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Analysis of Some Bottled Drinking Water Samples Available in Alkoms City

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***Abstract*- Commonly consumed six local brands of bottled drinking water from Alkoms city were analysed. The acquired results were compared with both Libyan and WHO standards. Various physical and chemical properties were studied: pH, conductivity, and levels of Na, K, Ca, Mg. Conductivity and pH values of the tested samples were agreed with both Libyan and WHO limits. Na, K, Mg levels were in the acceptable range comparing with both Libyan and WHO limits, whereas calcium levels were up to four times as high as Libyan and WHO limits.**

***Key words*: Bottled Water, WHO, pH, Conductivity.**

I. Introduction

The consumption of bottled water has increased significantly in the past years and has become an important industry in the food and soft drinks sector. The high tendency of people to use bottled water over tap water is attributed to many factors including the quality of bottled water, fear of biological or mineral contamination, as well as the unacceptable taste of chlorinated tap water [1-2]. Compared with other countries, Libyan markets aren't an exceptional case. Local markets are filled with a large number of bottled water brands, and neither the water source nor the type of water is mentioned on the label. Some of the bottles were labeled as mineral water or pure water, but there is no evidence on the label indicating the treatment method of the water from the original source. Several water quality parameters have been discussed in numerous research papers. Recently, researchers in Saudi Arabia have studied 30 bottled water brands, 23 of which were local and the rest were imported. The study included evaluating the physical, chemical, and biological parameters, and the results were mostly in line with Saudi standards and FDA regulations except for the pH value in one local brand and the level of fluoride in two local and six imported brands which were less than the Saudi regulations [3]. Available brands of domestic bottled water in Riyadh City, Saudi Arabia, were analysed and compared with drinking water standards of Saudi Arabia, World Health Organization, and U.S. Environmental Protection Agency. The obtained results indicated that, except for fluoride and bromate, the concentrations of dissolved salts, soluble cations and anions, nitrate, and trace elements of most bottled waters on sale were within the permissible limits set by standards used. On the other hand, the comparison between determined and reported label values recorded a substantial variation in some parameter values. Results indicated that more than 18 % of the sampled bottled waters exceeded the, permissible limits for drinking water [4]. In Baghdad, an intensive physiochemical and microbial study was conducted for a year on 400 local and imported water brands. The quality of the imported brands was much better compared to local water in all variables except for chlorides [5]. A comparative study was conducted in Turkey of 189 brands of bottled water that originated from the springs, and the results were in line with Turkish, European and WHO standards except for a slight increase in sodium and chloride levels [6]. Recently in Libya, levels of heavy metals (cadmium, lead, iron, zinc, chromium, Cobalt, and copper) and TDS were determined in bottled water for six different brands in Tobruk [7], Unfortunately, the level of heavy metals in all samples was higher than the permissible limits of both Libyan and World Health Organization, and the value of dissolved solids was less than the acceptable level. The studied samples were classified as poor quality water. Another study was conducted in Misurata in 2013; twelve samples of bottled drinking water were collected from different factories in the City. Total hardness, pH, soluble salts, in addition to sodium, potassium, calcium, magnesium, chlorides, and bicarbonate levels were investigated. The results indicated that the pH values of eight samples were less than the Libyan standards. One sample exceeded the Libyan limits in dissolved salts and total hardness values, while, chlorides exceeded the maximum value in one sample. Concentration of sodium, calcium, magnesium, potassium, copper, lead and zinc ions was in the allowable range of Libyan standards, while levels of cadmium and mercury were above the Libyan and international limits [8].

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II. Experimental

Six different samples of bottled water (0.50 L) were collected from the local markets of Alkoms city, and the bottles were closed tightly and kept in a dry and cool place before analysis. The measurements included the pH, conductivity, and concentrations of Na, P, Ca, and Mg elements. Libyan standards values [9] and WHO [10] for bottled water were used as a standard as in Table (1). Cationic ions concentrations were measured in ppm, and conductivity was measured in US / msec and compared with US regulations [11].

Table 1. Libyan and WHO standards values for commercial bottled waters

Variables	Standard values	
	Libyan standards	WHO standards
pH	6.5 – 8.5	6.5 – 8.5
Na	200 - 250	175 – 200
P	12	10 – 12
Ca	100	100
Mg	150	150
TDS	100	100
Conductivity	30 – 1500 (11)	

The pH of all samples was measured with a HI 8014 pH meter, the instrument was titrated with buffer solutions of pH 4, 7, and 9, and the readings were repeated twice. Conductivity was measured with a Jenway 4520 conductivity meter in s / cm units, and the instrument was calibrated with KCl (0.01N) solution. All physical measurements were performed at room temperature. Sodium and potassium levels were determined using a Jenway PFP7 spectrophotometer, and standard solutions of sodium and potassium were prepared at concentrations of 2, 4, 6, 8, 10 and 12 ppm and then the emission intensity (EI) was measured for each sample separately using the standard procedure [12], the results shown in Table 2.

