Central Organization for Standardization and Quality Control

Quality Control Directorate

Food Industries Department

A study on:

"Quality Assessment of Bottled Drinking Water in BaghdadCity, Iraq"

"تقييم الجودة لمياه الشرب المعبأة في مدينة بغداد، العراق"

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Contents:

Frame of Study (Time Frame):

The current study is conducted on samples of bottled drinking water received for analysis in laboratories of Food Industries Department (Central Organization for Standardization and Quality Control) during 2019; twenty of popular brands available in the markets of Baghdad Governorate were tested.

Aim of Study:

Assessment of quality of selected brands of bottled drinking water according to the requirements of Iraqi Standard 1937/ 2019 and showing the conformity (if any) of these brands regarding pH, total dissolved solids and turbidity.

"Quality Assessment of Bottled Drinking Water in Baghdad City, Iraq"

نهاد سعدون غني/ الجهاز المركزي للتقييس والسيطرة النوعية COSQC

دائرة السيطرة النوعية/ قسم الصناعات الغذائية

ABSTRACT

Twenty brands of bottled available in Baghdad Governorate water during 2019 were investigated for physiochemical properties according to the requirements of Iraqi Standard of bottled water (1937/ 2019), results showed no deviation in Total Dissolved Solids and Turbidity from the requirements of Iraqi Standard, which indicates good practice for plants covered by this study, on the other hand, three brands الساقي، الجادرية، دينار failed to comply to the requirement set to pH in Iraqi Standard; this failure can be attribute to the type of water used as a source for these plants, the composition of river water (source of public distribution system) is changing through seasons and consequently may affect the nature of water source of plants.

الخلاصة

تم اجراء التحليل على ٢٠ علامة تجارية للمياه المعبأة في محافظة بغداد خلال عام ٢٠١٩ للتحري عن مطابقة تلك العلامات لمتطلبات المواصفة القياسية العراقية للمياه المعبأة ١٩٣٧/ ٢٠١٩، كانت النتائج مطابقة للمتطلبات بالنسبة للمواد الصلبة الذائبة TDS والعكارة Turbidity لكل العلامات مما يؤشر تطبيق الممارسات التصنيعية الجيدة للمعامل ضمن الدراسة بينما لم تحقق ثلاث علامات هي دينار والجادرية والساقي متطلبات المواصفة فيما يخص الدالة الحامضية pH وهذا ممكن ان يعزى الى نوع المياه المستخدمة كمصدر في المعامل المنتجة للمياه حيث ان تركيب مياه النهر (مصدر شبكة توزيع المياه المحلية) يتغير عبر فصول السنة وبالتالي قد يؤثر على طبيعة المياه المجهزة للمعامل المنتجة للمياه المعبأة

1. Background:

Access to safe drinking water is essential to health, a basic human right and a component of effective policy for health protection **(WHO 2022)**, Up to 60% of a human body comprises water. Thus, it is commonly believed that water is life. Safe drinking water, human health, and well-being are interlinked **(Onyutha 2022)**, some 97.5% of the Earth's water is saltwater. Of the 2.5% that is fresh, about two-thirds is frozen mostly locked up in the Antarctic ice sheets and mountain glaciers

worldwide. If all the surface ice on earth fully melted, the sea level would rise about 70 m **(CIA 2022)**. In a 100-year period, a water molecule spends 98 years in the ocean, 20 months as ice, about two weeks in lakes and rivers, and less than a week in the atmosphere. Groundwater can take 50 years to just traverse 1 km **(CIA 2022)**. In recent years especially after the events of 2003 war, the demand to consume bottled water is increased in Iraq due to several reasons such as the sustainability of the bottled water quality comparing to tap water in distribution system, which differs according to the source, or it may be contaminated during distribution **(Al-obaidy 2016)**, people also relying on water vendors to supply them with treated water (usually RO water treated with UV and Ozone for Sterilization), unfortunately there is no Iraqi Standard for such water to date **(COSQC 2021)**.

