Evaluation of Mineral Bottled Water Samples for Different Physical and Chemical Parameters

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Summary: The quality of drinking water is regulated in most countries under recommendation and legal requirements. For developing countries regulations are framed by World Health Organization (WHO) since 1984 and onwards. Normally ground water and surface water (River, lacks, springs) are used for bottler's choice of water.

In the present paper we have evaluated the pure water supplied by many factories in bottles with different brand names. Such mineral water was analyzed for different physical and chemical parameters. The quality of bottled water is compared with U.S. Federal Drug Administration (FDA) guidelines for bottled water and World Health Organization standards for drinking water.

Introduction

Pure drinking water is primary need of every human beings. In Pakistan most of the urban population has no access to clean and pure drinking water. Many local companies have come in the field with "Bottled mineral water" of different brands and names. As there is no sustainable drinking water quality check system in Pakistan so quality of water deteriorates as it travels from the source to the end users. There are many National and some International companies producing pure mineral water with brand names and they claim rigid quality control for metals etc. The mineral bottled water should be soft and bacteria free [1]. However, many bogus companies do not mention their addresses completely on the label and none of the concerned agency is monitoring the quality of water. There is also lack of a comprehensive legislation, non-existence of National Water Quality Standards or guidelines for bottled water and lack of well-equipped certified laboratories to point out lack of quality control to consumers.

Results and Discussion

WHO reports that for every eight seconds, a child in low income countries dies of water related diseases [2]. In Pakistan over 40% of urban deaths are attributed to diseases caused by drinking of contaminated water [3]. The present study was under taken to determine the suitability of bottled water for drinking consumption.

The chemical quality of bottled water with respect to the tested parameters (pH, EC, Turbidity and TDS) did not seem to be deteriorated. All the samples have the values of pH, EC, and TDS within the legal recommendation. Except sample 12 all others have the turbidity above the recommendations. Highest value of Turbidity was found in sample 8 i.e. 29.55 NTU (Nephelometric Turbidity Unit).

Many salts are found dissolved in natural waters. The high concentration of dissolved solids (TDS) increases the density of water, reduces solubility of gases (like Oxygen) so, the water is not suitable for drinking [4]. The highest value of TDS was observed in sample 17 i.e. 538 ppm.

The standard value for bicarbonate is 400 ppm. And it was observed that all the samples have the values within the safe limits of WHO i.e.400 ppm. [5].

Table - 1* Analytical results of physico-chemical parameters.

S. Code.	PH	E.C. (mS)	Turbidity (NTU)	TDS mg/l	Bicarbonate mg/l	Chloride mg/l	Sulphate mg/l	Nitrate NO_3N	Calcium mg/l	Magnesium mg/l	Potassium mg/l	Sodium mg
WHO[1]	6.5-8.5	<0.7	<5NTU	1000	400	250	250	NS	100	30-50	12.0	200
PDA[3]	NS	NS	<5NTU	NS	NS	NS	NS	10	NS	NS	NS	NS
S-1	6.88	0.36	22.825	285	187.88	40.3	5.125	3.35	57.702	29.875	2.197	32.474
S-2	6.93	0.24	24.875	193	151.28	50.5	1.466	4.78	33.041	25.975	3.106	60.65
S-3	6.71	0.12	07.570	98	65.88	210.4	0.872	0.78	17.838	13.885	3.864	17.192
S-4	7.24	0.39	23.030	287	126.88	340.6	3.520	10.00	163.784	33.385	2.045	155.68
S-5	7.05	0.30	20.250	253	59.78	460.5	2.011	1.00	66.149	15.445	-	29.513
S-6	6.98	0.39	21.700	294	41.48	120.7	15.51	22.19	41.824	24.805	6.288	51.098
S-7	7.35	0.32	17.675	258	120.78	150.3	7.292	4.30	30.000	18.565	4.773	50.621
S-8	7.31	0.45	29.550	328	139.08	250.6	6.072	4.05	46-554	50.546	5.227	76.409
S-9	7.41	0.29	23.670	243	145.18	210.5	7.405	5.32	38.446	23.245	5.152	54.441
S-10	7.50	0.65	14.970	497	242.78	260.4	7.806	18.13	64.460	41.186	7.879	87.393
S-11	7.38	0.30	10.125	248	120.78	230.7	1.096	6.52	31.351	111.389	1.576	58.262
S-12	7.51	0.40	04,500	320	157J8	285.8	9.739	4.70	43.851	22.543	5.606	72.588
S-13	7.48	0.25	15.530	228	126.88	200.6	6.634	3.00	17.500	63.021	2.349	54.441
S-14	7.44	0.36	21.100	267	193.98	60.7	4.692	11.83	35.068	27.925	2.955	52.053
S-15	7.07	0.18	06.075	154	65.88	230.7	0.984	5.61	18.176	12.325	6.439	39.637
S-16	7.18	0.19	05.725	167	70.76	250.3	1.947	1.87	5.000	50.547	1.015	29.131
S-17	6.95	0.70	14.850	538	90.28	260.4	2.316	4.15	6.351	31.825	2.273	44.89

*Average Values (n = 4), (Confidence interval at 95%)
[1]WHO, World Health Organization guidelines for drinking water.
FDA, U.S. Federal Drug Administration guidelines for bottled water.

