

QUALITATIVE ASSESSMENT OF BOTTLED WATER IN THE MIDDLE EAST

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ABSTRACT

Many brands of bottled water are being produced in the Middle East including the Gulf Cooperation Council (GCC) countries. Over fourteen brands of bottled water could be found in the market of Doha. Use of bottled water has kept on increasing in this region. Reasons for the increase in use of bottled water for drinking have been discussed.

The raw water source for the bottled water is groundwater. Most of the manufacturers of the bottled water claim bottled water as "Natural Mineral Water" which is contrary to the definition suggested by the International Bottled Water Association of Washington D.C. In fact there is no such thing as "mineral water" and the term is a misnomer.

Samples of various brands of bottled water available in Doha and municipal water were collected during 1993 and 1994 for physical, chemical, and bacteriological analysis. All the samples were found potable and safe for drinking and conform to various drinking water standards.

The physical and chemical composition of bottled water varies with time but the concentration of constituents printed on the labels of bottles is always the same. It may be preferable to print the range of concentration on the labels rather than a single value. Moreover the analysis should be monitored and certified by a competent authority, and should be displayed on the label.

INTRODUCTION

Water is seldom found in pure state in nature. It acquires impurities during the hydrological cycle as a consequence of human activities and water use. Therefore, the water quality has to be determined to find its suitability for use.

Water supply in the Middle East faces new challenges. Ten countries in the Middle East including Qatar already use more than 100% of their renewable water supply (World Bank Report, 1990). Therefore sea water is used as the main source of water for various purpose. Desalinated sea water blended with the ground water or chemicals to improve the taste/flavour is supplied to the community after chlorination for domestic, public, commercial and industrial uses. The water supplied to the community is potable, inspite of this a large cross section of the population, hotels and restaurants use bottled water for drinking.

Large quantities of bottled water of 1.5 liter capacity are being produced in the Gulf Cooperation Council (GCC) countries, e.g. about 140,000 to 150,000 bottles are produced in UAE and 36,000 bottles of Rayyan Water in Qatar every day. Several other brands of bottled water are imported in Qatar from other GCC, Arab and foreign countries. Over fourteen brands of bottled water (Fig. 1) could be found in the market of Doha.



Fig. (1). Bottled water found in the market of Doha

The objective of this work is to develop an understanding of the various water quality parameters of the bottled water available in the market including the tap water and compare their physical, chemical and bacteriological quality with the European Community (EC) and WHO standards (Carney 1991, and WHO, 1971). The reasons for increasing bottled water use in the region are also investigated.

Definition of Bottled Water

According to the International Bottled Water Association of Washington DC bottled water may be of two types viz., Drinking Water and Natural Mineral/Spring waters. The term drinking water refers to water from a protected source reasonably treated to assure purity and to which minerals might have been added to enhance flavour. Distilled purified water, Club Soda and Seltzer are all classified as drinking water. By definition natural mineral/spring waters must come from a natural underground source and must not have had their mineral content modified by an artificial process (Duff 1984). However most of the bottled water manufacturers in this region claim bottled water as "Natural Mineral Water" and display this claim with bold letters on the bottle labels. This claim is contrary to the definition proposed by the International Bottled Water Association. There is no such thing as "mineral water" and the term is a misnomer. The term mineral water is being abused by making all sorts of claims that water has creative and health properties. (Gulf Times 1985, 1994, Gulf Weekly 1989).

Reasons for the Use of Bottled Water

The following factors seem to be the driving force for the popularity and increase in the use of the bottled water, although the bottled water costs more than petrol in the region.

- The distribution main and water distribution pipes within the buildings get corroded due to the desalinated water coupled with hot and humid climate; as a result the consumer may sometime receive reddish coloured water.
- Intermittent supply which may lead to possible contamination and further corrosion.
- In the suburban area where piped water supply is not available properties are supplied through water tankers. Due to lack of confidence in the

quality of water supplied through tankers, the consumer tend to rely on the bottled water for drinking.

