Comparing the Label and Real Content of the Local Bottled Drinking Water Manufactured in Benghazi with Libyan Specifications for Labeling of Prepackaged Foods and Bottled Drinking Water

ABSTRACT

For consumers, the composition of the drinking water is indicated on a label attached to the water bottle. The main objective of this study is to evaluate the labeling of locally bottled drinking water comparing with the Libyan specifications for food and water labels. Physical and basic inorganic parameters were evaluated for six randomly selected samples from Benghazi, Libya. The results confirmed that the specific analysis complies with the water standards indicated on the bottle labels, proving the reliability of the labels within the standards but the values on the water bottles still differed from the real values detected in the laboratory. Only one sample (F) record a higher value of potassium comparing to the Libyan standards for drinking water, as it recorded 14 ppm, while the upper limit allowed was 12 ppm. In fact, bottled water quality control has become necessary, with the aim of having correct information on the label to reliably inform consumers and ensure human health.

Keywords: Label content; bottled drinking water; specifications.

1. INTRODUCTION

“Using of bottled water has spread. The bottled water companies have already succeeded in attracting a large audience of consumers” [1,2]. “Regard to standard specifications, a specification is an approved document used for the application of requirements, characteristics and types for a particular product or a certain method. It is issued by approved bodies. Bottled water in Libya is widely consumed preferably over tap water, and drinking water must meet standards to be healthy for human use. If the drinking water has impurities, such as physical, chemical, or microbial substances, and the drinking water does not meet the standards, it will be harmful to human life. According to the epidemiological study, water chemical impurities can cause cardiovascular diseases, venereal diseases, cancer and even cause death. Many chemical element impurities are present in drinking water, such as chlorine (Cl), sulfate (SO4), copper (Cu), cadmium (Cd), chromium (Cr), lead (Pb), and nickel (Ni). These elements are essential to the human body. That is, it should be present in drinking water, but within the standard limit. If they exceed the limit, the water will harm human health and cause the above diseases. In addition to this, the microbial contamination in drinking water can cause some severe diseases such as hepatitis, typhoid, cholera, etc [3,4]. There are some physical properties of water, such as pH, TDS, and Turbidity; if these properties disobey the standards, then it will be harmful to human health” [5,6]. “Bottled drinking is sold as "spring water" or natural mineral water. It can come from a variety of sources, including municipal supplies, and must meet internationally approved drinking water requirements. The bottle term means that one- time use plastic containers, to be crushed after use. Labeling is an important part of product marketing [7,8,9]. Labeling is essential as it helps in getting the customers attention and can be combined with packaging and can be used by marketers to encourage potential buyers to buy the product. Packaging is also used for convenience and information transmission, as it is an international health requirement and otherwise the product is considered in violation of the standards" [10]. Libyan standards are concerned with the requirements that must be fulfilled in the labeling data of food packages. As there are general requirements for any food product and mandatory requirements that must be written on the packages of all kinds, and for bottled water, special illustrative data will be discussed in detail in this research [11]. The present study aims is to compare between real and label content of number of Libyan bottled water brands, and to comparing the data label mentioned on the bottled water packages with Libyan specifications of Labeling Prepackaged Foods and Bottled Drinking Water [10-12].

2. METHODS AND MATERIALS

The study focused on the city of Benghazi overlooking the Mediterranean Sea in the northeastern part of Libya, whose administrative borders start from the Sidi Khalifa area to theAl-Halis area with an area of 89,191 km. The study was conducted on six different brands of locally bottled drinking water, the samples were selected randomly. The name of the brands not mentioned in the paper and symbolized by the symbols (A-B-C-D-E-F) [12].

2.1 Sample Analysis

All samples were analyzed to compare the results to what was written on the labelling. pH measurements were performed with a pH meter, and total dissolved solids (TDS) concentrations were measured using a TDS meter. The concentrations of cations were measured: sodium (Na +) and potassium (K+).The concentrations of anions, such as chloride (Cl-),fluoride (F-), sulfates (SO4 2-), and nitrate (NO3-), were measured by ion chromatography. All measured values are referred to as "true content", and concentrations are expressed in milligrams /l (ppm).

