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Evaluation of the Chemical Composition of three Bottled Drinking Water Brands from Gaser Bin Gasheer, Libya, in Comparison with WHO and Libyan Standards

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Abstract:
Bottled water is an important source of drinking water in many developed and developing countries, including Libya. One of the main public health concerns related to bottled water consumption is its low mineral content or the absence of essential minerals that are vital for human health. This study aimed to assess the chemical quality of selected bottled water brands available in Bin Ghasheer, Libya(Uno , Aquasila, Sultan). A range of water quality parameters was analyzed, including physical parameters (total dissolved solids (TDS)) and chemical parameters (calcium (Ca^{2+}), and sulphate (SO_4^{2-})), using standard analytical procedures and compared with the standards set by the Libyan authorities as well as the World Health Organization (WHO) guideline. "The results revealed significant variations among the tested bottled water samples and identified certain inconsistencies in the information provided on the labels, emphasizing the need to strengthen regulatory oversight to ensure the accuracy and reliability of information available to consumer.
Keywords: Bottled Water, WHO, Standards, TDS, Libyan authorities.

Introduction

Due to the increasing demand for water, which is considered one of the essential and continuous human needs that cannot be dispensed with for any reason, this has led to the necessity of searching for other renewable and complementary water sources, which must meet the conditions and standards of water quality in terms of color, as well as chemical and physical specifications[2,1]. The most important of these technologies is the desalination technology (treated water), as Libya was on the list of countries using this technology [1], due to the recent increase in drinking water consumption. The reason for this increase is the quality of bottled water compared to tap water, as well as the importance of drinking water for health [3] .

Water is produced using a bottling method known as the open bottling system, either by the consumer bringing plastic containers into which water is filled from desalination sites (treated water), or by the owners of these sites preparing plastic container[3] . Because of the improved quality of water compared to tap water, in addition to the lack of fresh drinking water, this has led to an increase in drinking water consumption in recent years, and consequently, the number of consumers of treated (bottled) drinking water has increased by about two-thirds of the human race[3] .

In addition, there are various reasons for the increased consumption of treated drinking water, including the poor quality of tap water in some areas, which depends on their geographical location. Bottled water has gained widespread acceptance among citizens across all segments of society[4].
Although not all water is suitable for drinking or human consumption, it requires a high level of purity, in addition to being free of organic materials, dissolved substances, and other microbes[1,5].
Now, in recent years, Libya is considered one of the countries where the treated drinking water industry has become widespread. A study by a number of researchers indicated that approximately 33% of bottled and treated water types contained higher levels of pollutants (bacteria and various organic chemicals) than the levels permitted by the quality specifications for drinking (treated) water. It also showed that approximately 25% of bottled (treated) water was in fact tap water that was filled without treatment or after additional treatment[1]. A study by Chiarenzelli and Pominville (2008) showed that sulphur, potassium, silicon, and chloride were the dominant inorganic elements found in their samples[6].
In addition, one researcher indicated that one of the main reasons for The increased consumption of treated (bottled) water by citizens in the United States of America is due to the diversity of marketing and advertising methods used by the producing party to convince the consumer of the safety of treated water and its complete freedom from pollutants compared to tap water, which leads to an increase in the citizen's consumption of bottled water from the manufacturing party. The annual consumption rate (US) in 1988 ranged to about 24 liters [1,7].
Several local and international studies have been conducted on treated drinking water, including a study conducted in the Western Kingdom of Saudi Arabia, which examined the compliance of 23 local products and seven imported products. It was found that manganese was not compliant in six imported products and 12 local products, while fluoride was found in 15 local products. In addition, the pH was not compliant in only one product, as well as the fluoride concentration in six imported products and two local products that did not meet the minimum Saudi quality specifications. In addition, the levels of nitrates, sodium, sulfates and fluoride were higher in local products compared to imported products[1,2].
The study also showed a significant decrease in levels of nitrates, sodium, and sulfates in imported varieties, and statistically significant differences compared to local varieties, ranging from 2 to 7%. Furthermore, the values listed for most elements on containers do not accurately reflect the actual content of the water components inside[7].
Also, a study by Al-Zarrouqi et al. (2010) in Baghdad, Iraq, showed a "study of some physicochemical and microbial properties of locally produced and imported bottled water." The study included 400 samples of different types of bottled water, 7 imported samples and 10 local samples. The results

showed lower levels of chemical elements in the imported samples (electrical conductivity, pH, total dissolved solids (TDS), turbidity, iron, lead, calcium, and magnesium) compared to the local samples[1,8].