Measurement of pH **(APHA 2017)** is one of the most important and frequently used tests in water chemistry. Practically every phase of water supply and wastewater treatment, e.g. (acid– base neutralization, water softening, precipitation, coagulation, disinfection, and corrosion control) is pH-dependent. pH is used in alkalinity and carbon dioxide measurements and many other acid– base equilibria. At a given temperature, the intensity of the acidic or basic character of a solution indicated by pH or hydrogen ion activity. Alkalinity and acidity are the acid and base neutralizing capacities of water and usually expressed as milligrams CaCO3 per liter. Buffer capacity is the amount of strong acid or base, usually expressed in moles per liter, needed to change the pH value of a 1-L sample by 1 unit. pH as defined by Sorenson is -log [H+]; it is the "intensity" factor of acidity. Pure water is very slightly ionized and at equilibrium the ion product is:

$$[H^+][OH^-] = K_w$$
$$= 1.01 \times 10^{-14} \text{ at } 25°C$$

and

$$[H^+] = [OH^-]$$
$$= 1.005 \times 10^{-7}$$

where:

$[H^+]$ = activity of hydrogen ions, moles/L,
$[OH^-]$ = activity of hydroxyl ions, moles/L, and
K_w = ion product of water.

Sixty-five plants producing bottled water in Baghdad **(Ahmed 2022)** they licensed by Iraqi Ministry of Health to produce bottled water, as of 2019 thirty-nine were active the rest was stopped for different reasons, inspection is done on regular basis to insure the compliance of these plants and there production of bottled water to related Standards **(IQS 1937/ 2019 and IQS 356/ 1990)**.

The number of plants mentioned by **(Ahmed 2022)** was in 2019, as of 2022 the number is fifty-three according to records obtained from General Directorate for Industrial Development **(GDID 2022)** that follow to Iraqi Ministry of Industry and Minerals, they are fully established and licensed both from Ministry of Health and GDID.

According to IQS 1937/ 2019, bottled water should fulfill many requirements, such as:

- Free of color, smell, and odor.
- Turbidity 5 NTU (max.)
- pH 6.5 – 8.5
- Total Dissolved Solids (TDS) 300 ppm (max.)
- Chemical Disinfectants 0.2 ppm (max.)
- Other pollutants (organic and non-organic), pesticides residues … etc.

2. Materials and Test Methods:

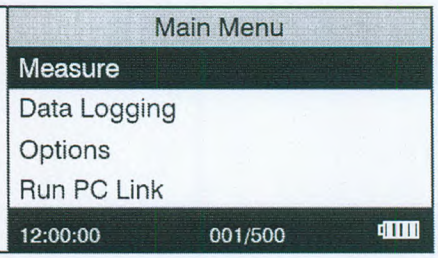
Samples collection: the study covers 20 brands of bottled water received in Food Industries Department/ Quality Control Directorate affiliated to Central Organization for Standardization and Quality Control, representing brands available in Iraqi markets, these brands are:

no.	Trademark
1.	لايف
2.	الكوثر
3.	سايا
4.	رويال
5.	الجنائن
6.	الساقي
7.	الطوق
8.	الانوار
9.	النجوم
10.	بردى
11.	لارا
12.	اكوافينا
13.	الوافي
14.	هني
15.	روى
16.	لؤلؤة
17.	فينيزا
18.	الجادرية
19.	دينار
20.	الحلوة

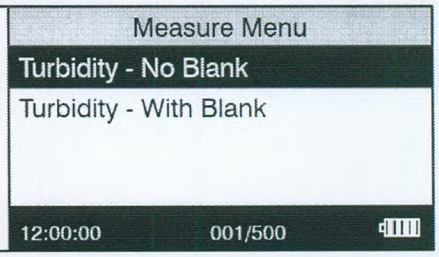
Turbidity was determined using Lamotte 2020we turbidimeter according to method described in its manual **(Lamotte 2020we manual)**, as follows:

To obtain the most accurate results the meter should be blanked before measuring a sample. The blanking step is not as critical for samples above 10 NTU. The meter should always be blanked before reading samples below 10 NTU.

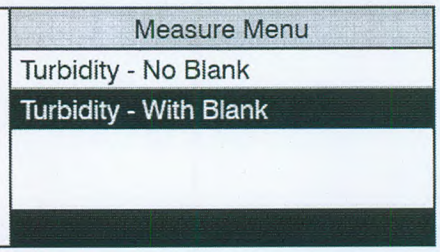
1. Press and briefly hold ⏻ to turn the meter on. The LaMotte logo screen will appear for about 3 seconds and the **Main Menu** will appear.