- Water is supplied to every property through a fiber glass surface storage tank from where it is pumped to the roof tank made of fiber glass and then distributed inside the building. These tanks are not regularly cleaned and maintained properly to avoid possible contamination.
- Possible hazard of disinfection by product which increases with time in the distribution system (Clark et al 1993).
- Changing trends in catering services in hotel and restaurant force the people to use bottled water for drinking.
- The affluent class of the society uses bottled water as a mark of higher status in the society.
- Some people may prefer a specific taste of water and hence use a specific brand of bottled water.
- A small segment of population seeks some medicinal value through it, because of the advertisement that bottled water has creative and health properties.
- Lack of public acceptance and confidence of municipal water supply encourage the purchase of bottled water. Moreover sales campaign for home filters creates doubts about quality of municipal water supply. Over and above the marketing technique of bottled water companies encourage people to use bottled water (Clicker, 1992).

Due to these factors and heightened public awareness about environmental impact on the quality of the municipal water supply, use of bottled water keeps on increasing. However the municipalities in this region make all possible effort to minimize corrosion by replacing old and corroded CI and GI pipes with cement lined ductile iron pipes and copper pipes and strive to produce potable water. The population in the low income group, the popular eating houses and restaurant and labour camps continue to use municipal water directly or after passing through cartridge filters for drinking.

Bottling Practice in the Region

The two plants in Qatar use raw water from underground sources and bottle it after treatment. The bottling plant consists of the reverse osmosis unit, microfilters, clear water tank, ozonizer, bubble reactor, pressure filters using gravel and activated carbon, pumps, blow moulds for the manufacture of bottles, and a filler, capping and labeling units. The schematic layout of a typical plant is shown in Figure 2.

Most of the bottling plants in the Middle East obtain raw water from underground sources, some are reported to use shallow well water which is treated thereafter (Ahmed 1992). Well water is normally treated by chlorination, filtration using activated carbon and reverse osmosis processes. Some producers use a series of filters followed by UV sterilisation only. A few bottled water manufacturers claim to use spring water without treatment (Gulf News 1994).

Analysis of Samples

Samples of various brands of bottled water available in different districts of Doha were collected from various shops. At least two bottles of 1.5 L capacity of each brand were collected during Feb.1993, Oct. 1993 and Feb. 1994 and stored in cold condition in the Environmental Engineering Laboratory. The collected samples were randomly selected with respect to time and may therefore be considered as representative samples of each brand. The raw water used in Rayyan bottling plant and tap water samples from the university campus were collected at the same time when bottled water were collected. The tap was run for at least ten minutes before collecting the sample. Average of the three reading was recorded for each test and three samples of each brand were analyzed resulting in a total of nine readings. The results of the analysis are presented in Table 1. All the tests were conducted as per Standard Methods (APHA 1989). The accuracy of the analysis was checked by calculating ion balance for each sample, the result of which were found to be within 10%, which is considered to be acceptable (Peavy et.al, 1988). MPN of coliform organisms in all the samples was found to be negative indicating that the water is bacteriologically safe. Apart from this dissolved nitrate was also analysed for both the raw water and various samples of bottled water and was found to be in trace quantities.