Table 2. EI for Sodium and Potassium standard solutions

Sol. Conc.	2 ppm	4 ppm	6 ppm	8 ppm	10 ppm	12ppm
Na EI	2.80	4.30	5.40	6.20	8.20	10.20
P EI	1.20	2.70	4.0	5.20	6.40	7.30

Calcium and magnesium levels were determined by titration the samples solutions with EDTA (Ethylene Diamine Tetra Acetic acid) standard solution in presence of ammonia solution (pH = 10) and Erochrome Black T as an indicator [13].

III. Results and Discussion

From the results shown in Table 3, the pH of the studied samples was in the range 7.01 - 7.73 which nearly neutral. Sample no. 4 recorded the highest value (7.73) while sample no. 1 was the lowest (7.01)

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Table 3. pH values of studied samples

Sample No.	1	2	3	4	5	6	WHO
pH	7.01	7.03	6.44	7.73	6.69	6.72	8.5-6.5

The acidity of water is mostly attributed to the solubility of acidic gases such as carbon dioxide, while the basicity of water is mostly attributed to the presence of carbonate and bicarbonate salts, in addition to the presence of monovalent and divalent basic minerals. Increasing the pH gives the water a bitter taste and intense color, while a low pH may corrode the metal containers [14]. The results were within the permissible values of WHO as shown in Fig. 1.

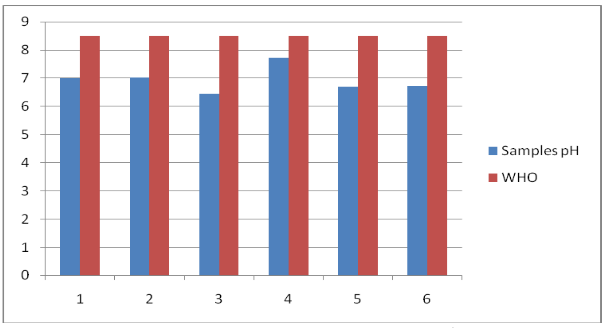

Figure 1. Graphic comparison between pH values of studied samples and WHO values

Electrical conductivity (EC) is a measure of the ability of water to pass electrical flow. This ability is directly related to the concentration of ions in the water. These conductive ions come from dissolved salts and inorganic substances such as alkalis, chlorides, sulphides, and carbonate compounds. The values of electrical conductivity of the studied samples ranged between 20.3 - 228.5 (μs / cm), as shown in Table 4; sample No. 5 recorded the highest value, while sample No. 3 was the lowest.

Table 4. EC values for studied samples

Sample No.	1	2	3	4	5	6
EC	130.5	138.7	20.30	293	228.50	80.90

Increasing EC values higher than acceptable may increase water salinity and as a result make water taste unacceptable. All studied samples were within US specification limits (30 - 1500 μg / cm), and because of the significant difference between the two variables we chose 500 μg / cm as a minimum value for American standards, a comparison is shown in Fig. 2.

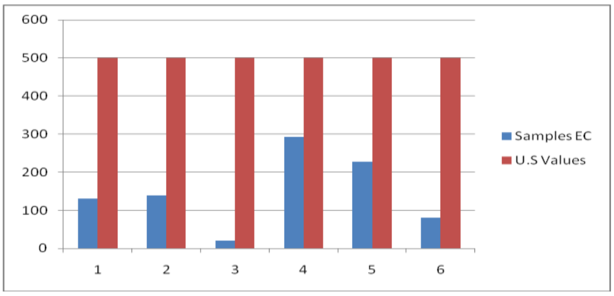

Figure 2. Graphic comparison between EC values of studied samples and American standards

Measuring levels of alkaline minerals in drinking water is very vital, sodium salts are highly soluble in water, and water rich in sodium salts may cause vomiting and dehydration [15]. Water samples were analyzed using a flame spectrometer and the results are shown in Table 5. In general, the studied samples were very low in sodium. Sample No. 6 recorded the highest value (4.50 ppm), while Sample No. 4 recorded the lowest value (0.30 ppm).

Table 5. Sodium concentration (ppm) in studies samples

Sample No.	1	2	3	4	5	6
Na Conc.	2.70	1.10	2.40	0.30	0.90	4.50

Comparing with WHO limits, all samples were in the permissible range (175-200 ppm), and because of the significant difference between the two variables we chose 50 ppm as a minimum value for WHO as shown in Fig. 3.