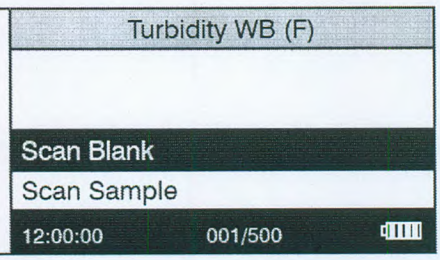
2. Press ENTER to select **Measure**.



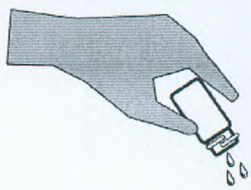
3. Press ▼ to scroll to **Turbidity - With Blank**.

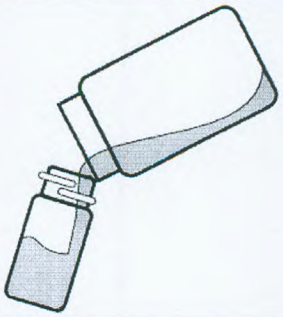
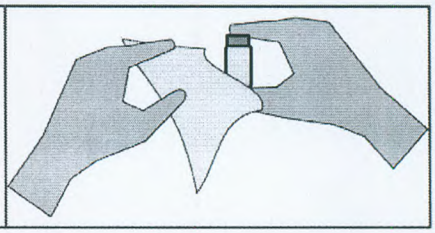
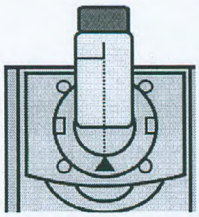
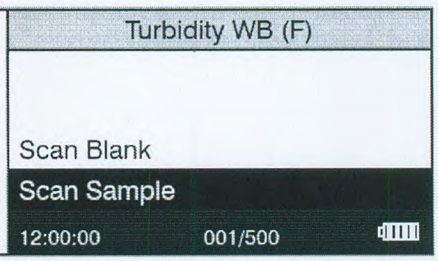
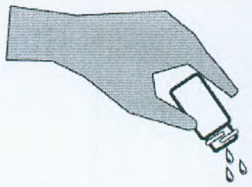


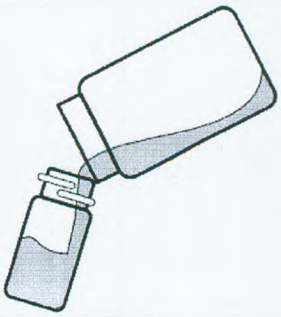
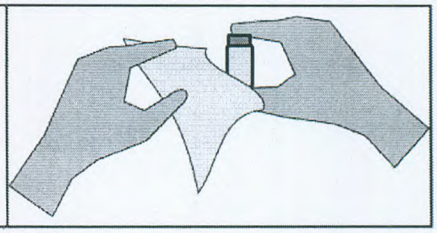
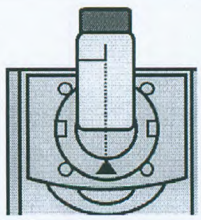
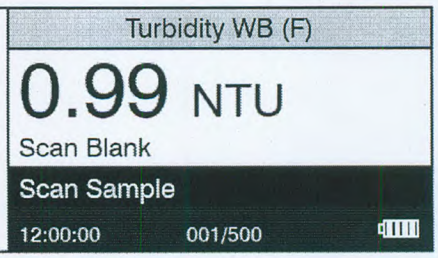
4. Press ENTER to select **Turbidity - With Blank**.



5. Rinse a clean tube (0290) three times with the blank. If samples are expected to read below 1 NTU the meter should be blanked with a 0 NTU Primary Standard or prepared turbidity-free (<0.1 NTU) water. For the most accurate results, use the same tube for the blank and the sample.



6. Fill the tube to the fill line with the blank. Pour the blank down the inside of the tube to avoid creating bubbles. Cap the tube.	
7. Wipe the tube thoroughly with a lint-free cloth.	
8. Open the meter lid. Insert the tube into the chamber. Align the index line on the tube with the index arrow on the meter. Close the lid.	
9. Press ENTER to scan the blank. The screen will display **Blank Done** for about 1 second and then return to the **Turbidity - With Blank** menu.	
10. Rinse a clean tube (0290), or the same tube, three times with the sample.	

