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Estimation of sodium and potassium content in bottled water available in commercial markets

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Abstract

The purpose of this study was to assess the quality of the most popularly traded bottled water in Tripoli. The quality of two types of imported water and 30 types of locally produced bottled water were assessed using samples taken from the commercial markets of different companies that produce bottled water. The outcomes were then compared to the Libyan standard and the World Health Organization's (WHO) guidelines. In this case, the assessment involved looking at a few physical and chemical characteristics of drinking water, such as pH, TDS (total dissolved solids), EC (electric conductivity), Na (Sodium), and K (Potassium). The study's findings demonstrated that bottled water in the study area complied with WHO guidelines and the Libyan standard, but it did so at much lower levels than the minimum and maximum allowable standards that were approved. This has a negative impact on human health because drinking water with low salt content can lead to a number of health issues, such as low blood pressure, osteoporosis, imbalance, memory loss, and other illnesses. The findings also indicated that there is a discrepancy between the specifications listed on the packages and the outcomes of the examination of the samples that were examined in the center's laboratories, indicating that the specification values listed on the packages do not accurately reflect the actual content of these packages.

Keywords: Bottled drinking water, standard specifications, physical and chemical properties.

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تقدير محتوى الصوديوم والبوتاسيوم في مياه الشرب المعبأة المتوفرة داخل الأسواق التجارية

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الملخص

الغرض من هذه الدراسة تقييم جودة المياه المعبأة الأكثر تداولاً في مدينة طرابلس. حيث تم تقييم جودة نوعين من المياه المستوردة و30 نوعاً من المياه المعبأة المنتجة محلياً، باستخدام عينات مأخوذة عشوائيا من الأسواق التجارية لشركات مختلفة تنتج المياه المعبأة، ثم مقارنة النتائج بالمواصفات الليبية ومواصفات منظمة الصحة العالمية.

حيث تضمن تقييم بعض الخصائص الفيزيائية والكيميائية لمياه الشرب المعبأة مثل: الرقم الهيدروجيني، التوصيل الكهربائي، مجموع المواد الصلبة الذائبة، الصوديوم والبوتاسيوم. أظهرت نتائج الدراسة أن المياه المعبأة في منطقة الدراسة تتوافق مع إرشادات منظمة الصحة العالمية والمعيار الليبي، ولكن بمستويات أقل بكثير من الحد الأدنى والحد الأقصى للمعايير المسموح بها. وهذا له تأثير سلبي على صحة الإنسان لأن مياه الشرب ذات المحتوى المنخفض من الملح يمكن أن تؤدي إلى عدد من المشاكل الصحية، مثل: انخفاض ضغط الدم، هشاشة العظام، اختلال التوازن وفقدان الذاكرة وأمراض أخرى. وأشارت النتائج أيضاً إلى وجود تناقض بين المواصفات المدرجة على العبوات ونتائج فحص العينات التي تم فحصها داخل المختبر، ما يدل على أن قيم المواصفات المدرجة على العبوات لا تعكس بشكل دقيق المحتوى الفعلي لهذه العبوات.

الكلمات المفتاحية: مياه الشرب المعبأة، المواصفات القياسية، الخصائص الفيزيائية والكيميائية.

Introduction

Water is one of the most important of all natural resources known on the earth. It is mainly used for drinking purposes, which come from the surface and underground water sources [1]. 97% water exists in the oceans that are not suitable for drinking purpose and 3% is fresh water. Of the 3% fresh water, 2.97% is comprised of glaciers and ice caps and remaining little portion of 0.3% are available as a surface and groundwater for human use [2]. A high quality water is required for drinking purposes for better health [3]. Likewise, in most of Libya, groundwater is believed to be the only resource that may be utilized for a wide range of applications. Libya's low water levels, frequent rainstorms, and exposure to numerous pollution sources are considered factors contributing to the country's water scarcity. Pollution is the result of poor management, such as the improper use of water resources. Since groundwater is thought to be the primary source of water, accounting for more than 98% of total use, interference from sewage and seawater has resulted in a lack of drinking water. Due to pollution from this source, the physical, chemical, and

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وتم نشرها على الموقع بتاريخ: 30/ 10/2024م

microbiological characteristics will change, and this water becomes as per [4, 5], it is unsuitable for a variety of purposes and will harm both the environment and human health since drinking water is regarded as one of a person's basic needs, it must adhere to the water quality standards for taste, color, and compliance with physical, chemical and biological specifications [5]. Regular testing of drinking water quality is also important for improving bodily health and determining how suitable it is for consumption [6]. Since the bottled water industry has grown in Libya over the past few years and Libyan consumers have become primarily dependent on water bottled in various plastic containers, some of which are used once and others repeatedly, potable water must be pure and free of chemical and microbiological contaminants additionally, a variety of bottled water varieties are available in the Libyan market [7]. Many local investigations on the quality of bottled water were carried out as concerns about the quality of this water and the quality of its source.