Disolved salts affect the specific properties of drinking water, such as hardness and taste, in addition to the formation of scales. However, there is no evidence to support the occurrence of any physiological reactions in people who consume drinking water containing high levels of TDS, exceeding 1000 mg/L (WHO, 1997)[9] . Drinking water with high levels of dissolved solids (TDS) is less palatable to consumers, depending on the type of dissolved salt present in the water. It produces a salty taste when chloride concentrations exceed 250 mg/L, and an unpleasant taste when sulfate salts are present at levels above 300-400 mg/L.

In addition, some studies have shown that dissolved salts in drinking water can have health benefits for consumers, as drinking water with low levels of dissolved solids is undesirable and unpalatable to drink [10].

Total dissolved solids levels should be within the average range of 1500 to 500 mg/L, which is consistent with the body's need for these salts. Total reliance on this type of water may, over time, lead to serious illnesses such as kidney disease and others [11].

Calcium is also considered one of the most important elements for normal blood clotting and the process of building bones and teeth. It is also a key mediator in a number of physiological reactions and the function of many different enzymes. Calcium salts are also essential elements in water and play a fundamental role in building the human body.

Material and methods

Three bottled drinking water samples, each with a capacity of 50 mL, were obtained from local markets. The manufacturers' labels provided information on the chemical composition of the water, including parameters such as total dissolved solids, and the concentrations of calcium (Ca), and sulfate (SO_4^{2-}).The data were collected and documented, and the chemical analyses were carried out using the **photometer method (Palintest)** according to standard analytical procedures. The laboratory-measured values were then compared with the values indicated on each bottle label, as well as with the standards and guidelines established by the **World Health Organization (WHO)** and the **Libyan Standards and Metrology Authority**[12], in order to assess the compliance of bottled water quality with recognized health standards.

Results and discussion

The obtained results were analyzed and compared with both international and Libyan national standard specifications for packaged drinking water, in addition to being compared with the

information provided on the bottle labels, in order to assess the compliance of the tested samples with quality standards and the accuracy of information presented to consumers.

Total Dissolved Solids (TDS)

The (TDS) concentration was measured in all bottled water samples, with values ranging between 53 and 120 mg/L. The results showed a noticeable decrease in Total Dissolved Solids levels compared to the permissible limits established by both the Libyan and international standards for packaged drinking water. The highest concentration was recorded in the (Uno) sample at 120 mg/L, followed by 85 mg/L in (Sultan), and 53 mg/L in (Aquasila). When comparing the obtained results with the values reported on the bottle labels (as shown in Table 1), it was observed that the (Uno) sample matched the upper limit of the declared range, while the (Aquasila) sample showed a lower concentration than the minimum value stated on the label, and the (Sultan) sample also recorded a concentration below the declared minimum. Although all measured Total Dissolved Solids concentrations fall within the acceptable limits set by the Libyan and WHO standards, the discrepancy between the actual and labelled values for some samples suggests possible inaccuracies in labelling or quality control during the bottling process. The Total Dissolved Solids concentrations in all samples were determined using the Photometer method (Palintest) to ensure the accuracy and reliability of the obtained results.

Sample name	**Label (mg/L)**	**Measured (mg/L)**	**Libyan limit**	**WHO limit**
Uno	120	100-120	100-500	1000
Aquasila	53	100-120	100-500	1000
Sultan	85	100-500	100-500	1000

Table1 : Results of the total dissolved salts (TDS) concentrations in the studied samples and their comparison with the concentrations listed on the bottle labels.

