Study of physico-chemical and bacteriological properties of bottled water in Iraq

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Study of physico-chemical and bacteriological properties of bottled water in Iraq

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Abstract

Bottled drinking Water" means water that is intended for human consumption and that is sealed in bottles or other containers with no added ingredients except that it may optionally contain safe and suitable antimicrobial agents. The bottles water were collected from some Iraqi governorates (Basrah, Karbala, Najaf, Baghdad and Arbeel). Water quality was assessed by examining various physico-chemical and biological parameters such as pH, EC, TDS, Total hardness, Total alkalinity, Chloride, Sodium, Potassium, sulphate, NO_2, NO_3 total coliform count at 44c° and fecal coliform count total plate count at 22◦C, 37C°.The results of the bacterial analysis showed that there are variation in bacterial counts so its un fit for human consumption. While, the pH (7.07-8.50) and EC (20-366µS/cm), TH (9.00-1207mg/l). B(0.11-7.91 mg/l), Na(10-273mg/l), K(2.86-62.89mg/l), Mg(0.48-288 mg/l), Ca(2.0-40 mg/l), Cl(27-511 mg/l) and SO4(1.30-190.7),NO_2(1.00-0.12),NO_3(1.00-0.06).

KEY WORD: Iraq, bottled water physico-chemical, biological parameters

Introduction

Bottled water consumption has been steadily growing in the world for the past 30 years. It is the most dynamic sector of all the food and beverage industry. Consumption in the world increases by an average of 12% each year in spite of its high price compared to tap water (Abd El-Salam, *et al*., 2008).

The quality of water is determined largely by bacteriological analysis, in bottled water the bottling process may be a source of additional contamination. In addition, the common sources of contamination of bottled water are equipment, bottles and cups, exposure to air and contact with humans during the bottling process. (Osman *et al*., 2009).

Epidemiological studies have reported the occurrence of disease including problems with reproduction, cancer, congenital malformation of the central nervous system, cardiovascular disease and even death due to exposure to trace elements and mineral contents of water such as Calcium (Ca), Magnesium (Mg), Sodium (Na), and Potassium (K).(Abed & Al-Wakeel, 2007).

So, the objective of this study is to assess the microbiological and chemical parameter of the bottled

water retailed in local markets and study if their suitability for human consumption.

Materials& Methods

Water Samples

A total of 28 different bottles were collected from local markets in Basrah, Karbala, Najaf, Baghdad and Arbeel governorates during the period from 2011-2012. The bottles are including local and imported products.

Bacteriological Analysis:

A duplicate of 100 ml from each sample were filtered by membrane filtration

Technique using 47 mm cellulose acetate filters with a nominal pore size of 0.45µm (Sartorius, Germany) and analyzed for total coliforms and fecal coliforms and plate count. The membrane filters were placed on the surface of M- endo agar contained in Petri dishes and incubated at 37 ± 1°C for 24 h. The coliform colonies will appear as pink to dark red spots with metallic (golden) sheen, which may vary in size from pinhead to complete colony coverage. While for fecal coliforms the membrane filters were placed on the surface of M-FC agar without rosolic acid contained in Petri dishes and incubated at 44.5°C for 18 h in water bath. The colonies will appear as blue or light blue. In addition to that total plate count at nutrient agar have done at 22° c for 18-24h.

Physicochemical analysis:

HCO_3, Cl and SO_4) were analyzed in the laboratory using standard procedures according to APHA (2005). Sodium and potassium were determined by flame photometer (Jenway pep7). Calcium and Magnesium were titrated with 0.01N Na_2EDTA. Chloride was determined volumetrically by titration with 0.01 N $AgNO_3$. Sulfate was determined by spectrophotometer (Cecil, UK) using turbidity method and bicarbonates were determined volumetrically by titration with 0.01N H_2SO_4. Nitrite (NO_2^{1-}) determined by colorimetric method. Cadmium reduction method was used to determining nitrate (NO_3^{1-}).