The quality of locally bottled water and imported water has been the subject of numerous local studies. One such study evaluated the biological and chemical contaminants of bottled drinking water in some western region cities, 20 samples from desalination plants were examined, and the quantity of well water used for desalination was counted. where the results indicated that the chemical element concentrations in 95% of the 19 wells had levels above the Libyan standard's permissible limits, but the chemical element concentrations in the bottled desalination factory water samples become within the standard's permissible limits [5].

Another study conducted in Misrata city looked at 12 bottled water samples in order to identify certain indications of water quality. The study's findings showed that eight samples had pH levels that were below the acceptable range. The findings for total hardness and dissolved salts showed that one sample went over the maximum allowable in Libyan standards but not the international Health Organization standards, while the remaining chemical elements remained within the maximum allowable range [8]. In a different study, the quality of bottled drinking water was evaluated using eight locally circulated samples that were analyzed. The results indicated that none of the samples contained any harmful microbes, and the dissolved salts concentrations were found to be below the allowable limit in accordance with Libyan standard specifications for locally bottled drinking water [9].

The aim of the study is to evaluate the quality of bottled water that is sold in Tripoli's commercial market, to compare it to the Libyan drinking water standards and World Health Organization [14] standards, and to determine how closely the product complies with the stated standards on the label.

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Research Methodology

Study area and study design

This study was conducted in Tripoli a capital city of Libya. A sets of three bottles each (volume 0.5-1-1.5 L) from two types of imported water and 30 types of locally produced bottled water of commercially available bottled water was purchased randomly taken from the commercial markets of different companies that produce the bottled water from grocery shops and supermarkets in Tripoli city for evaluation of their chemical quality, samples were collected during of May to Jun 2023. All the samples were contained in their original sealed containers and kept at lab temperature, until the water samples was analyzed for some chemical elements of interest. The product name, the size of the bottle, production date and the concentration of pH, total dissolved solids TDS, sodium (Na), and potassium (K) values were noted from the labels of the bottles. All chemical analysis for this study were conducted in Environment and Food Department laboratories, within laboratories of Libyan Biotechnology Research Center. A pH-Meter (JENWAY 3510) was used to measure the pH value, and a conductivity meter (JENWAY 4510) was used to measure the total dissolved solids (TDS) and electric conductivity (EC). Additionally, a flame photometer was used to quantify the K, and Na in the samples.

Analysis Methods

pH Measurement

The pH was measured using a pH-Meter (JENWAY 3510) as shown in Figure 1 and to measure the pH value.

Figure 1. Shown the pH Meter

The first step was calibration the pH-meter with buffer solutions (pH 4, 7, 10), and the calibration was completed once the reading matches the buffer solution's pH value. After that, rinsed the electrode with distilled or deionizer water. The samples were ensured at an appropriate temperature before analysis. It is known that a decrease in pH occurs by (0.45) when the temperature rises above 25 °C. Meaning that the decrease in the pH makes the water an acidic medium that has a major negative impact on human health [10][11].

Total dissolved solids TDS and Electric conductivity EC

The quality of drinking water is typically measured using two methods: Total Dissolved Solids (TDS) and Electrical Conductivity (EC). Both TDS and EC are important indicators of water quality, as high levels of dissolved solids can affect the taste, appearance, and safety of drinking water. Ideally, drinking water should have low levels of TDS and EC, usually less than 500 ppm for TDS and less than 1000 µS/cm for EC. Usually, EC measures the water's ability to conduct an electric current and is directly proportional to the amount of ions in the water. EC is often used to measure the concentration of salts in water, as salts are good conductors of electricity and the TDS level is measured in parts per million (ppm) and milligrams per liter (mg/L) (Libyan standard. 2015). In this study a conductivity meter (JENWAY 4510) was used to measure the electric conductivity (EC) and total dissolved solids (TDS) as shown in Figure 2.

Figure 2. Shown the Conductivity Meter

A Few Of The Drinking Water's Chemical Characteristics

As shown in Figure 3. A Flame photometer was used to determine the amounts of Na, and K in samples of bottled drinking water.