11. Fill the tube to the fill line with the standard. Pour the standard down the inside of the tube to avoid creating bubbles. Cap the tube.	
12. Wipe the tube thoroughly with a lint-free cloth.	
13. Open the meter lid. Insert the tube into the chamber. Align the index line on the tube with the index arrow on the meter. Close the lid.	
14. Press ENTER to scan the standard. The screen will display **Reading** for about 1 second. The result will appear on the screen.	

Total Dissolved Solids (TDS) were determined according to **(APHA 2017)** method number 2540C as follows:

Heat cleaned dish to 180 ± 2°C for ≥ 1 hour in an oven. Cool dishes to ambient temperature and weigh. Store in desiccator or oven until needed, filter the sample and transfer certain volume using pipette to a weighted dish, evaporate on water bath until dryness then move to oven maintained at 180 ± 2°C for ≥ 1 hour, cool in a desiccator to ambient temperature, and weigh. Repeat cycle (drying, cooling, desiccating, and weighing) until weight change is less than 0.5 mg, calculate TDS using the following formula:

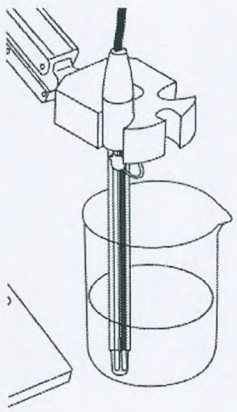
$$\text{mg total dissolved solids/L} = \frac{(A - B) \times 1000}{\text{sample volume, mL}}$$

where:

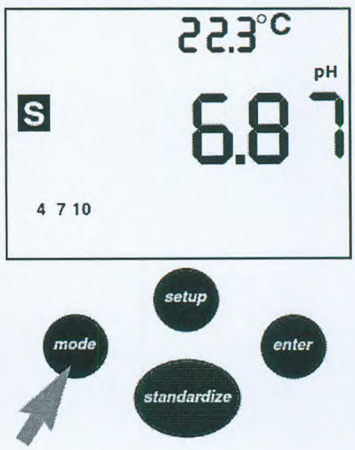
A = final weight of dried residue + dish, mg, and
B = weight of dish, mg.

pH of samples was determined using Denver UB10 pH meter, standardized prior to determination using standard solutions traced to NIST, three point calibration is used to cover all the range 4, 7, 10 from acidic to basic as follows **(DENVER INSTRUMENT manual)**:

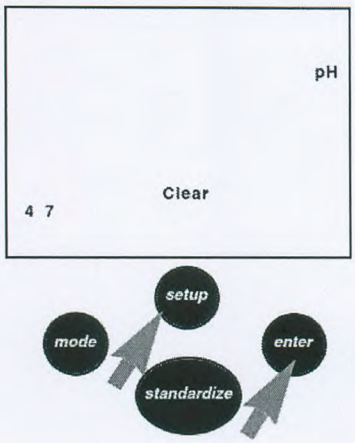
1. Immerse electrode in a buffer solution. Stir gently. Allow the electrode to reach a stable value.



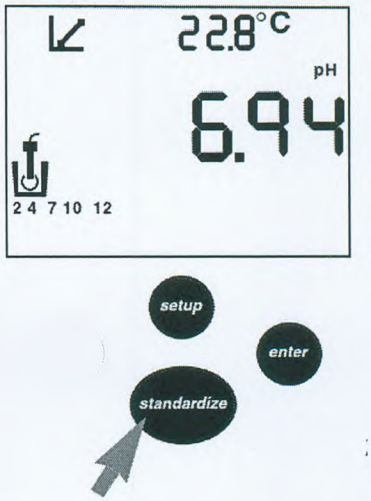
2. Press and release the **mode** button until your digital display indicates pH mode.



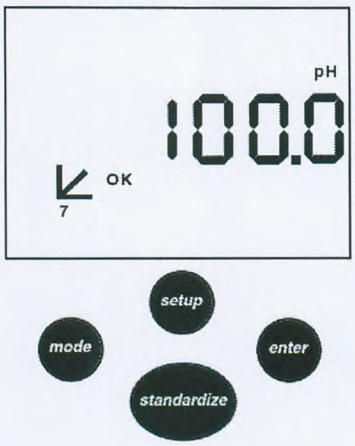
3. Clear existing buffers when doing a new standardization. Use the **setup** and **enter** buttons to clear existing buffers.