Results &Discussion

The results of the bacterial analysis for the commercially available bottled mineral water were tabulated in table (1), these results showed that there are variation in bacterial counts among the tested brands of bottled mineral water. The most contaminated brands was Alrawabee (UC for four bacterial tests) while only one brand (Life) which had no bacterial growth (nil for four bacterial tests). There was a wide variation in the levels of bacterial indicators of contamination recorded in different categories of water. Mean total and fecal coliform bacteria count in the tested brands ranged from (1-UC) cu/100ml, these results were in agreement with the findings of Oyelude and Ahenkorah (2012) who stated that improper handling might

The pH ,

be a reason why coliform bacteria were detected in some bottled water.
WHO (2011) recommended that fecal coliform bacteria must not be detectable in a 100-ml sample of drinking water, out of 28 tested brands,14 brands were contaminated with total coliforms (50%), while 26 brands (92.85%) of tested brands were contaminated with fecal coliforms, these findings were in agreement with what founded by Islam *et al* (2010) who indicated that 50% of mineral water tested by them were exceeded the drinking water guideline value of WHO, also our findings were in agreement with Razuki & Al-Rawi (2010) who attributed the presence of coliform bacteria in bottled water to some reasons such as the difference in the quality of water used for production and amount of pollutants and the quality purges in the systems of bottled water as a result of not controlling ozone doses wavelength rays UV necessary to ensure the cleansing process successful as well as reasons not to apply health conditions that must be met in the coefficient of water filling contained in the terms of specification Iraqi No.356 of 2000 and the rules of health in manufacturing plants and food preparation.

Total plate counts at 22° C and 37◦ C were varied from nil to UC ,our results showed that there is no correlation between the two tests , this is in disagreement with Osman *et.al.*, (2009) who found that the average counts of total bacteria were at 22° C was higher than those at 37◦ .

Table (1) The bacterial analysis for the bottled water

Sample	T.C.	F.C.	T.P.C.22˚C	T.P.C
DORalynabee / Iraq	1	Uc	100	Nil
Auyoun / Iraq	Nil	Uc	45	66
Pearl / Iraq	1	Uc	Uc	Uc
Al-Waha / Iraq	10	Uc	Uc	Uc
Al-Khaleej / Iraq	5	Uc	Uc	Uc
Refresh / Kuwait	1	Uc	5	Uc
Al-Badeea / Iraq	Nil	Uc	55	Uc
Life / Iraqi	Nil	Nil	Nil	Nil
Aquafina /Kuwait	Nil	1	Nil	Nil
Lolav /Turkey	2	5	Nil	Uc
Al-Janaen / Iraq	Uc	36	Nil	Uc
Al-Tour / Iraq	9	Uc	14	31
Al-Dafiq / Iraq	Nil	27	Nil	Uc
Al-Buraq / Iraq	Nil	1	9	33
Mazaya /Iraq	Nil	6	7	18
Yahya / Iraq	Nil	6	2	19
Babeet / Iraq	Uc	24	Uc	33
Al-Mudheef /Iraq	Nil	8	1	12
Al-Naqawah / Iraq	2	2	1	18
Aquagulf / Kuwait	1	Uc	Uc	Uc
Salsal / Iraq	1	Uc	Nil	Uc
Mazee / Iraq	Nil	10	1	2
Al-Rawabee / Iraq	Uc	Uc	Uc	Uc
Al-Raad / Iraq	Nil	7	9	54
Al-Aaelah / Iraq	Nil	Nil	1	57
Karwan / Iraq	Nil	4	3	62
Al-Radhadh /Iraq	Nil	3	Nil	Uc
Al-Khazer /Iraq	173	43	Uc	Uc

*T.C.: total coliform * F.C.: fecal coliform

+ Nil: No growth ++UC: Uncountable

*T.P.C.22˚C: total plate count at 22˚C * T.P.C 37˚C: total plate count at 37˚C

Figures 1, 2 and 3 shows the pH, EC, and TDS. The pH values range between 7.07 and 8.50 and the average value was 7.93 the higher frequency acquire in value from 8 to 8.5. The results are within the acceptable limits of DW Iraqi standard (6.5 – 8.5).

