilo, Reggio Calabria; Messina, 20/04/1999); Moschetta (Grifalco, Catanzaro; Cosenza, 31/05/1996); Oasi Sorgente Dipodi (Feroleto Antico, Catanzaro; Messina, 12/06/2003); Olimpica (Feroleto Antico, Catanzaro; Messina, 25/09/2003); Sorgente Serra Policaretto della Sila (Acri, Cosenza; Cosenza, 14/01/2003); Sorbello (Decollatura, Catanzaro; Messina, 12/02/2004); Vita Sana, Fonte Santa Chiara (Feroleto Antico, Catanzaro; Messina, 25/09/2003)

CA, Campania

Acetosella Antiche Fonti Plinio (Castellammare di Stabia, Napoli; Portici, 21/11/2002); Don Carlo (Contursi Terme, Salerno; Napoli, 11/09/2001); Faito (Castellammare di Stabia, Napoli; Caserta, 11/03/1991); Ferrarelle (Riardo, Caserta; Napoli, 04/04/2003); Futurella (Sant'Arsenio, Salerno; Bari, 05/03/2004); Giada (Fratte, Salerno; Salerno, 12/06/2001); Ielo (Pratella, Caserta; Roma, 03/09/2003); Lete (Pratella, Caserta; Roma, 20/04/2000); Lyde (Vitulazio, Caserta; Napoli, 12/03/1969); Natia (Riardo, Caserta; Napoli, 04/04/2003); Prata (Pratella, Caserta; Roma, 29/09/2000); San Ciro (Ercolano, Napoli; Benevento, 25/10/1999); Santagata (Rocchetta e Croce, Caserta; Napoli, 08/05/2003); Santo Stefano (Montesano sulla Marcellana, Salerno; Salerno, 05/12/2001); S. Donato (Pianura, Napoli; Caserta, 26/05/1986); Telese (Telese Terme, Benevento; Napoli, 08/06/1994); Vesuvio (Ercolano, Napoli; Benevento, 15/12/1994); Vitologatti (Fratte, Salerno; Salerno, 25/01/2002)

E, Emilia Romagna

Aemilia (Ramiola, Parma; Parma, 28/04/1992); Acqua Parmalat (Sant'Andrea dei Bagni, Parma; Parma, 12/01/2001); Aquattro (Montefiorino, Modena); Acqua Arvè (Salsomaggiore Terme, Parma; Reggio Emilia, 25/05/1999); Cerelia (Cereglio di Vergato, Bologna; Bologna, 12/03/1999); Cerva (Busana, Reggio Emilia; Roma, 25/01/1976); Ducale (Tarsogno di Tornolo, Parma; Piacenza, 28/09/1998); Edea (Fanano, Modena); Fonte Chiara (Sant'Andrea dei Bagni di Medesano, Parma; Parma, 11/10/2001); Fonte del Parco (Montefiorino, Modena; Modena, 06/03/1992); Fontenova (Fornivo di Taro, Parma; Parma 22/06/1994); Galvanina (Rimini; Rimini, 13/10/1995); Glaxia (Gusciola di Montefiorino, Modena); Acqua di sorgente Imperiale (Trasogno, Parma); Fonte Lidia (Medesano, Parma; Parma, 10/10/1996); Fonte Lieta (Cervazza Terme, Reggio Emilia; Reggio Emilia, 04/11/1998); Lynx (Begonia, Parma; Parma, 08/05/1997); Madonna della Mercede (Ramiola di Medesano, Parma; Parma, 06/05/1997); Sorgente Monte Cimone (Fanano, Modena; Modena, 30/03/1998); Monteforte Sorgente Coveraie (Montese, Modena; Reggio Emilia, 07/05/2002); Montinverno (Medesano, Parma; Parma, 08/04/1998); Pergoli (Salsomaggiore Terme, Parma; Reggio Emilia, 02/10/2000); Sorgente Reale Tarsogno (Tarsogno, Parma; Pavia, 20/02/98); Riviana (Varano de' Melegari, Parma; Pavia, 01/07/1981); Rocca Galgana (Fornovo di Taro, Parma; Parma, 22/06/94); Sacramora (Riserba, Rimini; Rimini, 12/07/99); San Daniele (Montefiorino, Modena; Modena, 09/03/1992); S. Andrea (Medesano, Parma; Parma, 07/10/00); San Fermo (Begonia, Parma; Pavia, 18/04/2001); Sangiuliano (Riserba, Rimini; Rimini, 12/07/1999); San Remo (Medesano, Parma); Santa Lucia (Cervarezza, Reggio Emilia); Silvana (Galeata, Forlí; Forlí, 22/01/2001); S. Moderanno (Bercelo, Parma; Parma, 08/02/1994); Tre Fontane (Montefiorino, Modena; Modena, 06/03/1992); Unica (Cereglio di Vergato, Bologna; Bologna, 20/02/2004); Varanina (Medesano, Parma; Parma, 08/04/1998); Ventasso (Cervarezza, Reggio Emilia; Reggio Emilia, 12/03/1999); Verdiana (Medesano, Parma; Parma, 14/01/2002); VIS (Carpiteti, Reggio Emilia; Reggio Emilia, 07/05/1999)