2.2 Statistics

Results were expressed as mean ± standard deviation (SD). Statistical analysis was performed by using SPSS software version 22. A descriptive statistical analysis was carried out and to compare bottled water sample parameters between real content and label content. The normal distribution test and Wilcoxon Signed Ranks Test comparisons were performed. A *p*-value below 0.05 was considered statistically significant.

3. RESULTS AND DISCUSSION

The following Table (1). shows the general requirements provided by the Libyan specifications for prepackaged labeling foods and its comparison with the selected locally manufactured water labels that were randomly selected from the shops of the city of Benghazi. Based on what is specified in the Libyan specifications for bottled drinking water, Table (2) shows the producing radiant list for the basic inorganic ingredients, which should be written on the outer packaging of bottled water in a clear font**.** Table (3) explains the maximum allowed of physical and basic inorganic compounds according to Libyan specification, comparing with label content of 6 selected randomly sample.

In order to compare the real content of all measured parameters with the respective label content. Non parametrical mean ± SD comparisons of locally bottled water were performed, as presented in Table 4. According to the test of normality Kolmogorov- Smirnov and Shapiro-Wilk the data of this study does not follow the normal distribution of the resulting variables due to the small sample, missing values, and the large difference in the results (where *P* value less than 0.05). Wilcoxon Signed Ranks Test was done to test the difference between real and label content. The results are statistically significant (*P*.0.028) for the TDS, Potassium, and less statistically significant (*P* 0.345, *P* 0.173) for the total hardness and bicarbonate , respectively as shown in (Table 5).

Table (6). shows the results of fluoride concentration in locally manufactured drinking water samples. The results showed that the highest concentration of fluoride was recorded for A and D sample.

In this study, label, and real contents of bottled water of 6 brands from Libyan bottled water were studied. To the best of our knowledge, this is the first study to investigate the accrue of the numbers reported on the label of local bottled water by comparing it with the laboratory results for the same samples. The current analysis showed that the values reported on the bottle label may be accurate or overestimated, and the analyzed bottled water meets Libyan's specifications for bottled drinking water, indicates that it is in general safe within the established guidelines. According to the general requirements of Libyan specifications for prepackaged labeling foods all samples of this study achieved the requirements except sample D and E. The criterion of data should be clear, irremovable, and easy to read by the consumer, was not applied as shown in (Table 1). All bottled water samples in this study did not record the license number and issuing authority, except for sample B. Sample B is registries by ISO 22000 Professional Evaluation and Certification Board (PECB), and this certification body accredited by the American National Standards Institute (ANSI) to the ISO/IEC 17024 standard. Among the specific criteria for bottled water labels is to specify the type of bottle material and the cap or the mark that indicates that, where all samples have not any indication. One of the most important standards in Libyan specification are determine the method of sterilization of water on the label, and this is applied on most of the bottled sample, except for E sample [11,13]. Another standard that should be mentioned for the consumers on the label, the bottle must keep in a well-ventilated place, away from direct sun light and sources of pollution, where all samples record down that except samples D and F. The rest of the general and specific requirements were fully met in all samples, but what the researchers noticed that there are no previous similar studies, which makes this study the first of its kind in this area.

By comparing the mentioned data on the local water bottles with what was stipulated in the Libyan standard specification for bottled drinking water No [14]. for the year 2008 AD. The presence of data recorded on the data card for the package other than the data that must be mentioned as stipulated in the Libyan standard specification, including chlorides, nitrates, potassium, magnesium in addition to not mentioning all the elements that must be recorded in the data card for the package stipulated in the Libyan Standard. The list contains the basic inorganiccomponents of the product according to the following: ph. Totaldissolvedsalts(mg/l).-sodium(mg/l).-

Table 1. The general requirements provided by the Libyan specsifications for prepackaged labeling foods and its comparison with the selected locally manufactured water labels