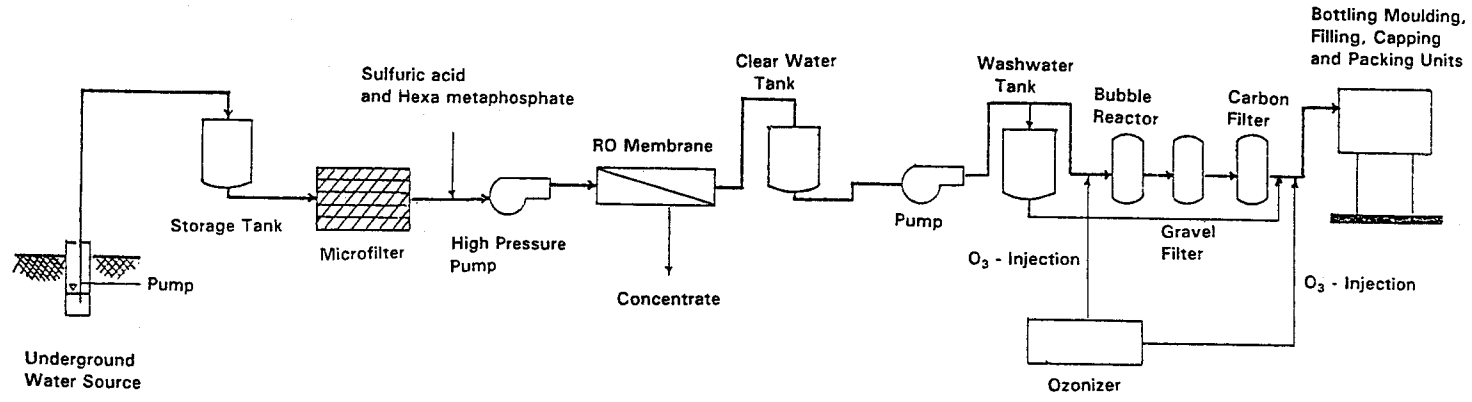


Fig. 2. Typical Layout of a Bottling Plant

Fig. (2). Typical layout of a bottling plant

Table 1. Water Quality of Bottled Water

Sl. No.	Constituents Sample	pH	Conductivity μS/cm at 25°C	Total Dissolved Solids (TDS) (mg/L)	Alkalinity as CaCO ₃ (mg/L)	Total Hardness as CaCO ₃ (mg/L)	Ca ⁺⁺ (mg/L)	Mg ⁺⁺ (mg/L)	Na ⁺ (mg/L)	K ⁺ (mg/L)	HCO ₃ (mg/L)	Cl (mg/L)	SO ₄ ⁼ (mg/L)
1.	Qatar Water ¹ (Qatar) ²	8.00 - 8.57	594.00 ³ (213.00) ⁴	368.00 (105.00)	185.00 (20.00)	157.30 (71.70)	36.89 (0.02)	5.84 (1.38)	58.20 (17.30)	18.56 (13.51)	228.60 (20.10)	53.87 (34.3)	21.67 (17.40)
2.	Gulfa (UAE)	8.23 - 8.45	513.33 (3.21)	438.67 (72.7)	118.33 (15.27)	231.33 (24.19)	34.74 (28.76)	34.08 (9.53)	18.30 (5.91)	1.32 (0.62)	144.37 (18.63)	80.04 (19.46)	53.50 (12.29)
3.	Al Shifa (KSA)	6.89 (0.29)	219.33 (14.84)	195.76 (61.55)	41.67 (10.41)	31.33 (24.19)	9.10 (8.34)	1.52 (2.15)	37.10 (2.76)	1.78 (1.13)	50.83 (12.70)	52.67 (11.72)	15.82 (4.07)
4.	Masafi (UAE)	7.94 - 8.22	336.33 (65.62)	269.00 (114.81)	51.67 (5.77)	130.67 (31.07)	17.03 (21.82)	18.35 (5.67)	17.67 (10.93)	0.72 (0.31)	60.03 (12.24)	74.93 (13.38)	34.13 (16.86)
5.	Sohat (Lebanon)	7.93 - 8.20	207.67 (1.53)	100.57 (62.73)	90.00 (5.00)	101.33 (23.44)	24.07 (6.83)	7.29 (2.06)	5.30 (2.86)	7.84 (6.62)	109.80 (6.10)	9.52 (2.31)	16.32 (11.59)
6.	Safa (Iran)	7.65 - 8.32	335.33 (58.11)	167.33 (20.03)	155.00 (36.05)	183.25 (30.88)	54.51 (11.33)	15.27 (1.76)	1.00 (1.73)	0.33 (0.30)	192.10 (45.52)	10.95 (3.38)	19.19 (14.00)
7.	Al Rawabi (UAE)	8.03 - 8.27	314.67 (19.43)	207.77 (135.58)	45.00 (10.00)	107.67 (21.55)	8.42 (11.91)	18.10 (8.76)	16.77 (7.22)	0.72 (0.31)	54.90 (12.20)	69.91 (18.60)	21.93 (19.12)