The EC values range between 20 and 366 (± 104.07) µS/cm and the average is 159.08 mg/L the higher frequency acquire in value 200) µS/cm. The EC of samples are within the acceptable limits of WHO (2011) and the European standards recommended value of EC is 250 µS/cm. The TDS values range between 12.80 and 234.24mg/L and the average is 101.65 mg/L the higher frequency acquire in value100 mg/l. EC were correlated with TDS values (Barbooti *et al*. 2010).

Figures 4, 5, 6 and 7 shows the frequency concentration values of the major anions: SO_4, Cl, HCO_3 and NO_2. The sulphate concentration values range between 0 and 191 mg/L and the average is 28.89 mg/L. within the acceptable limits of DW Iraqi standard (2000). The higher frequency acquire in value 0-50 mg/L. The chloride concentration values range between 0 and 511 mg/L. A few samples is higher than the maximum limit of standard. Most of the samples were within the value 100 mg/L. The concentration of bicarbonate values range between 0 and 996 mg/L and the average is 178 mg/L. The highest frequency of the nitrite concentration was within acceptable limits of standard (0.02-0.03 mg/L).

Figures 8, 9 and 10 shows the frequency concentration values of the major cations Ca, Mg and hardness. The Ca and Mg concentration values ranged from 0 to 40 mg/L and the average is 12.44 for Ca that value within the acceptable limits of DW Iraqi standard(50 mg/L) and from 0 to 288 mg/L ,the average is 64.24 mg/L for Mg that values higher than the maximum limit of stander. The hardness ranged from 0 to 1207 mg/L (the high concentration have a few frequency) the average 259.66 mg/L. The highest frequency of calcium appeared at concentration 0-15, while the frequency of magnesium from 0 to 50 of the magnesium concentration and high frequency of hardness from 0-100 mg/L. There is a highly significant correlation between turbidity and magnesium (0.998), while there were not any correlation with calcium, this is reverse Barbooti *et al*. (2010) who found a high correlation between calcium and turbidity in drinking water. Moyel *et al*. (2013) Found that reverse water RO water which used for drinking in Basrah city is not suitable for health, due to the deficiency of Calcium and Magnesium and Ions, such ions are demanded for human health.

The highest frequency of concentration of sodium is within the limits of the acceptable standard of Iraqi DW (0-50) figure (11).