General Requirements (Prepackaged Labeling Foods)	A	B	C	D	E	F
Packaged food must contain label information.	√	√	√	√	√	√
Data must be written in Arabic.	√	√	√	√	√	√
The data should be written in a different color Thanthebackgroundcolor.	√	√	√	√	√	√
The data should be clear, irremovable, and easy to Read by the consumer.	√	√	√	X	X	√
The outer package should be transparent or if otherwise should written all required data outside.	√	√	√	√	√	√
Do not use names, symbols, tags, or images that are prohibited or prohibited by law.	√	√	√	√	√	√

Table 2.Comparisonofthemetadataofthelocallybottleddrinkingwatersampleswith the requirements of the Libyan Standard Specification for bottled water

Specific Requirements (Libyan specification)	A	B	C	D	E	F
Product name and water source location.	√	√	√	√	√	√
License number and issuing authority.	X	√	X	X	X	X
Manufacturer's name and address.	√	√	√	√	√	√
Package volume in liters.	√	√	√	√	√	√
Production and expiry date in month, year and in a non- token way.	√	√	√	√	√	√
Write the type of material of the bottle and the cap or the mark that indicates that	X	X	X	X	X	X
Product ingredient list for selected inorganic base ingredients.	√	√	√	√	√	√
If fluoride is added to drinking water, the phrase fluoride added should be written on the packaging, indicating its fluoride content, mg/L.	√	-	-	-	-	-
In the case of treated bottled water, the method of Sterilizations hall be written on the package.	√	√	√	√	X	√
The product is kept in a well –ventilated place, away from direct sun light and sources of pollution.	√	√	√	X	√	X
Environmentally friendly mark.	√	√	√	√	√	√

Table 3. Comparing the basic inorganic components listed on the package of bottled drinking water with the Libyan specification for bottled drinking water "ppm"

Parameters	Libyan Specifications maximum allowed	A	B	C	D	E	F
TDS "PPM"	500	130	130	70	130	130	115
pH	6.5 -8.5	7.5	7.5	7.5	7.5	7.2	7.5
Total hardness "PPM"	200	200	100	----	----	----	70
Bicarbonate "PPM"	150	60	150	0.4	65	65	----
Sulphate "PPM"	150	65	250	45	----	9.0	----
Sodium mg/l	100	14.5	45	10.2	14.5	73	10.3
Potassium mg/l	12	0.8	----	0.6	0.5	----	----

Table 4. Comparison between Label and Real Content in Bottled Locally Libyan Water Samples "ppm"

Sample / Parameters	A	B	C	D	E	F	Mean±SD
Label TDS	130	150	70	130	130	115	120.83±27.27
Real TDS	80	50	40	65	55	45	55.83±14.63
Label pH	7.5	7.5	7.5	7.5	7.2	7.5	4.950±3.83
Real pH	6.5	6.5	6.5	6.6	6.6	6.5	6.533±.05
Label total hardness	200	100	----	----	----	70	61.667±80.10
Real total hardness	22	30	32	35	25	22	27.667±5.46
Label bicarbonate	60	150	0.4	65	65	----	56.733±55.20
Real bicarbonate	12	15	5.5	29	48	25	22.417±15.19
Label sulphates	65	250	45	----	9.0	----	61.500±96.05
Real sulphates	17	30	32	76	48	11	35.667±23.58
Label sodium	14.5	100	10.2	14.5	73	10.3	37.083±39.26
Real sodium	55.13	62.16	41.01	36.10	22.003	18.21	39.118±17.50
Label potassium	0.8	----	0.6	0.5	----	----	.317±.36
Real potassium	9.90	10.81	8.19	7.00	6.00	14.02	9.317±2.90

Table 5. Mean Comparison between Label and Real Content in Bottled Locally Libyan Water Samples by Wilcoxon Signed Ranks Test