¹Brand Name

²Country

³Mean of 9 observations

⁴Standard deviation

UAE - United Arab Emirates

KSA - Kingdom of Saudi Arabia

Table 1 (Continued): Water Quality of Bottled Water

Sl. No.	Constituents Sample	pH	Conductivity μS/cm at 25°C	Total Dissolved Solids (TDS) (mg/L)	Alkalinity as CaCO ₃ (mg/L)	Total Hardness as CaCO ₃ (mg/L)	Ca ⁺⁺ (mg/L)	Mg ⁺⁺ (mg/L)	Na ⁺ (mg/L)	K ⁺ (mg/L)	HCO ₃ (mg/L)	Cl (mg/L)	SO ₄ ⁼ (mg/L)
8.	Nissah (KSA)	7.67 - 7.90	446.67 (6.66)	270.83 (26.02)	45.00 (8.66)	146.33 (23.24)	43.50 (16.12)	6.56 (4.47)	28.67 (9.81)	1.45 (0.62)	54.90 (10.56)	60.23 (20.77)	98.77 (11.45)
9.	Al Shalal (UAE)	7.87 - 8.27	317.00 (33.78)	195.00 (106.07)	46.67 (2.89)	113.67 (27.06)	11.82 (16.72)	16.77 (7.91)	17.17 (10.08)	0.89 (0.95)	56.93 (3.52)	70.83 (16.27)	28.67 (3.67)
10.	Jabal Al-Khadar (Oman)	8.31 - 8.34	512.00 (2.83)	420.00 (197.99)	168.33 (7.64)	220.00 (24.33)	38.26 (29.22)	26.85 (18.38)	19.40 (5.72)	1.75 (1.07)	205.36 (9.32)	39.60 (11.60)	50.07 (7.25)
11.	Emirate (UAE)	8.22 - 8.48	942 (780.64)	275.00 (120.21)	92.50 (17.68)	227.50 (85.56)	14.62 (20.67)	27.95 (7.22)	18.40 (0.00)	1.56 (0.56)	112.85 (21.56)	99.00 (67.88)	50.65 (1.77)
12.	Tap Water (Qatar)	7.76 - 8.12	232.00 (69.30)	150.00 (14.14)	76.67 (25.65)	95.33 (32.02)	16.02 (9.08)	9.48 (0.35)	16.30 (6.21)	0.53 (0.46)	93.53 (31.30)	43.83 (9.39)	12.20 (2.96)
13.	Rayyan - Raw Water (Qatar)	7.82 - 8.44	1374.00 (14.14)	1190.00 (296.98)	177.50 (31.82)	479.50 (21.92)	113.99 (52.45)	47.40 (26.44)	77.05 (1.63)	39.88 (1.10)	216.55 (38.82)	162.48 (57.30)	368.58 (3.79)
14.	Rayyan (Qatar)	7.32- 7.797	585.00 (12.29)	460.00 (74.94)	78.30 (16.07)	173.30 (32.31)	43.89 (16.67)	13.24 (0.51)	46.16 (10.31)	23.68 (5.50)	95.56 (19.61)	65.69 (20.27)	122.5 (8.31)
	Drinking Water WHO Highest desirable Level	7 - 8	400*	500	-	100	75	30	20*	10*	-	200	200

* EC Guide level
all values are in mg/L except pH and conductivity

The analysis for heavy metals, pesticides and herbicide was not taken as the possibility of presence of these substances in underground water sources of this region is very remote because of the following reasons.

- In general the region is sparsely populated.
- The underground source of the bottled water plants is located in remote areas far away from the human settlements and industries.
- The area being arid, there is very little agriculture activity near the source of raw water used in bottling.
- The level of industrialization at present is quite low, moreover it is compulsory for the industries to be installed in specific areas.

It is also reported in literature (Ahmed 1992) that the elements like cadmium, arsenic, manganese, zinc, lead and mercury are present in non detectable levels, in the bottled water of United Arab Emirates. A study regarding presence of trace metals in the drinking water including raw treated and bottled water in Bahrain, Qatar and Kuwait revealed that cadmium, chromium, lead, nickel, iron, manganese and zinc are present in traces and conform to WHO Guide lines (Raveendran and Juma 1989).