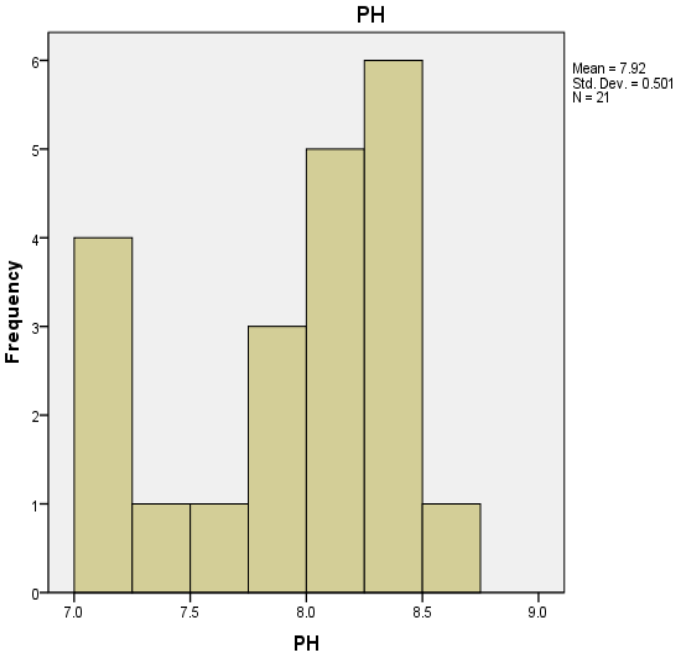

Fig.1: the frequency of pH value

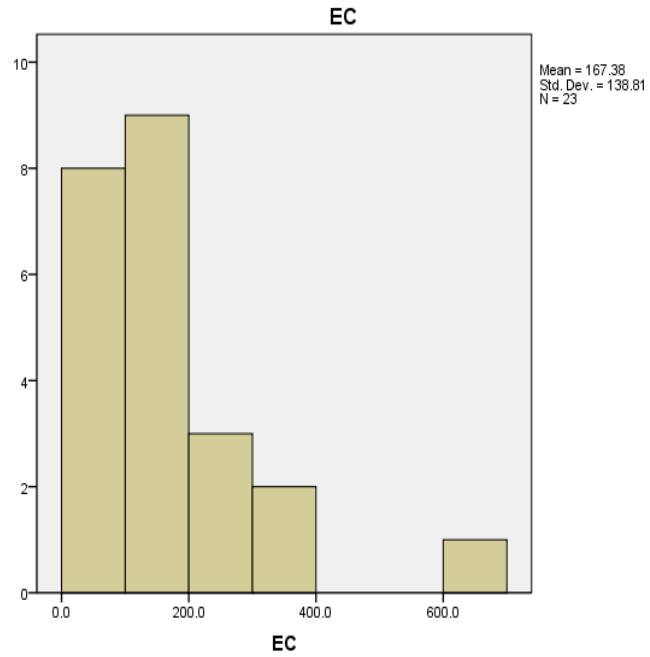

Fig.2the frequency of EC

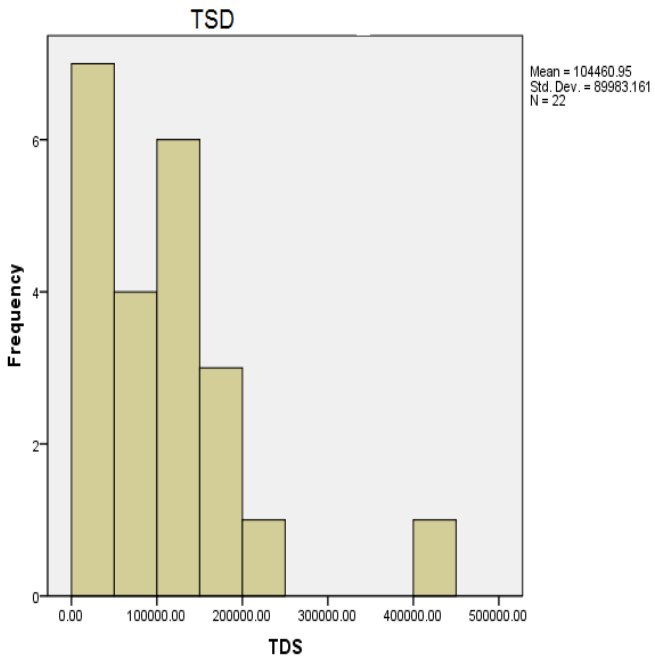

Fig.3: the frequency of TDS concentration

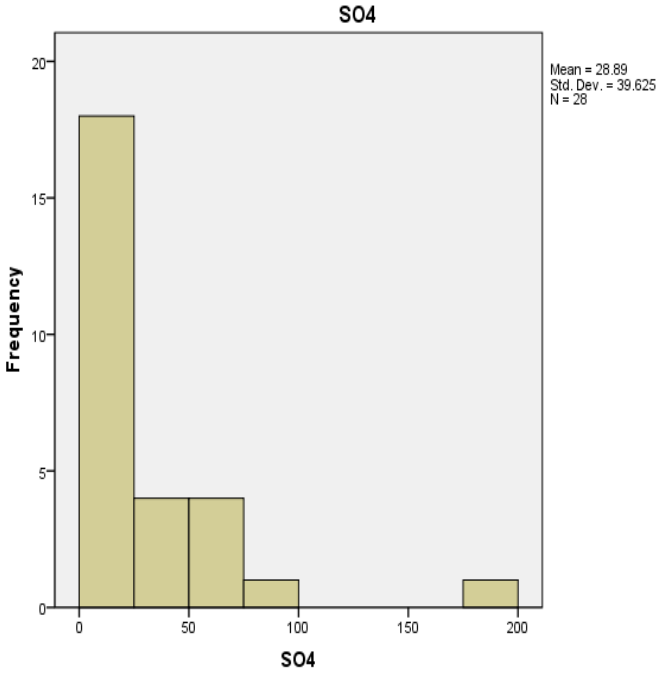