Figure 3. Shown a Flame photometer

PH

The pH scale, which is a measurement of the acid-alkaline balance that different chemicals dissolved in water can reach, shows that basic water has less hydroxyl ions and more hydrogen ions in acidic water. What regulates this are the causes; discover that carbon dioxide produces the water's acidity, and that bicarbonate and carbonate produce the water's alkalinity. Other factors also influence pH; for example, a temperature increase of more than 25^0 degrees causes the pH to decrease by 0.45.

Significant pH shifts occur during the water treatment process. The pH is typically lowered by the chlorination process, and to the extent that the pH influences the many water treatment procedures that help remove bacteria and other dangerous organisms, it may also be claimed that it indirectly affects health. Drinking water becomes sour to the taste and becomes more intensely colored when the pH rises. Decreases in pH have an impact on the corrosion of hazardous metals like lead. The pH of drinking water does not directly correlate with human health, but it does have an indirect, albeit particular, correlation with public health. Numerous facets of water quality.

Total dissolved solids TDS

Drinking features including taste, hardness, and tendency to scale are influenced by dissolved salts, although there is no proof that consuming water with total dissolved solids above 1000 mg/l causes any negative physiological effects. A high total dissolved salt content makes water less appealing to drinkers. Sulfate salts, in particular, can impart a sour flavor depending on the type of salt in the water. A chloride concentration of more than 250 mg/L results in a salty taste, and this is evident at levels more than 300–400 mg/L. In the case of water containing more than 1200 mg/L of dissolved salts, there is no proof that there would be any negative health effects. It seems that certain research findings have indicated that the presence of dissolved salts in drinking water may offer health benefits. Similarly, drinking water with little dissolved salt is not advised.

The body requires an average amount of total salts, which should be between 1500 and 500 mg/L. Relying solely on this kind of water can eventually result in major problems because it's thought that those who drink it have a higher risk of developing kidney disease. It doesn't adequately filter the salts, and maybe over time, the kidneys get used to this kind of water, which causes major illnesses [12].

Sodium Na

It is present in water due to the rapid dissolution of salts in the various mineral forms. Using salt water may result in vomiting and dehydration because it creates a disparity in osmotic pressure between the intestines and the stomach [13].

Potassium K

One of the most crucial components of the body's cellular fluid is potassium. It functions to control the ratio of bases to acids. Along with sodium, it helps control the filling and osmotic

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تم استلام الورقة بتاريخ:27/ 9/2024م

pressures both inside and outside of the cell. Specific functions of potassium are involved in the conduction of nerve impulses. In 1992, the European Community established the potassium content of water. Consume at 10 mg/L as indicated by Table 1. Certain chemical components recognized by national and international regulations [15].

Results and Discussion

All samples were examined according to defined procedures of ASTM and were compared with Libyan standard and WHO standards.

pH measurements

The level of pH in examined water samples is shown in Figure 4, find that the pH values of the 32 samples studied ranged between (6.86 and 7.8), and all samples were less than the maximum permissible limit, but there was only one sample with pH 8.6 found in L9 and it was over the range of WHO and Libyan standard's. pH level of all other examined samples were found within permissible limits. And the maximum pH value of 8.6 was found in L9 and minimum in L16 with 6.86, as the WHO's limits are 6.5 to 8.5 and the Libyan standard's acceptable level are 6.5 to 8.0.

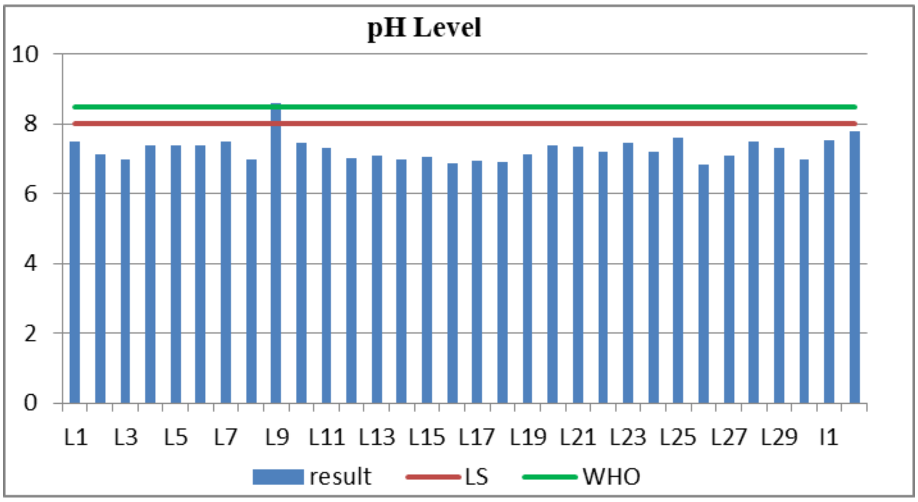

Figure 4. level of pH compared with Libyan standard and WHO

TDS and EC

The concentration of total dissolved salts for all samples was measured and the results were compared to local and international standards for drinking water, as shown in Figure 5. It was found that the total dissolved salt value in the 32 samples ranged between (21.32 - 250 mg/L). The values of total dissolved solids (TDS) samples are given in Figure 5. As the maximum TDS of 250 mg/l was found in I1 and minimum 21.32 mg/l in L11 and 27.3 mg/l in L2. All samples were found to have reasonably low values and to be within the WHO and local standard's acceptable upper limit. As the range of TDS in Libyan standards is 500 mg/l and in WHO are 500 to 1000 mg/l.