DISCUSSION AND CONCLUSION

EC, WHO and other standards for drinking water (Carney 1991, WHO 1971) stipulate a range for different quality parameters, based on which a water can be considered safe for human consumption. However it seems appropriate to compare bottled water with the requirements of water quality corresponding to "Highest desirable level of WHO standards and/or "Guide level" of EC standards.

The raw water used for bottling Rayyan water is slightly brackish but is free of coliform; which indicates that it is not contaminated. Based on the physical, chemical and bacteriological analysis of Rayyan bottled water, it can be concluded that it is potable and safe for drinking and conform to various drinking water standards. However it has a relatively high sodium and potassium concentration.

The physical and chemical analysis of other brands of water indicate that these are also potable. Most of the bottled waters are hard except Alshifa. However the total hardness in all the brands lies within the permissible limit. The sodium concentration in most of the brands except Masafi, Sohah, Safa and Emirate is greater than the desirable concentration in drinking water. The potassium concentration in Qatar and Rayyan water and the magnesium level of Gulfa water exceeds the desirable limit.

For heart patients high concentration of sodium, is not desirable. Therefore its concentration in those brands of bottled water which exceed the limit of desirable concentration, should be reduced.

The physical and chemical composition of bottled water varies, but the concentration of various constituents printed on the labels of bottles is always the same. One of the bottled water is found using same label for more than three years. This confirms the findings of bottled water analysis in UAE (Ahmed, 1992). It may be preferable to print the range of concentration on the labels rather than a single value. Moreover the analysis should be approved by a competent authority and should be displayed on the label.

There is no indication of the source of raw water for any brand on the label of bottles. The consumer has the right to know the source. According to the Gulf News report some bottling companies in UAE were found filling the bottles with tap water and supplying them to the market claiming it to be pure mineral water (Gulf News, 1984). Recently US Food and Drug Administration has made it compulsory for the manufacturers to describe the source of bottled water on the label using the defined terminology (AWWA, 1996).

“Natural Mineral Water” is printed on the labels of many bottled water even though their natural mineral content has been modified by treatment. As per the definition stated above it can be more appropriately called as “bottled drinking water”. There is no such thing as “Natural mineral water” and the term is a misnomer. The term mineral water is being abused by making all sorts of claims that water has creative and health properties (Gulf Times 1985). There is a need for adopting internationally recognized terminology so that a consumer from any part of the world is satisfied with his choice and knows what he is buying.

Doha city is supplied in adequate quantity with quality water which conforms to the highest desirable level of WHO and guide level of EC; it is true for other countries of the region as well (Raveendran and Juma 1989, Walton

1987). But most of the consumers receive the water in their homes through a ground storage tank and a roof tank. As a result, home filters are invariably used in the kitchen and laundry and for drinking, people use bottled water.

A functional relationship between taste and TDS defines water with a TDS upto 450 mg/L as "good quality" and that with a relatively lower TDS of 80 mg/L as "Excellent" (Bruvold and Daniels 1990). In a taste survey in New York tap water was rated number one when compared with various brands of bottled water (Duff, 1984). Therefore it may be presumed that the tap water of Doha with a lower TDS when compared to any bottled water might offer quite a good taste.

It looks that not only the taste but a number of other factors some of which are listed above, may tempt an individual to go for a bottled water drink. Whatever may be the reason for ones choice, the bottled water demand is increasing in the region. It is emerging as a rapidly growing beverage industry in the Middle East, like many other parts of the world. It is time to monitor the quality of bottled water sold in the market by the competent authority. Moreover to create confidence in the public regarding the water quality of the municipal water supply the condition of the water storage tanks and quality of water inside the property should be checked from time to time. The consumer should be made aware of the importance of regularly cleaning and properly protecting the storage tanks from dust, insects and any possible contamination. It is advisable to give an additional direct line from the water main for drinking purpose inside the house.

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