Fig.4: the frequency of SO4 concentration

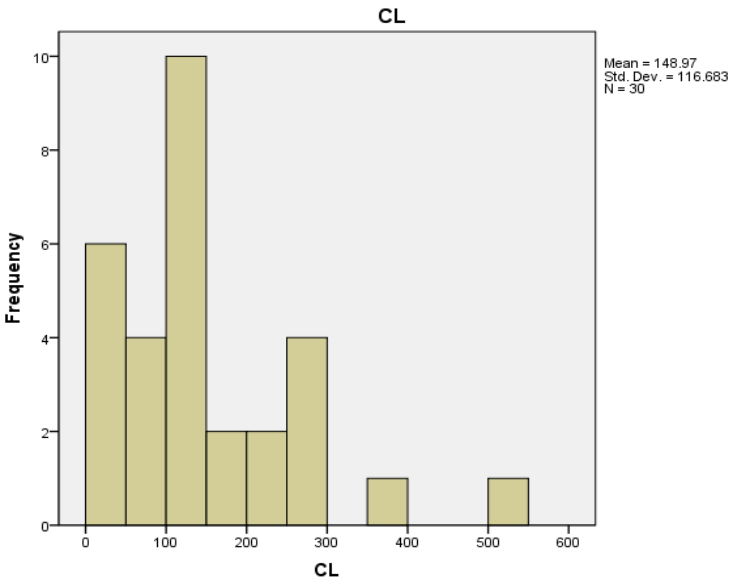

Fig.5: the frequency of Cl concentration.

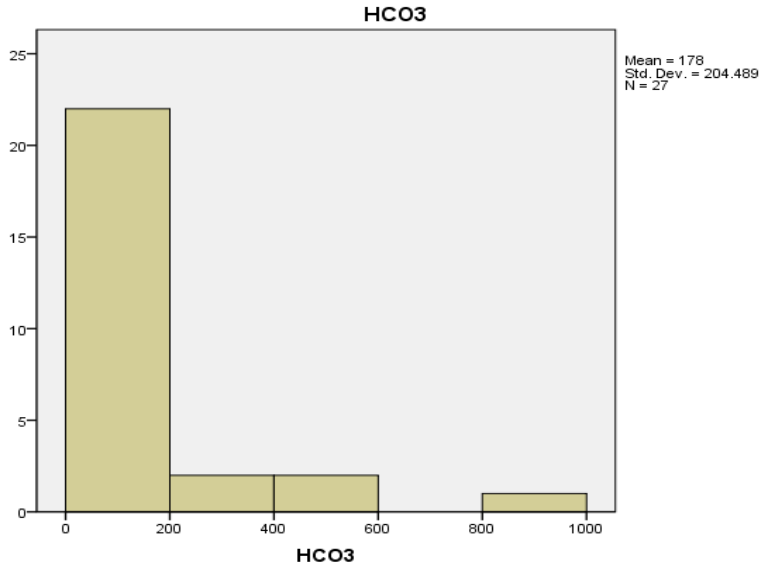

Fig.6: the frequency of HCO_3 concentration.

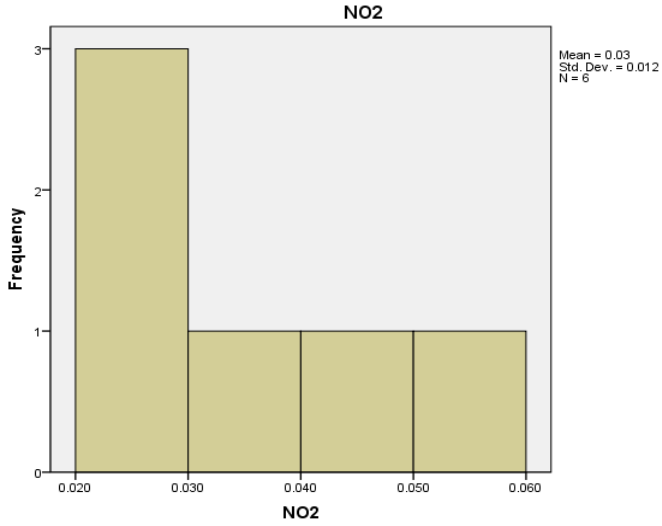

Fig.7 the frequency of NO_2 concentration.