Parameters ppm	Mean±SD	95%Confidence Interval of Difference		Z	Sig. * (2-tailed)
		Lower	Upper		
Label TDS–real TDS	65.000±23.66	40.166	89.834	-2.201-[b]	**.028**
Label ph–real ph	1.5833±3.85	-5.6241	2.4574	-.106-[c]	.916
Label TH–real TH	34.0000±83.45	-53.5836-	121.5836	-.943-[b]	**.345**
Label bicarbonate– real bicarbonate	34.3167±56.03	-24.4877	93.1210	-1.363-[b]	**.173**
Label sulphates– real sulphates	25.8333±104.19	-83.5165-	135.1832	-.314-[b]	.753
Label sodium–real sodium	2.0350±37.78	-41.6845	37.6145	-.105-[c]	.917
Label potassium–realpotassium	9.0000±3.01	-12.1644	-5.8356	-2.201-[c]	**.028**

**Significance p≤0.5*
b. Based on positive ranks.
c. Based on negative ranks.

Table 6. Fluoride Concentration between label and real content of Bottled Locally Libyan Water

Sample / Parameters(ppm)	A	B	C	D	E	F	Mean± SD
Real fluoride concentration	0.2	0.15	0.19	0.2	0.15	0.18	**0.023±1.178**
Label fluoride concentration	0.22	-	-	-	-	-	**-**

sulfates(mg/l). -bicarbonate(mg/l). In the data card for bottled drinking water of local brands, it was found that each of the two samples (A) and (B) recorded in its data label all the stipulated elements.It was also clear from the explanatory data card of the local bottled drinking water for the two samples (C) and (D) values of total hardness were not written, while the sample (E) did not mention the total hardness in the data card, and the bicarbonate and sulfates did not spin in the data card of the sample (F).All samples collected from different factories did not write on their packages any statement indicating the addition of fluoride to the bottled water except for sample A, and therefore all samples conform to the specifications, which indicates the importance of recording the concentration on the package in case of addition. The fluoridevaluerangedfrom0.12 to 0.22ppm. When researchers analyzed the concentration of fluoride, the results showed that all samples contain percentages of fluoride, which leads to the question whether these concentrations have been added or are within the actual water content, knowing that all concentrations were within the required range. The highest values usually occur in ground water and come from natural sources [14]. "In general, the average daily intake of sulphate from drinking water, air, and food is about500 mg, with food being the major source. However, in areas high in sulphates, drinking water may be the primary source of intake" [15]. "Reasons for not setting guideline values is that no health concern at concentrations in drinking water additional precautions may impair the acceptability of drinking water date of assessment 2003 key references WHO (2003)" [15,16]. "Sulfate in drinking water available no data have identified the concentration of sulphates in drinking water as drinking water has the potential to adversely affect human health. Data from previous a volunteer tap water study show laxative effects at concentrations of 1000-1200 mg/L, but no increase in diarrhea, dehydration, or weight loss. No health-based guidelines have been proposed for sulfates. However, due to the gastrointestinal effects of consuming drinking water with high sulphate levels, Libyan specifications recommend that sources of sulphate levels not above1 mg/l notified. The presence of sulfates in drinking water can also cause a pronounced taste and contribute to corrosion in water distribution systems" [15-18]. Indeed, the researchers could not study the comparison means of all samples between the label values and real results cause some companies did not write all parameters value on their label (missing values). In the current study, the researchers found a large discrepancy between the real values and the values recorded on the label, although they all fall within the permissible range, but this discrepancy reduces the credibility of the manufacturers. As shown in Table 5. a significantly differences (P=0.028) between label and real results of total dissolved salts(TDS), where ranged between (70-150 ppm), while there results showed that the highest value didn't exceed 80 ppm with mean comparison Mean± SD equal to 65.000 ± 23.66.This is completely consistent with a study conducted in Saudi2020, was found the real content of TDS in Saudi brand samples were lower than the label content. These differences may also be explained by differences in the geographic regions of water origin [16,17].

