Assessment of mineral content of various bottled water marketed in Saudi Arabia

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Abstract

Fifty-two brands of domestic bottled water were collected during the first quarter of the year 2011 from the supermarkets and food stores in Riyadh city, Saudi Arabia. The collected water was evaluated for their mineral content and the results were compared with the mineral content label on each bottle and/or with drinking water standards of either Saudi Arabia or the WHO. Evaluation included pH, TDS, soluble Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, NO_3^{-}, Cl^{-}, SO_4^{2-} as well as the concentrations of As, B, Be, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Se, Sr, Ti, V, Zn and BrO^{-}_3. The obtained results indicated that except NO_3^{-},F and BrO^{-}_3 the concentrations of TDS, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, NO_3^{-}, Cl^{-}, SO_4^{2-} and trace elements of most collected water agree well with the permissible limits set either by WHO or Saudi Arabian standards but with some variation for some major values. The result indicated the determined values of pH values are in agreement with the reported label values. On the other hand results of BrO^{-}_3 indicate that more than 18% of the total collected bottled water exceeded the allowable limits of Bromate (10 μg/L) according to Saudi Arabia Standards and WHO. Furthermore, comparison of the analytical results with the mineral content labeled in each bottle revealed a substantial variation in the parameter values, and that the reported label values of most parameters do not reflect the real content of the bottles.

Keywords: bottled water, mineral composition, Bromate, drinking water quality, bottled water standards.

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1 Introduction

The periodical analysis of bottled drinking water is very essential to ensure that water is safe and can be consumed by humans. In this respect, Guler [1] found a significant number of bottled water brands in Turkey contained Na, Cl, SO_4, F, polycyclic aromatic hydrocarbons and several heavy metals above the maximum concentration allowed for bottled waters either by Turkish legislation or other international organizations. Also, Baba *et al*. [2] came to the same results that bottled Turkish water has differences in their chemical composition and the majority of bottled water exceeded the pH limit of Turkish drinking water standards. Guler and Alpaslan [3] revealed that the analysis of 70 samples of bottled water collected from a Turkish market showed that the measured As concentration in one brand was more than three times the standard value set by EC and WHO. Khan and Chohan [4] pointed out that the mean level of F, Ca, and pH in bottled water in Saudi Arabia were significantly higher than reported on the labels. With respect to bromated concentration, Othman *et al*. [5] indicated that 30% of the samples of bottled drinking water in the Saudi Arabia market are acceptable as US EPA standards ($10\mu gL^{-1}$), 40% of the samples are acceptable as Saudi standards ($25\mu gL^{-1}$), and moreover 60% of the samples exceed the allowable limits for bromated in drinking bottled water. The objective of this study was to compare the accuracy of the concentration of minerals contents mentioned at the manufacturer labels of different bottled drinking water in Riyadh, Saudi Arabia. As well as to compare the chemical composition of such bottled water with drinking water standards of Saudi Arabian, USA and WHO.

2 Material and methods

Fifty-two different brands of locally produced bottled drinking water were collected during the 1st quarter of the year 2011 from the supermarkets and food stores in Riyadh city, Saudi Arabia. All bottles were stored in a dark place and in their original closed plastic containers at room temperature. The samples were analyzed for EC, pH, Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, SO_4^{2-}, NO_2^{2-},NO_3^{-} and F according to Matiti [6]. The bromate BrO_3^{-} in the bottled drinking water has been investigated using liquid chromatography (ICS-3000 Ion Chromatography System). Also, the concentration of As, B, Be, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Se, Sr, Ti, V, and Zn in the collected bottled water was determined using the ICP-Perkin Elmer Model 4300DV).

3 Results and discussions

Results in Tables 1 and 2 show that the compositions of the collected drinking bottled water are very different in character, and display a wide range of parameter values. There is a great difference between the determined values of each parameter and the respective value labeled in each bottle. The concentration ranged (in $mg.L^{-1}$) from 0.02–41.88 for Ca; 0.04–22.0 for Mg; 0.30–69.8 for Na;

0.02-13.4 for K; 0.09–88 for Cl^-; 0.05–5 for F; 0.0–35 .72 for $NO3^-$; 0.0–90.5 for SO_4^{2-}; 1.3–135.22 for HCO_3^-; 0.0–0.033 for As; 0.019–1.656 for B; 0.0–0.002 for Cd; 0.0–0.005 for Co; 0.0–0.004 for Ni; 0.0–0.086 for Se; 0.0–0.382 for Sr and 0.0–0.024 mgL^{-1} for Pb. The maximum concentrations of Na, NO_3^-, NO_2^-, SO_4^{2-}, Cl^-, and F^- were higher than the respective KSA, WHO and USA permissible limits (Tables 1 and 2). On the other hand, the Ca, Mg, K, ,HCO_3^-, Se, Sr, Ti, V and Bromide were detected in all collected bottled water samples, however, no permissible limits were available for comparing these parameters either with KSA, WHO or USA.

Table 1: Comparing the analytical composition of drinking bottled water with what is written on the label.