Table 1. Some chemical elements approved by local and international standards

No	Chemical &Physical Elements	Chemical symbol	Unit	Libyan Standard Specifications	World Health Organization Standards WHO
1	pH	pH	/	6.5-8.0	6.5-8.5
2	Electrical conductivity	EC	µS/cm	1000	2500
3	Total dissolved solids	TDS	Mg/l	100-500	500-1000
4	Sodium	Na^+	Mg/l	100	200
5	Potassium	K^+	Mg/l	12	12

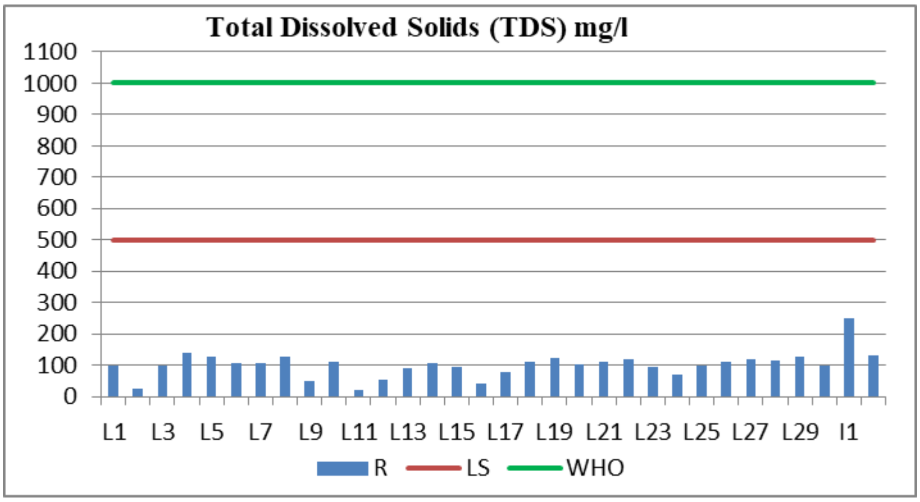

Figure 5. level of TDS compared with Libyan standard and WHO

Besides TDS, the results of electrical conductivity (EC) are given in Figure 6. The maximum electrical conductivity value was found in I1 with 384.61µS/cm and for local sample found in L4 with 204 µS/cm and minimum from L2 with 4.2 µS/cm. The EC of all samples was found within Libyan standard and WHO allowable limit of 2500µS/cm.

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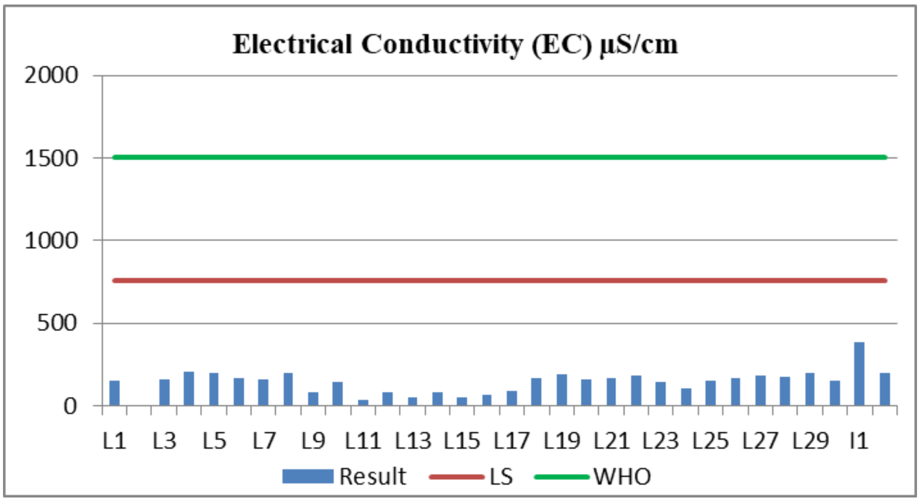

Figure 6. level of EC compared with Libyan standard and WHO

Sodium Na, and Potassium K Measurements

The results for sodium are shown in Figure 7, the sodium content of water samples. The highest sodium content was 70.4 mg/l in L4, the lowest was 0.1 mg/l for local brands in L11, and 2.6 mg/l for imported water in I2. As the WHO's limits are 200 mg/l and the Libyan standard's acceptable level is 100 mg/l. Additionally, the levels of potassium K in the samples are shown in Figure 8. L19 had the highest value of 3.8 mg/l, while L11, L22, L26 and I1 had the lowest value of 0.1 mg/l. while the WHO's and Libyan standard's limits are 12 mg/l.