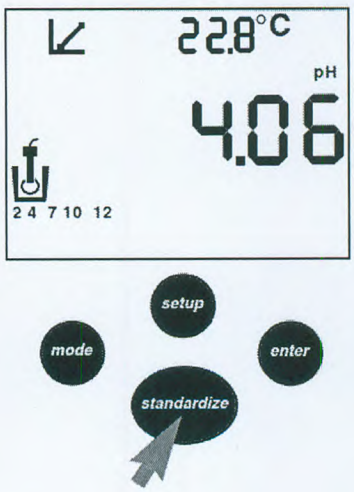
4. Press **standardize**. The meter flashes the current buffer set and recognizes the flashing buffer. When the signal is stable or when you press **enter**, the buffer is entered.



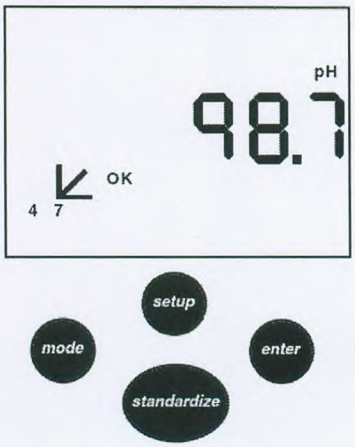
5. The meter displays the percent slope of the electrode as 100.0% on the first buffer. On entering a second or third buffer, the meter performs a diagnostic check on the electrode and displays the slope.



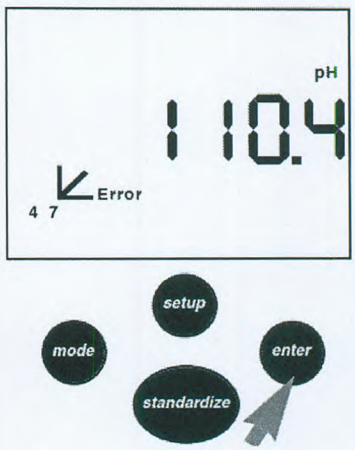
6. To enter a second buffer, place the electrode in the second buffer solution, stir, allow time for the electrode to stabilize, and press **standardize** again. The meter recognizes the buffe



7. Next, the meter performs a diagnostic test of the electrode. The display indicates electrode condition. The meter displays the % slope of the electrode.

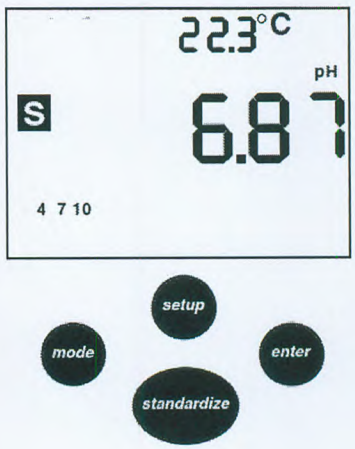


8. **Slope Error** indicates that your electrode is not working properly. The electrode response must be between 90 and 105% slope. Measurements causing Slope Error are not accepted, used or stored by the meter. Press **enter** to continue.



9. To enter a third standard, place the electrode in the third buffer solution, stir, allow to stabilize, and press **standardize**. The results will be the same as in steps 7 and 8.

10. After entering each buffer, the *Standardizing* icon goes off and the *Measuring or Stable* icon appears on the display to indicate that the meter returns to *Measuring* operation.



3.Results and Discussion:

During 2019, the number of water producing plants in Baghdad according to **(Ahemd 2022)** was 65, 39 of them were active while the other 26 plants were not producing for different reasons, active plants are:

مصنع جوهرة العين للمياه الصحية، شركة الدلتا للصناعات الغذائية المحدودة، معمل الصفا لإنتاج المياه الصحية، شركة الميسرة الدولية للتجارة العامة والصناعات الغذائية المحدودة، شركة النعمان للمياه الصحية، شركة الرؤى لإنتاج المياه الصحية، الشركة الدولية للمياه الصحية المحدودة، شركة حيفا للمشروبات الغازية والصحية والعصائر، معمل اليقين للمياه الصحية، شركة الطيف للمشروبات الغازية والمياه الصحية والعصائر، شركة العبير لإنتاج وتعبئة المياه المحدودة، معمل مياه مصافي لإنتاج المياه الصحية، شركة زين الشرق الاوسط للصناعات الغذائية، معمل ثلوج لإنتاج المياه الصحية، معمل النسيم لإنتاج المياه الصحية، شركة الراوية للمياه الصحية والمشروبات الغازية والعصائر المحدودة، شركة ورود الياسمين لتعبئة المياه، شركة مجموعة زاكي للصناعات الغذائية المحدودة، شركة زين الكوثر لإنتاج المياه، شركة السد لتعبئة المياه الصحية، معمل جود الخير للمياه الصحية، معمل الخليج العربي لتعبئة المياه الصحية، معمل النوري لإنتاج المياه الصحية، شركة مياه الراية، شركة دجلة الخير للمياه والعصائر/ سايا، معمل نبع الطيبات للمياه الصحية، معمل كاسات مياه مزن، معمل الشاهين لإنتاج المياه، معمل مياه السفير، معمل مياه روضتين، شركة بحر النوارس، معمل سمى بغداد لإنتاج المياه، الشركة الوطنية العراقية للصناعات الغذائية، شركة بريق اللؤلؤة لتنقية وتعبئة المياه المحدودة، معمل وفر الحياه للمياه المعقمة، معمل نبع النمير لتعبئة المياه الصحية والعصائر المحدودة، شركة الرافدين لإنتاج المياه الصحية المحدودة، شركة بغداد للمشروبات الغازية والمياه، معمل المنصور تابع الى وزارة الصناعة والمعادن (قطاع حكومي).

Many consumers are confused when consuming bottled water, they call it "Mineral Water" "مياه معدنية" while it is bottled water, we also noticed this confusion in the labeling of many brands in local markets; the current study shows the compliance and non-compliance of 20 brands of bottled water to Iraqi Standard 1937/ 2019 issued by Central Organization for Standardization and Quality Control (the governmental body responsible for National Standards setting).

Iraqi plants mainly use water from public distribution system as the source for their production as we can see in the labels of bottled water, except for Baghdad Beverages Company (AQUAFINA brand) and Al-Mansour Company (Zulal brand) they both use water from the Tigris River as the

source; they apply a pre-treatment procedure before introducing water to final treatment. Some plants (especially in southern Iraq) use underground water as a source due to problems in the supply of the public water distribution system.

The parameters studied were pH, turbidity, and total dissolved salts (TDS) during 2019; the results (figure 1) showed that (in general) compliance to Iraqi Standard regarding these parameters except الساقي، الجادرية، دينار that failed in pH; this failure can be attribute to the type of water used as a source for these plants, the composition of river water (source of public distribution system) is changing through seasons and consequently may affect the nature of water source of plants.

All the results of turbidity studied (figure 2) were conforming to the requirement of Iraqi Standard which indicates the effectiveness of operations performed by plants covered by this study, turbidity is a visual property of water that expresses the amount of suspended substances in the water. Its presence in quantities more significant than the permissible limit makes the water undrinkable and reduces the effectiveness of disinfectants in treating pathogens **(Nasier 2022)** while **(WHO 2022)** introduce more clear definition that turbidity, typically expressed as nephelometric turbidity units (NTU), describes the cloudiness of water caused by suspended particles (e.g. clay and silts), chemical precipitates (e.g. manganese and iron), organic particles (e.g. plant debris) and organisms. Turbidity can caused by poor source water quality, poor treatment and, within distribution systems, disturbance of sediments and biofilms or the ingress of dirty water through main breaks and other faults. At high levels, turbidity can lead to staining of materials, fittings and clothes exposed during washing, in addition to interfering with the effectiveness of treatment processes

TDS (Total Dissolved Solids) results (figure 3) were also conforming to the requirement of Iraqi Standard, the standard require that TDS must not exceed 300 ppm in bottled water, all the brands were too far below this number which indicates good practice in plants, The palatability of water **(WHO 2022)** with a total dissolved solids (TDS) level of less than about 600 mg/l is generally considered to be good; drinking-water becomes significantly and increasingly unpalatable at TDS levels greater than about 1000 mg/l. The presence of high levels of TDS may also be objectionable to

consumers, owing to excessive scaling in water pipes, heaters, boilers and household appliances. World Health Organization (WHO) has proposed no health-based guideline value for TDS.