Property	unit	Determined			On the Label		
		Mean	Min	Max	Mean	Min	Max
pH	---	7.480	6.700	8.440	7.20	6.70	7.50
TDS	mg/l	126.098	43.00	235.000	122.63	43.00	235.00
Ca	mg/l	13.401	0.019	41.880	14.31	0.30	40.00
Mg	mg/l	3.912	0.038	22.000	4.33	0.50	22.00
Na	mg/l	20.541	0.300	69.750	18.23	0.30	35.00
K	mg/l	1.370	0.018	13.400	1.62	0.10	13.40
CL	mg/l	32.483	0.090	88.000	26.25	2.60	88.00
HCO_3	mg/l	34.720	1.300	135.217	32.88	1.30	120.00
SO_4	mg/l	23.266	0.000	90.466	21.91	0.00	51.00
$N\text{-}NO_3$	mg/l	5.731	0.000	35.718	3.40	0.00	20.00
F	mg/l	1.040	0.050	5.000	0.89	0.05	5.00
Bro_3	µg/l	4.733	0.000	111.600	1.76	0.00	9.99

The concentration of BrO^-_3 were so much higher than Permissible limits (10 µg/l) set either by KSA, WHO [7] and USA. Furthermore, analyses of bromated indicated that more than 18% of the samples had higher limits compared to the Saudi Arabia standards (25 µg/L), 30% of the samples had higher limits of F compared to the Saudi Arabia standards (1.5 mg/L) , and about 20% of the samples had higher limits of $N\text{-}NO_3$ compared to the Saudi Arabia standards (10 mg/L).on the other hand, the maximum concentrations of As, Be, Cd, Cr, Cu, Fe, Mn, Mo, Ni, and Zn in bottled water samples, were below their respective values according to the KSA stander, and WHO. However, special attention should be paid to As, since measured arsenic concentration in one sample (brand #7) was nearly four times the standard value set by KSA.

Comparing the obtained results with the reported label in each bottle data in Tables 1 and 2 indicated that the mean concentrations of analytical and labeled values are relatively close for most parameters, but they are generally somewhat

higher than the values reported on the bottled labels. However, no data were found on the bottled labels for NO_2^-, Si, Ba, Br, Co, Mo, Sr, Ti and V, therefore, we could not compare such parameters.

Table 2: Chemical composition of drinking bottled water in relation to the other permissible limits.

Property	Unit	Mean	Min	Max	S. D	Permissible limits		
						KSA	WHO	USA
Nitrite	mg/l	0.005	0.000	0.033	0.006	3	----	1
Bromide	mg/l	0.082	0.014	0.680	0.091	---	---	----
Al	mg/l	0.007	0.000	0.145	0.021	0.2	0.2	----
As	mg/l	0.003	0.000	0.033	0.007	0.01	0.05	0.05
B	mg/l	0.327	0.019	1.656	0.349	0.5	----	----
Ba	mg/l	0.004	0.000	0.061	0.008	0.7	----	----
Be	mg/l	0.000	0.000	0.000	0.000	1	----	----
Cd	mg/l	0.000	0.000	0.002	0.000	0.003	0.005	0.05
Co	mg/l	0.001	0.000	0.005	0.001	----	---	----
Cr	mg/l	0.001	0.000	0.009	0.001	0.05	0.05	0.1
Cu	mg/l	0.000	0.000	0.001	0.000	2	1.3	1.3
Fe	mg/l	0.001	0.000	0.002	0.001	0.3	0.3	0.3
Mn	mg/l	0.000	0.000	0.002	0.000	0.1	0.2	0.05
Mo	mg/l	0.002	0.000	0.009	0.002	0.07	----	----
Ni	mg/l	0.000	0.000	0.004	0.001	0.02	----	----
Pb	mg/l	0.008	0.000	0.024	0.007	0.01	0.05	
Se	mg/l	0.008	0.000	0.086	0.017	0.01	0.01	
Sr	mg/l	0.105	0.000	0.382	0.085	----	----	-----
Ti	mg/l	0.000	0.000	0.000	0.000	----	----	----
V	mg/l	0.000	0.000	0.010	0.001	----	----	----
Zn	mg/l	0.001	0.000	0.029	0.004	3	----	-----
pH	---	7.480	6.700	8.440	0.385	6.5-8.5	6.5-8.5	6.5-8.5
TDS	mg/l	126.098	43.000	235.000	30.208	100-500	1600	755
Ca	mg/l	13.401	0.019	41.880	8.358	----	---	-----
Mg	mg/l	3.912	0.038	22.000	3.743	----	-----	----
Na	mg/l	20.541	0.300	69.750	9.925	100		200
K	mg/l	1.370	0.018	13.400	1.744	----	----	----
CL	mg/l	32.483	0.090	88.000	17.596	150	250	250
HCO_3	mg/l	34.720	1.300	135.217	21.410	----	-----	-----
SO_4	mg/l	23.266	0.000	90.466	16.319	150	400	250
$N\text{-}NO_3$	mg/l	5.731	0.000	35.718	6.511	10	10	10
F	mg/l	1.040	0.050	5.000	0.550	0.8-1.5	1.5	4
Bro_3^-	µg/l	4.733	0.000	111.600	2.451	10	10	10

4 Conclusion

Fifty-two brands of domestic bottled water were collected from the supermarkets and food stores in Riyadh city, Saudi Arabia. The collected drinking water bottles are very different in character, and display a wide range of parameter values. There is a great difference between the determined values of each

parameter and the respective value labeled in each bottle. Results of BrO^-_3 indicate that more than 18% of the total collected bottled water exceeded the allowable limits of Bromate (10 μg/L) according to Saudi Arabia Standards and WHO. Most collected water agrees well with the permissible limits of other parameters set either by WHO or Saudi Arabian standards, but with some variation for some major values.

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