Sulphate$(SO_4)^{-2}$

High levels of Sulphate$(SO_4)^{-2}$ in drinking water may pose potential health risks, such as stomach and digestive disorders, in addition to the formation of kidney stones [13]. The obtained results, as presented in Table (2), showed that the Sulphate concentration for the three samples were 10, 14, and 12 mg/L**,** respectively. In comparison, the concentrations declared on the bottle labels were 1, 12.9, and 9 mg/L**,** respectively. When these results were compared with the guideline values set by the Libyan Standards and Specifications for Packaged Drinking Water**,** which define an acceptable range of 200–400 mg/L**,** and the World Health Organization (WHO), which recommends a maximum limit

of 250 mg/L, it was found that all measured and labeled values were well within the permissible limits.

This indicates that the analyzed water samples are safe in terms of their Sulphate$(SO_4)^{-2}$ content.

However, noticeable differences were observed between the measured and labeled concentrations, highlighting the need to improve accuracy and transparency in labeling information, ensuring consistency with laboratory test results.

In this study, bicarbonate concentrations ranged from 10 to 14 mg/L, and all results were within the acceptable limits, consistent with both Libyan and international drinking water quality standards.

Sample name	**Label (mg/L)**	**Measured (mg/L)**	**Libyan limit**	**WHO limit**
Uno	1	10	200-400	250
Aquasila	12.9	14	200-400	250
Sultan	9	12	200-400	250

Table2 : Results of Sulphate$(SO_4)^{-2}$ concentrations in the studied samples and their comparison with the concentrations listed on the bottle labels.

Calcium (Ca^{+2})

The concentration of calcium was analyzed in three samples of bottled drinking water available on the local market: Uno, Aquasila, and Sultan. The chemical analyses were carried out using standard laboratory methods, and the values declared on the bottle labels were documented for comparison. The results are shown in Table (3). According to the standards set by the World Health Organization (WHO), the recommended range for Calcium concentration in drinking water is 30–200 mg/L. Comparing the obtained results with this range shows that all the analyzed samples contain concentrations much lower than the minimum recommended limit (30 mg/L).

This indicates that the studied waters are poor in Calcium, which may reduce their nutritional value as a source of essential minerals. In addition, discrepancies were observed between the declared and measured values, especially in the (Sultan) sample, where the analysis showed no magnesium at all, despite the label claiming 4 mg/L. Although all the analyzed samples met safety requirements by not exceeding the maximum permissible limits, the low calcium concentrations compared to the recommended range, along with the discrepancies between the declared and measured values, highlight the need to review the accuracy of label information and to strengthen monitoring of bottled drinking water quality in order to ensure transparency and protect consumer health.

Sample name	Label (mg/L)	Measured (mg/L)	Libyan limit	WHO limit
ONO	4	7	200-400	250
Aquasila	Not found	4	200-400	250
sultan	4	0	200-400	250

Table 3 : Results of Calcium (Ca^{+2}) concentrations in the studied samples and their comparison with the concentrations listed on the bottle labels.

Conclusion

This study revealed significant inconsistencies in the quality of bottled water in Gaser Bin Gasheer-Libya . While dissolved salts (TDS) levels in all samples ("Uno" "Aquasila," "Sultan") complied with permissible limits, the measured values for " Aquasila " and " Sultan " did not match their label claims. More critical concerns were identified for calcium and Sulphate . Calcium concentrations exceeded allowable limits in most samples, with one brand ("Aquasila ") failing to declare the value on its label entirely. Most alarmingly, all tested samples showed Sulphate levels that surpassed the permissible standards, and none of the measured values matched their respective label declarations. These findings highlight a clear issue with both product compliance and labeling transparency among local bottling companies. Therefore, this study underscores the urgent need for enhanced regulatory oversight and stricter enforcement of labeling standards to protect consumers. Future research should expand the scope to include a wider range of chemical and microbiological parameters to ensure the consistent safety of bottled drinking water in Libya.

Recommendations:

1- Require manufacturing companies to update product information and labeling accurately based on actual laboratory analyses.
2- Conduct regular and systematic monitoring of bottled and treated drinking water to ensure compliance with quality standards.
3- Strengthen the role of regulatory authorities to ensure transparency and protect consumer health.
4- Raise consumer awareness about the importance of essential minerals such as calcium and magnesium in drinking water.

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