4. Conclusion:

Most of samples were conforming to requirements of Iraqi Standard 1937/ 2019 regarding pH, Total dissolved solids and turbidity except three brands of 20 brands covered by current study.

5. Recommendations:

- Urging producers to commit more to the requirements of the Iraqi standard.

- Study other chemical parameters in bottled water beside pH, TDS and turbidity.

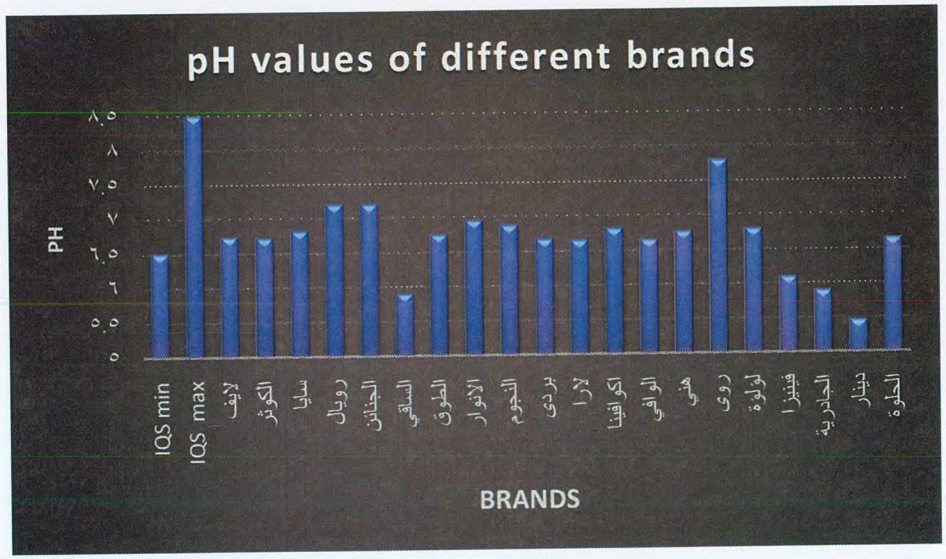
- Study the interaction between different chemical parameters in bottled water.

- Extending the frame of future studies to include more brands in different Governorates in Iraq.

- Performing joint studies with other researches in field of microbiology to study the interaction between chemical and microbial parameters in bottled water.

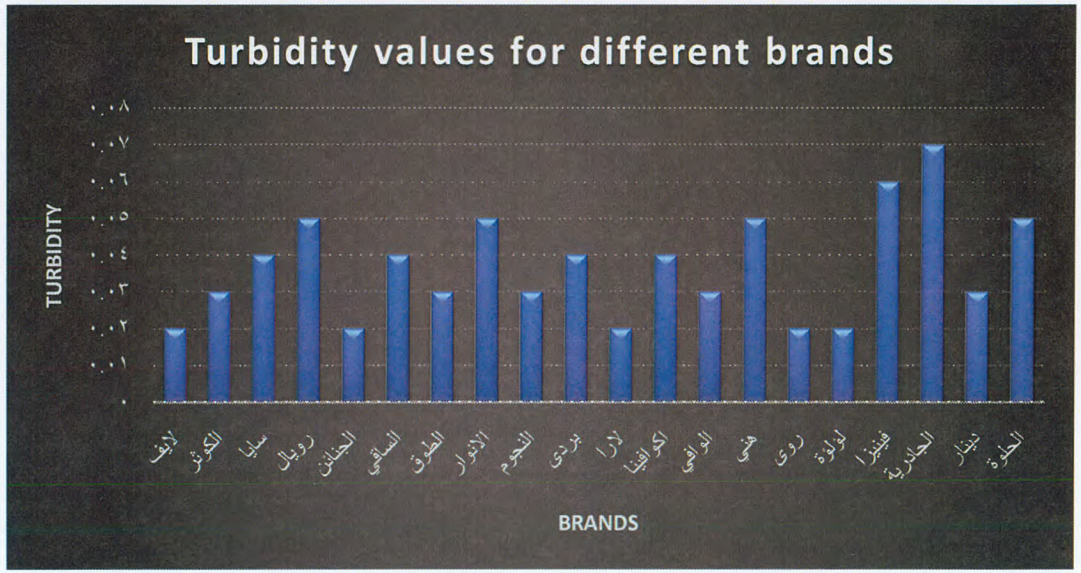
BRANDS	pH
IQS min	6.5
IQS max	8.5
لايف	6.74
الكوثر	6.72
سايا	6.82
رويال	7.2
الجنائن	7.2
الساقي	5.9
الطوق	6.75
الانوار	6.95
النجوم	6.88
بردى	6.67
لارا	6.65
اكوافينا	6.82
الوافي	6.65
هني	6.77
روى	7.8
لؤلؤة	6.8
فينيزا	6.1
الجادرية	5.9
دينار	5.46
الحلوة	6.65