FVG, Friuli Venezia Giulia

Acqua Gina (Forni Avoltri, Udine; Udine, 10/05/2001); Acqua Nevea (Forni Avoltri, Udine; Udine, 10/05/2001); Annia (Paradiso di Pocenia, Udine; Udine, 04/03/1999); Baby Goccia (Forni Avoltri, Udine; Udine, 10/05/2001); Corte Paradiso (Forni Avoltri, Udine; Udine, 08/04/2004); Goccia di Carnia (Forni Avoltri, Udine; Udine, 10/05/2001); Julia (Forni Avoltri, Udine; Trieste, 15/11/1977); Pradis (Clauzetto, Pordenone; Pordenone, 04/10/1999)

L, Latium

Acqua Sacra (Loc. Monte Sacro, Roma; Roma, 10/03/95); Appia (Roma; Roma, 29/10/97); Capannelle (Roma; Napoli, 10/09/2003); Claudia (Anguillara Sabazia, Roma; Napoli, 05/07/2001); Ceciliana (Palestrina, Roma; Roma, 09/11/1988); Cottorella (Rieti; Terni, 19/10/1999); Filette (guardino, Frosinone, Napoli, 21/03/2001); Fiuggi (Fiuggi, Frosinone, Roma, 26/06/2003); Gabinia (Gavignano, Roma; Roma, 16/12/1996); Giulia (Anguillara Sabazia, Roma; Napoli, 18/11/1996); Laurentina (Roma; Roma, 07/07/1992); Meo (Gavignano, Roma; Roma, 13/03/1978); Nepi (Nepi, Viterbo; Napoli, 18/01/2000); Opera (Rieti; Terni, 13/01/1995); Regilla (Rocca Priora, Roma; Roma, 02/07/1994); San Luca (Guardino, Frosinone; Napoli, 21/03/2001); San Paolo (Roma; Roma, 22/02/2002); Santa Maria Capannelle (Modica, Ragusa; Catania, 11/07/1997); S. Marco (Modica, Ragusa; Caserta, 13/07/1992); S. Pietro (Marino, Roma; Napoli, 04/04/1997); Suio (Castelforte, Latina; Napoli, 13/04/1999); Vivia (Nepi, Viterbo; Napoli, 11/03/2003)

LI, Liguria

Aqua Fontis (Montegrosso Pian Latte, Imperia; Genova, 17/04/2000); Argentiera (Sassello, Savona; Genova, 17/12/1997); Bauda (Coalizzano, Savona; Grugliasco, 20/08/2001); Fonte del Lupo (Altare, Savona; 09/07/1998); Madonna della Guardia (Ceranesi, Genova; Pavia, 11/11/1994); Santa Clara (Borzonasca, Genova; Genova, 25/02/1999); Santa Rita (Ne, Genova; Genova, 20/01/1993); Vallechiara (Altare, Savona; Genova, 10/05/2003)