In fact, these differences apply to all parameters in this study. The great discrepancy between what is written on the label and the results shown in Table (4). Regarding reading the pH for all samples were matched with mean comparison around Mean±SD equal to 1.5833±3.85 with a no significant difference (P.916).This is in agreement with another study of some physical and chemical properties of bottled drinking water, research has shown significant differences between real content and label content, and in some cases, real content did not match quality standards. Another study reported that discrepancies between actual and labeled content in water samples for both Saudi and international brands [16,18]. "A previous study of bottled water study showed that some parameters such as pH and TDS were above reference values, while others were very low" [19]. Another study also reported that 18% of samples of water from Riyadh, Saudi Arabia exceeded the reference limit, but many of the sample bottles the labels values were inaccurate. Further study showed that bottle storage conditions can also change water composition. Depending on the water composition, high temperatures can promote crystal formation and precipitation. The authors suggested that the presence of Mg2+, SO42-,Na^+,and K^+, among other components, might mitigate this effect. Storage conditions may explain, at least in part, the differences between actual contents and labels found in some studies [20-22].Other parameters recorded no significant difference between label and actual results was sodium (P.917). Although concentrations of sodium in potable water are typically less than 20 ppm, they can greatly exceed this in some countries likeLibyan specifications the maximum allowed

100 ppm [23]. “The levels of sodium salts in air are normally low in relation to those in food orwater. It should be noted that some water softeners can add significantly to the sodium content of drinking water. Reasons for not establishing a guideline value are health concern and acceptability of drinking-water. Assessment date 1993 Principal reference WHO(2003) Sodium in drinking-water no firm conclusions can be drawn due to the occurrence of hypertension. Therefore, no healthbased guideline value is proposed. However, concentrations in excess of 200 ppm may give rise to unacceptable taste. In contrast, to study conducted in Saudi Arabia showed that some water brand had highest sodium content” [19-21]. In this study, the researchers show that only the sample F exhibited higher levels of potassium than proposed by the Libyan specification for bottled drinking water 14.02 ppm, with mean ±SD is 9.0000±3.01, Z -2.201. It indicated that there were significant differences between real and label content of potassium (P 0.028).It is worth noting that the sample F did not write on the label the percentage of potassium in the water, which raises controversy about the most important of health concerns would be related to the consumption of drinking-water treated by potassium-based water treatment (principally potassium chloride for regeneration of ion exchange water softeners), affecting only individuals in high-risk groups (i.e. individuals with kidney dysfunction or other diseases, such as heart disease, coronary artery disease, hypertension, diabetes, adrenal insufficiency, pre-existing hyperkalaemia; people taking medications that interfere with normal potassium-dependent functions in the body; and older individuals or infants). It is recommended that susceptible individuals seek medical advice to determine whether they should avoid the consumption of water.Instate for high-risk individuals have been advised by a dietitian to avoid elevated potassium intake from water, the recommended strategy is to limit the addition of potassium to water that will be ingested or to avoid ingesting such water. As know the potassium is an essential element in humans and is seldom, and the recommended daily requirement is greater than 3000 ppm. Otherwise, if there is potassium in the drinking water at high levels that could be a concern for healthy humans. Overall, all drinking water samples are safe to drink, as we know the environmental change and human activity can affect the quality and safety of bottled water. A recent study suggested that the quality of drinking water sources has declined since 1999. Changes in the composition of water sources can pose new challenges to water treatment. These observations suggest that strict management of bottled water is necessary to ensure a safe water supply and avoid water containing undesirable substances or low levels of desirable compounds [17,16-19].

4. CONCLUSION

The results showed that all samples were in terms of Libyan specifications, indicating that all brands provide drinking water of high quality and fit for consumption. Moreover, the sticky content is within the permissible values, but the true values do not correspond to the sticky content except for the pH, which proves that the attached labels are not a reliable source of information about the composition and properties of bottled water. What distinguishes most of the samples is that they apply the special Libyan standards for prepackaged labeling foods and Libyan Standard Specification for bottled water. Given that the consumption of bottled water is increasing, the quality control of bottled water becomes important to ensure the quality of drinking water. In this regard, our results are of paramount importance to consumers, as they clearly prove that Libyan bottled water is safe, but their results must be documented and carefully followed up. In the future, differences between batches of a single brand will still have to be investigated to discover potential inaccuracies between batches as well as batches that exceed reference values or with deviations between real and classified content. Furthermore, careful studies of the potential adverse effects of various water components on human health are still required in clinical research to ensure safe longterm exposure.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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