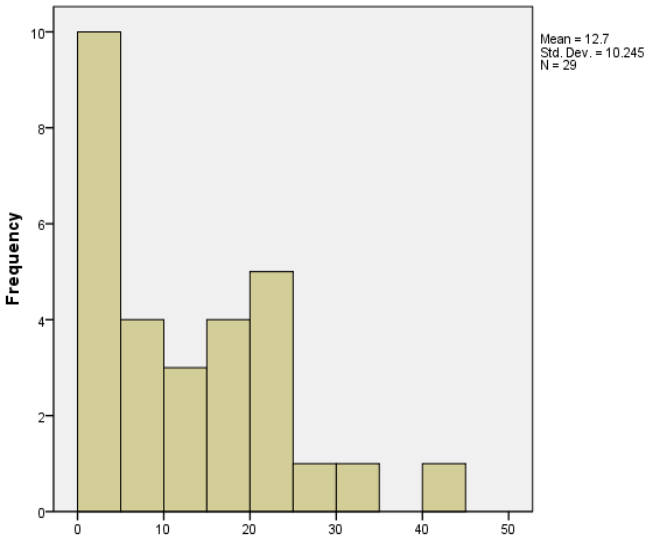

Fig.8: the frequency of Ca concentration.

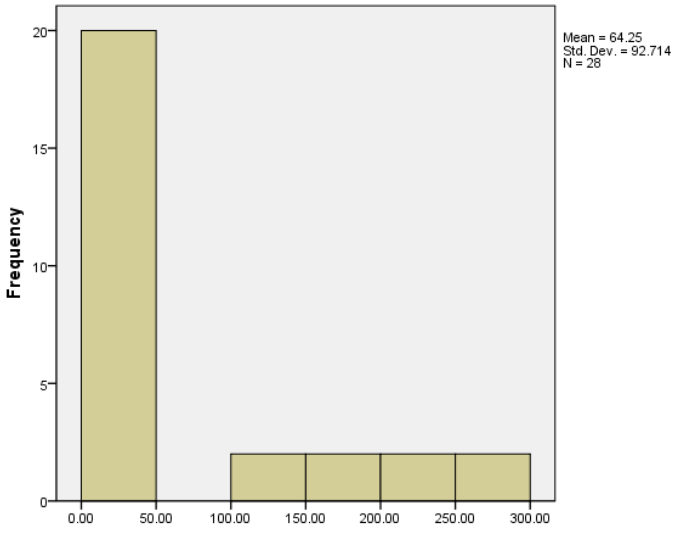

Fig.9: frequency of Mg concentration.

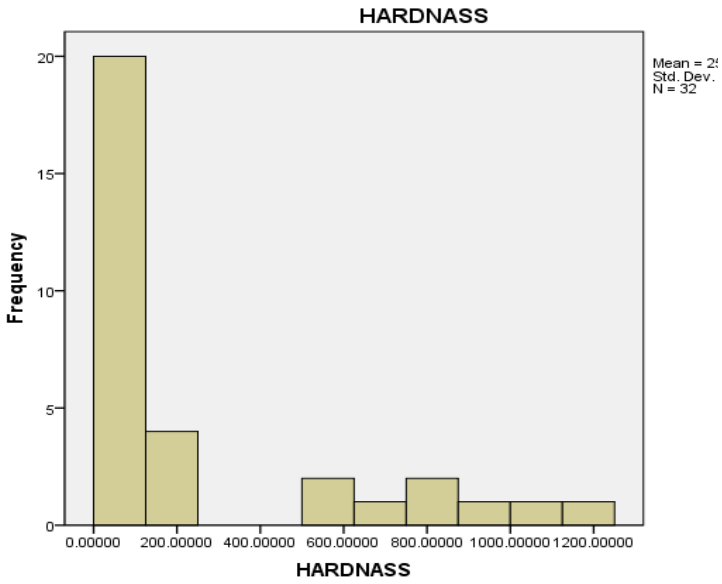

Fig.10: the frequency of Hardness.