Figure (1)
pH value 6.5 - 8.5 according to IQS 1937/ 2019



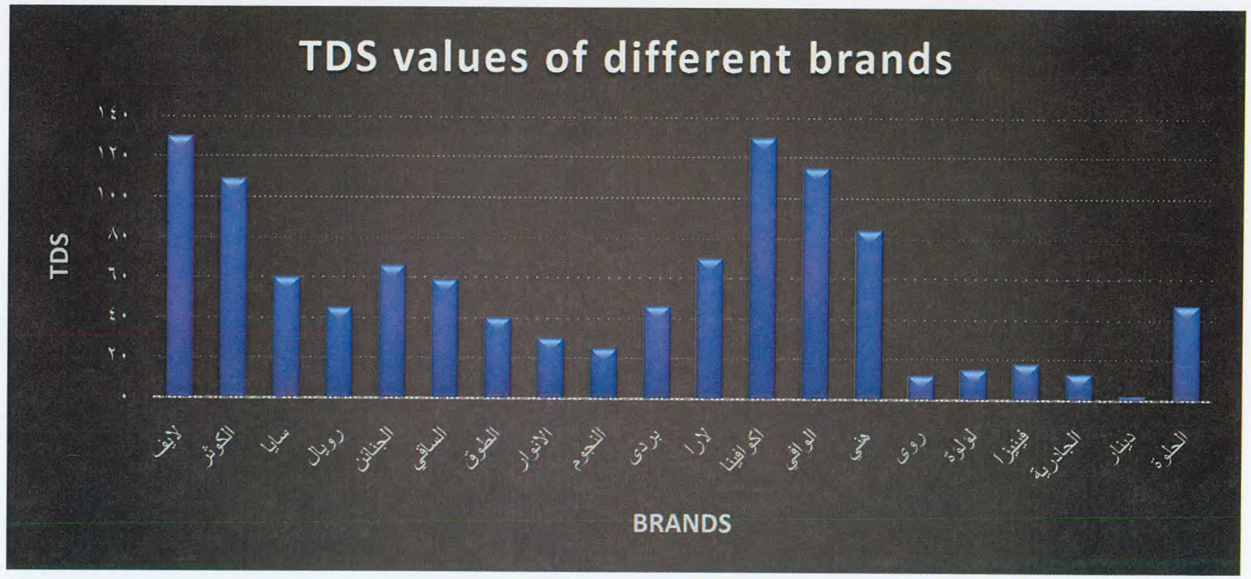
BRANDS	Turbidity/ NTU
IQS max	5
لايف	0.02
الكوثر	0.03
سايا	0.04
رويال	0.05
الجنائن	0.02
الساقي	0.04
الطوق	0.03
الانوار	0.05
النجوم	0.03
بردى	0.04
لارا	0.02
اكوافينا	0.04
الوافي	0.03
هني	0.05
روى	0.02
لؤلؤة	0.02
فينيزا	0.06
الجادرية	0.07
دينار	0.03
الحلوة	0.05

Figure (2)
Turbidity value 5.00 NTU (max.) according to IQS 1937/ 2019



BRANDS	TDS/ ppm
IQS max	300
لايف	130
الكوثر	109
سايا	60
رويال	45
الجنائن	66
الساقي	59
الطوق	40
الانوار	30
النجوم	25
بردى	46
لارا	70
اكوافينا	130
الوافي	115
هني	84
روى	12
لؤلؤة	15
فينيزا	18
الجادرية	13
دينار	2
الحلوة	47

Figure (3)
TDS value 300 ppm (max.) according to IQS 1937/ 2019



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(*) APA style.