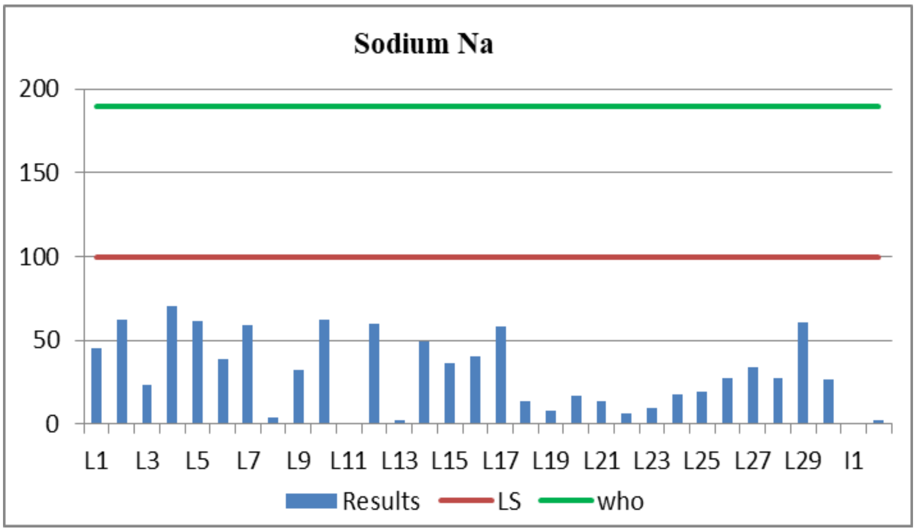

Figure 7. level of Sodium Na compared with Libyan standard and WHO

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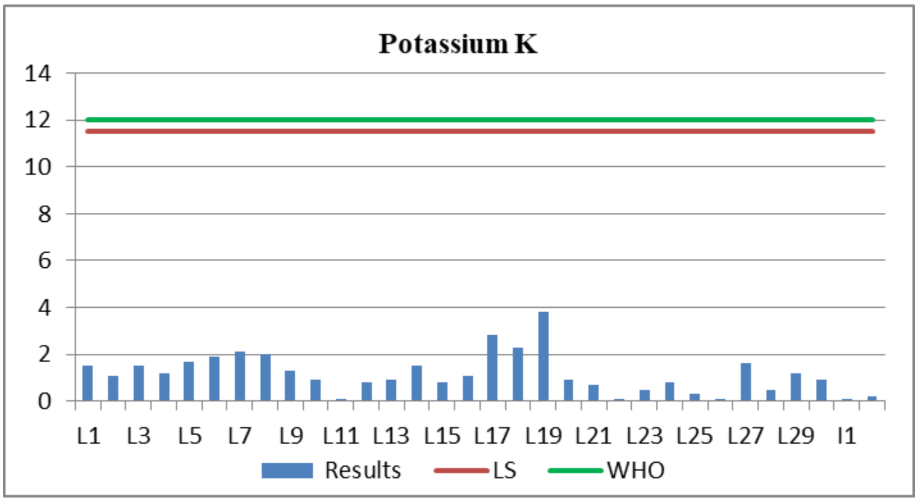

Figure 8. level of Potassium K compared with Libyan standard and WHO

Conclusion

Through the results of this study, which was conducted on 32 bottled drinking water samples and compared to the Libyan standard's and WHO standard's. The chemical analysis was different from the permitted maximum. While the pH measurement analyzes proved that all samples were acceptable and within the permissible limit, which is (6.5 - 8.5), only one sample was out of range with pH 8.6. while the total dissolved salts (TDS) results were less than the recommended optimal limit, which is (500 mg/l). Where as that the measurements of 12 samples out of 32 samples that were evaluated had concentration of dissolved salts less than 100 mg/l, which may increase the probability cause the health problems in the human body due to a lack of salts. Also, most of the results of the samples recorded on the packaging were different of the laboratory results obtained to the important elements such as sodium and potassium.

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