LO, Lombardy

Bernina (Piuro, Sondrio; Sondrio, 16/03/1999); Bianca Neve Flavia (Zogno, Bergamo; Bergamo, 19/07/1999); Bianca Neve Presolana (Zogno, Bergamo; Bergamo, 23/07/2001); Boario Sicilia (Darfo, Brescia; Pavia, 15/03/2000); Antica Fonte Bracca (Zogno, Bergamo; Bergamo, 19/07/1999); Castello (Vallio Terme, Brescia; Pavia, 09/07/1998); Chiarella (Plesso, Como; Como, 09/01/1997); Sorgente Daggio (Introbio, Lecco; Pavia, 12/08/1968); Flavia (Zogno, Bergamo; Bergamo, 25/11/2002); Fonte Allegra (Salò, Brescia; Pavia, 08/07/2003); Fontelaura (Plesso, Como; Como, 27/03/1997); Frida (Cimbro di Vergiate, Varese; Pavia, 27/05/1983); Frisia (Piuro, Sondrio; Sondrio, 16/03/1999); Fonte Gajum (Canzo, Como; Como, 27/03/1997); Gavernina Fonte Centrale (Casazza, Bergamo; Bergamo, 03/06/1999); Sorgente Grigna (Primaluna, Lecco; Pavia, 18/06/1999); Leonardo (Primaluna, Lecco; Como, 24/10/1977); Levissima (Cepina/Valdisotto, Sondrio; Pavia, 29/05/2000); Limpia (San Pellegrino Terme, Bergamo; Bergamo, 18/12/1998); Sorgente Linda (Salò, Brescia; Bergamo, 17/03/2003); Luna (Primaluna, Lecco; Pavia, 07/01/1999); Maniva (Bagolino, Brescia; Pavia, 13/12/1999); Neve (Casalino al Piano, Como; Como, 28/11/2001); Paraviso (Lanzo d'Intelvi, Como; Pavia, 27/05/1983); Pineta (Elusone, Bergamo; Bergamo, 23/07/2001); Pioda (Lenna, Bergamo; Bergamo, 17/06/1997); Acqua Pliniana (Bormio, Sondrio; Parma, 27/01/2006); Fonte Pracastello (S. Pellegrino Terme, Bergamo; Bergamo, 17/09/1981); Prealpi (Almè, Bergamo; Bergamo, 14/01/2003); Sorgente Primula (Spinone al Lago, Bergamo; Bergamo, 15/12/2000); San Carlo Spinone (Spinone al Lago, Bergamo; Bergamo, 14/04/2003); S. Bernardo Della Rocca (Ormea, Cuneo; Grugliasco, 30/05/2000); San Carlo (Massa, Toscana; Pavia, 31/03/2003); S. Antonio (Cadorago, Como; Como, 31/10/2000); S. Luigi (Barni, Como; Pavia, 09/02/2001); Sole (Nuvolento, Brescia; Bergamo, 28/01/2000); S. Pellegrino (San Pellegrino Terme, Bergamo; Bergamo, 28/09/1994); S. Silvestro (Angolo Terme, Brescia; Bergamo, 11/05/1999); Stella Alpina (Moio De' Calvi, Bergamo; Bergamo, 09/06/2000); Syrma (Sirmione, Brescia; Padova, 14/07/1997); Talians (Darfo, Brescia); Antica fonte Tartavalli (Taceno, Como; Milano, 30/06/2002); Fonte Tavina (Salò, Brescia; Bergamo, 09/07/2001); Vaia (Bagolino, Brescia; Pavia, 13/12/1999); Vitas (Darfo, Brescia; Pavia, 17/03/1999)

M, Marches

Acqua Parmalat (Montefortino, Ascoli Piceno); Bonaqua Tinnea (Montefortino, Ascoli Piceno; Ascoli Piceno, 26/02/2002); Cinzia (Pennabilli, Pesaro; Rimini, 10/09/1992); Fonte Elisa (Genga, Ancona; Macerata, 09/08/2000); Fonte di Palme (Fermo, Ascoli Piceno; Ascoli Piceno, 07/06/2000); Frasassi (Genga, Ancona; Macerata, 10/11/2001); Gaia (Genga, Ancona; Macerata, 08/08/2003); Metaura (Sant'Anna di Fossombrone, Pesaro; Pesaro, 29/05/2002); Nerea (Castelsantangelo sul Nera, Macerata; Macerata, 15/09/1999); Orianna (Carignano di Fano, Pesaro; Pesaro, 11/05/1993); Palmense (Fermo, Ascoli Piceno; Ascoli Picentino, 28/02/1998); Petra Pertusa (Fossombrone, Pesaro; Pesaro, 20/07/1987); Preistorica (Montefortino, Ascoli Piceno; Camerino, 25/06/1999); Roana (Ussita, Macerata; Camerino, 03/03/1983); S. Cassiano (Fabriano, Ancona; Pesaro, 29/07/1983); S. Giacomo (Sarnano, Macerata; Portici, 13/03/1995); S. Nicola (Penna S. Giovanni, Macerata); Sulfurea (Macerata Feltria, Pesaro; Pesaro, 19/05/2001); Tinnea (Montefortino, Ascoli Piceno; Ascoli Piceno, 26/02/2002); Tolentino (Tolentino, Macerata; Macerata, 24/08/1998); Tre Santi (Sarnano, Macerata; Macerata, 11/05/1998); Val di Meti (Apecchio, Pesaro; Pesaro, 22/03/1999)