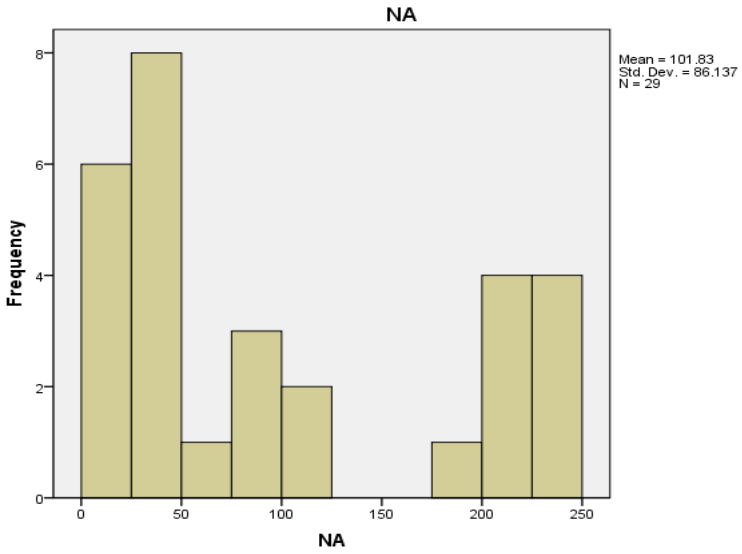

Fig.11: frequency Na concentration

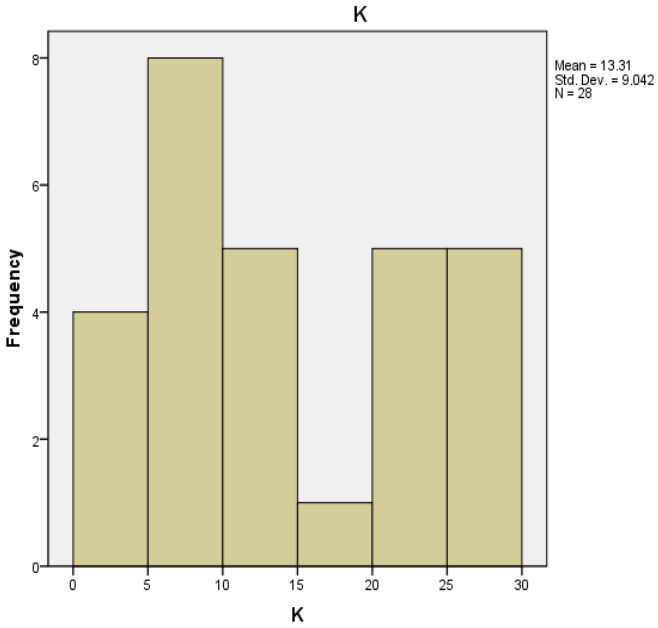

Fig.11: the frequency K concentration

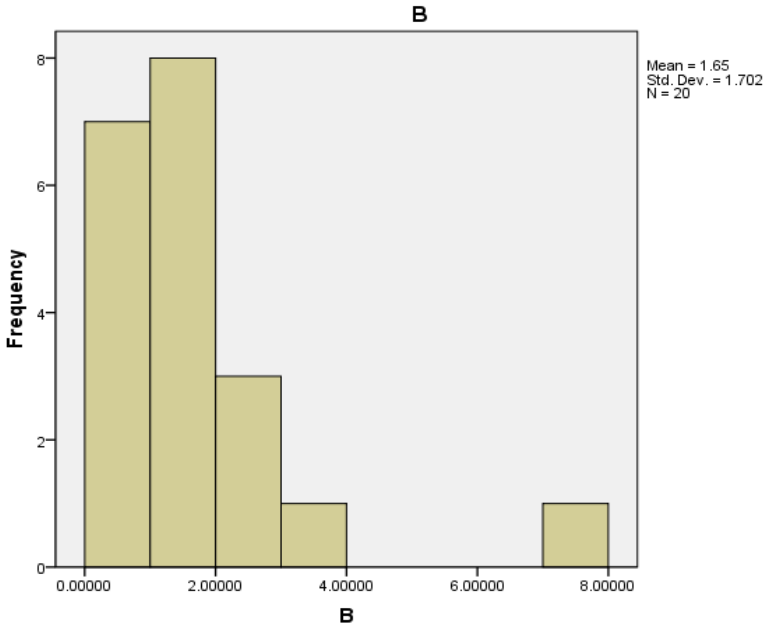

Fig.12: the frequency B concentration

The highest frequency of concentration of sodium are from 5-10 mg/L.

Figure (12) showed the frequency of concentration of boron in the samples. The higher frequency appeared in concentration 1-2 mg/L. A few samples high concentration ranged from 2-8 mg/L. Most of sources of drinking bottled water were ground water. In ground water boron concentrations can be as high as 10 mg/L in areas to the west of Euphrates River (Al-Dabbas, 2006).

From the results of water samples selected that most of the samples are not in conformity with the standard specifications for the Iraqi drinking water, for both presence of bacterial or concentrations of some ions, as well as turbidity or boron addition to the low concentrations of elements also are not conforming to specifications showing that some of the samples where the concentration of elements up to zero (SO_4,HCO_3,Cl,Ca,Mg,Na,and K) so the quality of the bottled water must be over control. That bottled water is in direct contact with people's lives, especially children, to the confidence of the people because they are subject to the supervision and quality control.