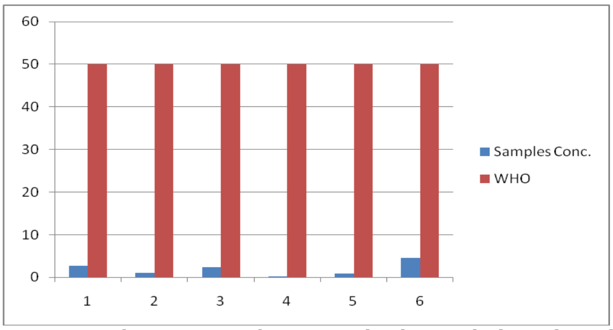

Figure 3. Graphic comparison between Na levels in studied samples and WHO values

Potassium is an important component of cellular fluid, and along with Sodium, it plays an important role in regulating osmosis, as well as an important base in the conduction of nerve impulses (16). Again, sample no. 4 has the lowest concentration of potassium (0.30 ppm) while sample no. 3 recorded highest concentration (1.40 ppm) as in Table 6.

Table 6. Potassium concentration in studies samples

Sample No.	1	2	3	4	5	6
P Conc. (ppm)	0.70	1.00	1.40	0.30	0.50	0.50

Compared to the WHO limits for potassium in drinking water (10-12 ppm), the level of the studied samples is still very low as shown in Fig. 4.

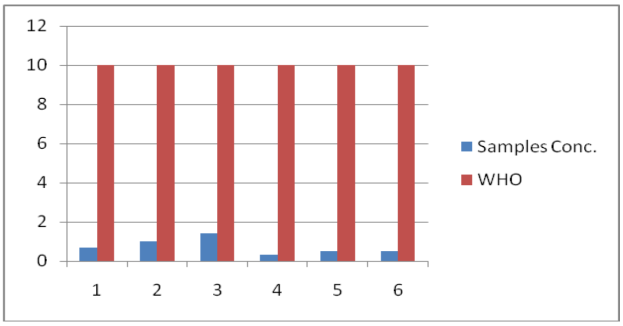

Figure 4. Graphic comparison between P levels in the studied samples and WHO values

Calcium and magnesium are important chemical elements of drinking water and have a vital role in human health, especially in long-term consumption. Magnesium and calcium have been linked to a decreased frequency of sudden death and osteoporosis respectively. Researchers are promoting the consumption of brands that are high in magnesium and calcium and low in sodium [17], both elements have protective effects against stomach cancer [18]. From the results shown in Table 7, the magnesium levels were in the range 1.44 - 18.48 ppm and sample no. 5 had the lowest value while sample no. 3 had the highest concentration. Calcium concentrations ranged between 506.15 - 257.85 ppm, and sample no. 2 was the richest in calcium and the lowest was sample no. 3.

Table 7. Magnesium and Calcium concentrations in the studied samples

Sample	Mg conc. (ppm)	Ca conc. (ppm)
1	17.76	296.05
2	5.28	506.15
3	18.48	257.85
4	7.44	410.65
5	1.44	382.0
WHO	150	100

In comparison with WHO values, the level of magnesium in all samples was within the permissible limits, while the calcium concentration was higher than the permissible values as shown in Figures 5 and 6. Insufficient calcium intake was associated with an increased risk of osteoporosis and nephrolithiasis (Kidney stones), colorectal cancer, high blood pressure, stroke, coronary artery disease, insulin resistance and obesity [19].

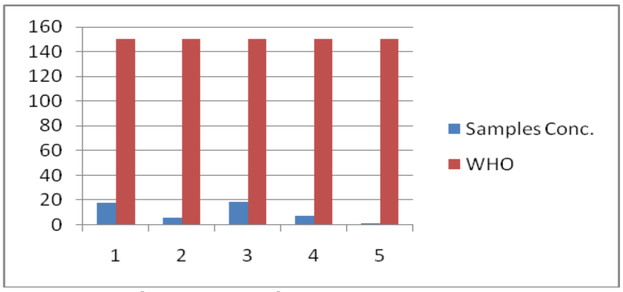

Figure 5. Graphic comparison between Magnesium concentrations in studied samples and WHO values

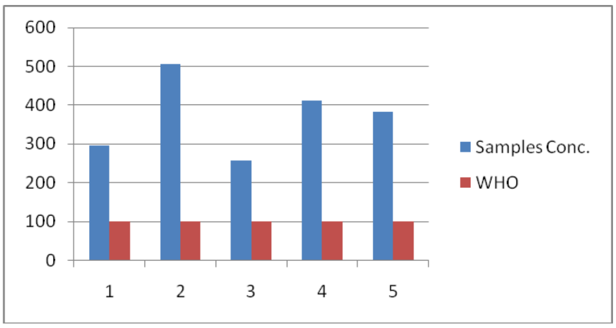

Figure 6. Graphic comparison between calcium concentrations in studied samples and WHO values

IV. Conclusion

With the increase in the daily use of bottled water, routine chemical investigation has become a priority, in terms of chemical composition, packaging and even label information. This study examines some of the chemical and physical aspects of commercial bottled water in AlKoms city. In general, the levels of the examined parameters were in the acceptable range according to the Libyan and WHO limits except for calcium concentration.

V. Acknowledgments

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VI. References

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