MO, Molise

Castellina (Castelpizzuto, Isernia; Pesaro, 04/08/2003); Sepinia (Sepino, Campobasso; Benevento, 18/09/2000)

P, Apulia

Amata (Casamassima, Bari; Matera, 01/06/1995); Eureka (Corigliano d'Otranto, Lecce; Matera, 01/06/1995); Paravita (Parabita, Lecce; Bari, 22/11/1999)

PI, Piedmont

Abrau (Chiusa di Pesio, Cuneo; Grugliasco, 30/04/1998); Alpia (Malesco, Verbania; Novara, 21/10/1998); Alpi Bianche (Vinadio, Cuneo; 12/03/2003); Alpi Cozie (Luserna San Giovanni, Torino; Torino, 23/05/2002); Alte Vette (Vinadio, Cuneo; 12/03/2003); Aquanori (Castelletto d'Orba, Alessandria; Grugliasco, 10/10/2002); Augusta (Castelletto d'Orba, Alessandria; Grugliasco, 05/05/2000); Aurora (Castelletto D'Orba, Alessandria; Alessandria, 10/05/1983); Ausonia (Bognanco, Verbania; Novara, 05/11/1997); Brunella (Oggebbio, Verbania; Novara, 30/08/1956); Buvera (Anzola D'Ossola, Verbania; Novara, 02/12/1991); Camorei (Borgo San Dalmazzo, Cuneo; Novara, 25/05/1987); Cappuccino (Torino, Piemonte; Torino, 21/11/1923); Caudana (Donato, Biella; Ivrea, 26/05/2003); Cime Bianche (Vinadio, Cuneo; 12/03/2003); Coralba (S.Damiano Macra, Cuneo; Alessandria, 30/09/1987); Crodo (Crodo, Verbania; Novara, 21/03/2001); Fonte delle Alpi (Bagnolo Piemonte, Cuneo; Grugliasco, 14/11/1996); Gaudenziana (Bognanco, Verbania; Novara, 09/04/1997); Gioiosa (Quarona Sesia, Vercelli; Novara, 22/06/1998); Lauretana (Graglia, Biella; Novara, 30/10/1997); Maxim's (Roccaforte Mondoví, Cuneo; Grugliasco, 05/05/2000); Molino Albedosa (Castelletto D'Orba, Alessandria; Genova, 17/04/1952); Monviso (Luserna San Giovanni, Torino; Grugliasco, 07/07/1998); Nova (Crodo, Verbania; Novara, 18/05/2001); Nuova Gareisa (Roccaforte Mondoví, Cuneo; Grugliasco, 05/05/2000); Pian della Mussa (Balme, Torino; Pavia, 26/02/1997); Pic (Vaie, Torino; Pavia, 16/01/1978); Roccolo (Busca, Cuneo; Alessandria, 12/04/1979); San Damiano (S. Damiano Macra, Cuneo; Grugliasco, 21/05/2002); San Lorenzo (Bognanco Terme, Verbania; Novara, 19/12/1997); S. Bernardo Della Rocca (Ormea, Cuneo; Grugliasco, 30/05/2000); S. Bernardo Rocciaviva (Garessio, Cuneo; Grugliasco, 27/06/2001); Serena (Oleggio Castello, Novara; Novara, 30/10/2000); S. Michele (Vaie, Torino; Grugliasco, 19/06/1997); Sparea (Luserna San Giovanni, Torino; Grugliasco, 30/04/1998); Valbina (Donato, Biella; Alessandria, 20/03/1978); Valle Stura (Vinadio, Cuneo); Valmora (Luserna San Giovanni, Torino; Grugliasco, 08/07/2003); Valverde (Quarona Valsesia, Vercelli; Novara, 25/06/1998)

S, Sicily

Acquarossa (Belpasso, Catania; Catania, 19/04/1996); Ambra (Torrenova, Messina; Messina, 21/05/1998); Corinthia (Montevago, Agrigento; Messina, 07/05/2001); Cavagrande (Milo, Catania; Catania, 24/03/1998); Ciappazzi (Castroreale Terme, Messina; Messina, 20/06/1977); Fontalba (Montalbano Elicona, Messina; Messina, 21/02/2000); Gerasia (Alí, Messina; Messina, 04/