Ground waters are generally having low chloride concentration, often less than that of bicarbonates and sulphates. Chloride contents above 250 mg/L makes a water salty in taste, however, a level up to 1000 mg/L has been safe for human consumption [6]. According to the values recommended by WHO, most of the samples were found with high level of chlorides.

Sulphate salts have been mostly soluble in water and impart hardness. Waters with about 500 mg/L sulphate are having a bitter taste and those with 1000 mg/L or more sulphate may bring about intestinal disorders [1]. Experimental values [Table 1] show that all the samples are well within the permitted limits of WHO i.e. 250 ppm.

The high concentration of nitrate in water indicates pollution. High nitrate contents (<40 mg NO_3 – N/L) may bring about blue-baby disease [8,9]. The high amounts of nitrates were observed in sample nos. 6, 10 and 14. These values are found above the permitted limits of FDA i.e.10 ppm. as NO_3 – N.

Calcium occurs in great abundance in all natural waters and is an important micronutrient. It is an important contributor to hardness in water and is able to reduce the utility of waters for domestic use [6,9,10]. Only one sample i.e. 4 has shown higher value of calcium than the safe limits of WHO i.e. 100 ppm.

Magnesium also occurs in all natural waters. Important of magnesium intake in dirnking water is correlated with multiple health problems [18]. It has long been known that there is relationship between the hardness of drinking water and incidence of cardiovascular diseases [9,10,11]. Its concentration above 500 mg/L give an unpleasant taste and makes it unfit for drinking purposes. In the present work

Table 2 . Statistical data for standard of elements

Elements	Conc. range ppm (x)	Absorption range (Y)	Statistical calculation y = mx +c m c r		
			m	c	r
Sodium	0.0-1.0	0.0-0.313	0.3079	0.0032	0.999
Potassium	0.0-1.0	0.0-0.565	0.5654	0.0026	0.999
Calcium	0. 0 - 1.0	0.0-0.0305	0.0304	0.0002	0.999
Magnesium	0.0-1.0	0.0-0.883	0.886	0.0133	0.996

seven samples were found with higher concentration of magnesium. Sample 11 has very high value for magnesium i.e. 111.389 ppm and continually use of this type of drinking water is dangreous to health.

Sodium salts have been highly soluble in water and causes softness. If sodium content, in the form of chloride and sulphate, is very high, it makes the water salty in taste and unfit for human consumption. In our study all the values for sodium are within the safe limits of WHO i.e. 200 ppm. People having cardiac problems prefer to buy salt or sodium free bottled water. Sample 3 has claimed sodium free bottled water, but it is not true and the observed amount of sodium was 17.192 ppm.

Potassium is an important macronutrient. Like sodium, potassium also plays an important role in establishing the electrolytic balance of human body [12,13,14]. Observation shows that all the samples are well within the recommended limits of WHO i.e. 12 ppm.

Experimental

Sample Collection

During this study 5–7 samples of each 17 different brands of bottled mineral water were purchased from the local market of Hyderbad, Karachi, Faisalabad and Lahore especially in summer season of the year 1999.

Equipment and Chemical Reagent

All the chemicals and reagents used were of Analytical grade. Deionized water was used throughout experiment.

5-7 samples of each brand were analyzed for pH, EC, Turbidity, TDS [15], Bicarbonate, Chloride, Sulphate, Nitrate, Calcium, Magnesium, Potassium, and Sodium. pH, EC, TDS, and Turbidity were determined by pH-Meter CD 7400 WPA, Conductivity-Meter CMD 8500 WPA, and Turbidity-meter TU 1200 WPA respectively. Bicarbonates and Chlorides were determined titrimetrically [16]. Nitrates were determined by Brucine method [17,18,19]. Sulphates were determined spectrophotometrically. Calcium, Magnesium, Potassium and Sodium were analysed using Hitachi model 180–50 Atomic Absorption Spectrophotometer.

Determination of Mineral Elements

For determination of sodium, potassium, calcium and magnesium, all samples were diluted ten times with 2 N nitric acid to match with matrix of standards and to obtain signal within experimental range.

A series of working standard solutions of each cation was prepared from certified stock standard solution (1000 ppm) of Fluka company. All standards and samples were run on atomic absorption spectrophotometer Hitachi model 180-50 equipped with zeeman back ground correction using air-acetylene flame mode.

Calibration curve drawn for all four elements by concentration versus absorbance were staistically analyzing using fitting of straight line by least square method. 2N Nitric acid is used as blank

Conclusions

Millions of people have switched to bottled water because they think it is better for their health. This report shows that it may not be any purer or safer than tap water.

The quality of bottled water available in Pakistan was not so good as anticipated. The values of Turbidity, chlorides, nitrates, calcium, and magnesium were found higher than the FDA and WHO legal recommendations. People having cardiac problems prefer to buy salt or sodium free bottled water, but the results were found surprisingly higher for those samples which were claimed to be sodium or salt free.

The present study can be used as a base line for water management Authorities and in this regard an effective programme to control the chemical quality of bottled drinking water is highly recommended.

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