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دراسة الخصائص الفيزيائية والكيميائية والبكتريولوجية للمياه المعبأة في العراق

وصال فخري حسن ، ايمان عبد الله الامارة ، ايناس قاسم محمد ، اسعد محمد رضا ، ر نا طارق شبلي

قسم الكيمياء البيئية البحرية – مركز علوم البحار – جامعة البصرة

المستخلص

مياه الشرب المعبأة هي تلك المياه التي عادة ما تخلو من اي مضافات عدا تلك التي تكون غير مضرة بصحة الانسان. جمعت عينات مياه الشرب المعبأة المطروحة في الاسواق من بعض محافظات العراق (البصرة، كربلاء، النجف، بغداد واربيل). حددت المواصفات الفيزيائية والكيميائية للمياه من خلال قياس درجة الحامضية، التوصيلية، الاملاح المذابة الكلية، القاعدية الكلية، الكلوريد، الصوديوم والبوتاسيوم والكبريتات والبورون النترات و النتريت ودرست ايضا اعداد البكتريا الكلية، بكتريا القولون الكلية وبكتريا القولون البرازية.

اظهرت نتائج التحليل البكترولوجي بوجود تغاير في الاعداد وان المياه غير صالحة للشرب في حين اظهرت نتائج التحاليل الفيزيائية والكيميائية بأن قيمة الحامضية تراوحت بين (7.07–8.50) ، التوصيلية (20–366) مايكروسيمينز\سم، العكارة الكلية (9–1270) ملغم\التر ،العسرة الكلية (9–1207) ملغم\التر ،البورون (0.11–7.91) ملغم\ لتر ،الصوديوم (10–273) ملغم \التر، البوتاسيوم (2.86–62.89) ،مغنيسيوم (0.48–288) ملغم\التر ،كالسيوم (2.0–40) ملغم\التر ، الكلوريد(27–511) ملغم\التر والكبريتات (1.3–190.7) ،النتريت(0.06–1.00)والنترات(0.12–1,00).

الكلمات المفتاحية : العراق ، الصفات الفيزيو– كيميائية للمياه المعبأة ، الصفات البكترولوجية.