07/2001); Mia (Alí, Messina; Messina, 10/02/2004) Milicia (Altavilla Milizia, Palermo; Messina, 10/02/2004); Pozzillo (Acireale, Catania; Catania, 31/10/2003); Roccabianca (Terme Vigliatore, Messina; Messina, 02/03/1999); Roverella (Modica, Ragusa; Catania, 19/06/2002); Ruscella (Modica, Ragusa; Catania, 11/11/1999); Santa Maria (Modica, Ragusa; Catania, 11/07/1997); Santa Rosalia (Santo Stefano Quisquina, Agrigento; Palermo, 14/02/2002)

SAR, Sardinia

Acqua del Tempio (Tempio Pausania, Sassari; Sassari, 09/12/1993); Aqualieve (Olbia-Sassari); Boschetta (Siliqua, Cagliari; Cagliari, 08/07/2003); Federica (Villasor, Cagliari; Cagliari, 14/07/1998); Funte Fria (Macomer, Nuoro; Sassari, 22/10/1998); Giara (Villasor, Cagliari; Cagliari, 14/08/1998); Levia (Siliqua, Cagliari; Cagliari, 08/07/2003); Linas (Guspini, Cagliari); Pura (Siliqua, Cagliari; Cagliari, 08/07/2003); Purissima (Siliqua, Cagliari; Cagliari, 30/11/2000); Rocce Sarde (San Pantaleo, Olbia; Sassari, 09/03/1999); Sandalia (Villasor, Cagliari; Cagliari, 14/08/1998); S. Angelo (Siliqua, Cagliari; Cagliari, 08/07/2003); San Martino (Codrongianos, Sassari; Sassari, 21/09/1998); San Pantaleo (San Pantaleo, Olbia; Sassari, 06/07/1999); Sattai (Guspini, Cagliari; Cagliari, 29/08/2002); S. Giorgio (Siliqua, Cagliari; Cagliari, 08/07/2003); Siete Fuentes (Santulussurgiu, Oristano; Cagliari, 08/07/2003); S. Lucia (Bonorva, Sassari; Sassari, 15/09/1998); Smeraldina (Tempio Pausania, Sassari; Sassari, 25/02/2003)

T, Toscany

Abetina (Alpe di Poti, Arezzo; 17/02/1998); Acqua Silva (Pistoia, Toscana; Roma, 25/07/2003); Alice (Greve in Chianti, Firenze; Firenze, 26/03/1998); Amorosa (Massa, Toscana; Pisa, 19/03/2002); Azzurrina (Careggine, Lucca; Lucca, 20/06/2002); Canciulle (San Casciano Val di Pesa, Firenze; Firenze, 10/03/1938); Cinciano (Poggibonsi, Siena; Firenze, 25/05/1994); Cintoia (Greve in Chianti, Firenze; Firenze, 30/01/2001); Collalli (Montalcino, Siena; Siena, 30/07/1951); Coniano (Poggibonsi, Siena; Firenze, 25/01/1972); Corona (S.Giuliano Terme, Pisa; Pisa; 08/02/1993); Donata (Loc. Montacchiello, Pisa; Pisa, 21/03/1994); Fontemura (Alpe di Poti, Arezzo; Arezzo, 28/01/1998); Fontepatri (Lastra a Signa, Firenze; Firenze, 04/12/1998); Fonteviva (Massa, Toscana; Pavia, 30/09/1992); Fucoli (Chianciano Terme, Siena; 17/02/1998); Generosa (San Miniato, Pisa; Pisa, 25/03/1983); L'Aqua (Alpe di Poti, Arezzo; Arezzo, 13/03/2000); Lentula (Cantagallo, Prato; Firenze, 29/04/1993); Leona (Montevarchi, Arezzo; Arezzo, 01/12/1978); Marzia (Chianciano Terme, Siena; Pisa, 08/04/2002); Maxim's (Roccaforte Mondoví, Cuneo; Grugliasco, 04/10/1998); Monteverde (Loc. Pracchia, Pistoia; Roma, 23/07/2003); Monti del Chianti (Greve in Chianti, Firenze; Firenze, 30/01/2001); Napoleone (Marciana, Livorno; Lucca, 25/10/1997); Panna (Scarperia, Firenze; Firenze, 11/04/2001); Perla (Monte San Savino, Arezzo; Arezzo, 11/06/1994); Piersanti (Collesalvetti, Livorno; Firenze, 06/03/1979); Pieve (Calci, Pisa; Pisa, 29/01/1993); Regina, Acqua (Montecatini Terme, Pistoia; Pisa, 13/07/1994); San Felice (Loc. San Felice, Pistoia; Firenze, 07/07/2000); Santafiora (Monte San Savino, Arezzo; Arezzo, 05/12/2002); Sant'Elena (Chianciano Terme Siena; Pisa, 19/05/1997); S. Carlo (Massa, Toscana; Pavia, 31/03/2003); S. Leopoldo (Casciana Terme, Pisa; Pisa, 27/02/1987); Tesorino (Monopoli, Pisa; Pisa, 21/05/1999); Tiglio (Castelfranco di Sotto, Pisa; Pisa, 22/02/1978); Uliveto (Vicopisano, Pisa; Pisa, 19/02/2004); Vallicelle (Pontedera, Pisa; Pisa, 09/03/1992); Verna (Chiusi della Verna, Arezzo; Arezzo, 28/01/1998)

TAA, Trentino Alto Adige

Kaiserwasser (San Candido, Bolzano; Bolzano, 28/05/2003); Lavaredo (S. Candido, Bolzano; Bolzano, 16/09/2002); Levico Casara (Levico Terme, Trento; Trento, 04/04/2001); Meraner (Merano, Bolzano; Bolzano, 10/11/1998); Pejo (Cogolo di Pejo, Trento; Trento, 17/11/1999); Plose (Bressanone, Bolzano; Bolzano, 14/12/2000); Sanct Zacharias (Brennero, Bolzano; Bolzano, 06/07/2001); Surgiva (Carisolo, Trento; Trento, 03/02/2000)

U, Umbria

Amerino (Acquasparta, Terni; Perugia, 04/09/1998); Angelica (Nocera Umbra, Perugina; Perugia, 31/03/2001); Aura (San Gemini, Terni; Perugia, 28/03/2001); Fabia (San Gemini, Terni; Perugia, 24/02/1998); Flaminia (Nocera Umbra, Perugia; Perugia, 06/07/1998); Lieve (Gubbio, Perugia; Macerata, 18/12/2002); Misia (Cerreto di Spoleto, Perugia; Perugia, 11/12/1999); Motette (Scheggia Pascelupo, Perugia; Camerino, 21/02/1988); Rocchetta (Gualdo Tadino, Perugia; Perugia, 23/06/2000); Sanfaustino (Massa Martana, Perugia; Perugia, 13/03/2000); Sangemini (San Gemini, Terni; Perugia, 24/02/1999); Santa Chiara (Scheggia-Pascelupo, Perugia; Perugia, 12/12/1998); Sassovivo (Foligno, Perugia; Perugia, 07/01/1998); Tione (Orvieto, Terni; Terni, 04/10/2002); Tullia (Sellano, Perugia; Perugia, 14/11/2002); Viva (Cerreto di Spoleto, Perugia; Perugia, 21/01/2002)

VA, Valle D'Aosta

Courmayer (Morgeux, Aosta; Pavia, 08/10/1998); La Vittoria (Courmayeur, Aosta; Torino, 01/01/1970); Monte Bianco (Courmayeur, Aosta; Pavia, 10/05/1999); Rey (Courmayeur, Aosta; Torino, 05/06/2000); Youla (Courmayeur, Aosta; Torino, 01/06/1974)

VE, Veneto

Acquachiara (Valli del Pasubio, Vicenza; Padova, 10/05/2002); Alba (Valli del Pasubio, Vicenza; Padova, 05/12/1997); Azzurra (Torrebelvicino, Vicenza; Padova, 05/12/97); Beber (Posina, Vicenza; Padova, 23/03/00); Bucaneve (Scorzè, Venezia; Padova, 06/05/99); Dolomiti (Valli del Pasubio, Vicenza; Pavia, 06/06/97); Guizza (Scorzè, Venezia; Padova, 13/10/00); La Vena d'Oro (Ponte nelle Alpi, Belluno; Pavia, 24/10/83); Lissa (Posinia, Vicenza; Padova, 23/03/00); Lonera (Valli del Pasubio, Vicenza; Padova, 19/01/96); Lora (Recoaro Terme, Vicenza; Pavia, 15/01/02); Margherita (Torrebelvicino, Vicenza; Padova, 05/12/97); Pasubio (Valli del Pasubio, Vicenza; Pavia, 23/10/97); Fonte Regina (Valli del Pasubio, Vicenza; Padova, 04/06/97); San Benedetto (Scorzè, Venezia; Padova, 13/10/00); Vera (S. Giorgio in Bosco, Padova; Padova, 26/06/02).

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