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Assessment of Content Cations Present in Groundwater Samples Collected from Wells of Ajdabya City and its Environs

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Abstract

The purpose of this study was aimed to evaluate the quality of the drinking water in fifteen wells from Ajdabya City and its surrounding areas. By measuring the conductivity, total dissolved solids, major calcium (Ca2+), magnesium (Mg2+), sodium (Na+), potassium(K+), lithium(Li+), and total hardness (TH) in the groundwater. According to this study, the conductivity, total dissolved solids, and cation concentrations were rose in the majority of the groundwater samples except in forth wall of Zuwaytinah area, which was in limiting value (EC = 770), (TDS =340), (TH =360), (Ca2+ =160). Meanwhile rest the chemical analysis were higher than limiting value (Na+= 390), (k+ 60) and (Li+ =60) when compared to the WHO and Libyan drinking water standards.

Keywords: Groundwater; Cations; Flame photometry; Titration; Ajdabya City.

INTRODUCTION

Water is the source of life on Earth for all living organisms, as Allah Almighty says in the Munificent Quran ﴿And, We made from water every living thing﴾ (The Prophets:30). The two main sources of it are surface water and groundwater (Dawood & Sanad, 2014; AZAZA et al., 2012), and about one-third of people on Earth use groundwater for drinking (Nickson et al., 2005). One valuable natural water resource that is suitable for residential use and is easily accessible is groundwater (Najafi et al., 2020). In arid and semiarid regions, groundwater has traditionally been the preferred source of drinking water (Loh et al., 2020). Subterranean water is the world's primary source of drinking water and is also utilized as a backup supply for the industrial and agricultural sectors (Mishra & Bhatt, 2008)). Elements exist in aquatic systems as suspended, colloidal ions, dissolved ions and complexes, and solid in sediments. The ionic strength, pH, redox potential, biological processes, and activities all have a significant impact on the concentrations of these ions (Arjonilla et al., 1994).

Numerous techniques for analyzing ions (anions and cations) in water have been documented in the literature. Water cation analysis has historically been done using flame atomic absorption spectrophotometry (Aberoumand & Deokule, 2009). Flame atomic emission is another name for flame photometry. The study of species in the form of atoms is known as spectrometry, and it primarily relies on the ionization of salts containing alkali metals that are drawn into a non-luminous flame.

When alkali metal salt absorbs enough energy from a flame, it vaporizes and emits light with a distinctive wavelength that can be seen by a change in color intensity (Chikhale & Chikhale, 2017).

The present study aims to evaluate a simple, fast, and accurate method for the determination of pH, electrical conductivity, and cations, which included (total hardness, calcium ion, magnesium ion, sodium ion, and potassium ion) in different sites of wells water samples of groundwater, which collected in the year 2019 from Ajdabya City in Libya and its Environs.

MATERIALS AND METHODS

Sample Collection:

In this study, fifteen groundwater samples were taken from three different areas in Ajdabya City and its surroundings: The Sultan and Zuwaytinah areas. Five samples from various well sites were taken from each locality. 500 ml plastic bottles were used to collect the samples. The water samples were later brought to the lab. A water quality parameter test was conducted right away. After that, nitric acid was added to the models in order to preserve the metal content for as long as possible during storage.

Materials

Sodium Hydroxide (NaOH) Guangdong, 515021, China. Ammoniachloride (NH_4Cl) Riedei-DeHaen Germany. Ethylenediaminetetraaceticdisodium ($EDTA_2Na$) Riedel-DeHaen Germany. Ammonia NH_3. Deionized water was used for preparation of solutions. And the reagents which used are Powder Eriochrome Black T and powder murexide MERK company Germany.

Electrical Conductivity and Total Dissolved Solids:

The conductivity and TDS measurements were carried out using (Conductivity / Temp / TDS meter Goldpoint Company Ltd (Taiwan)). Then, the samples were measured when the laboratory was reached, and stabilize the sample temperature at 25.

Determination of Total Hardness

The total hardness (TH) was measured by the Lind method, in this method we took 5-10ml of the groundwater sample, then the volume was completed with distilled water to 50ml and titrated with (Na2EDTA) solution 0.01N after raising the pH of the sample solution to 10 by adding 1ml of ammonia regulator solution. Then add a suitable amount of Erichrom Black-T powder as a dry indicator until the color changes to blue. Then we took the average of the reading. [10] The total hardness is calculated according to the following equation:

$$\text{Total Hardness} = \frac{\text{VNa2EDTA} \times \text{NNa2EDTA} \times 1000 \times \text{M.W as CaCO3}}{\mathbf{V}\text{sampl}}$$

Determination of Calcium ion:

Calcium ion was calculated by taking 5-10ml of the filtered groundwater sample and then softening the complete volume with distilled water to 50 ml in a correction method using the standard solution (Na2EDTA) 0.01N, then the pH raised to 13-14 by adding 2ml of NaOH 0.1N and used the Murexid as a dry powder 0.2 g indicator to change the color to solid blue (APHA, 1926). Calcium ions calculated according to the following equation:

$$\text{Calcium Hardness} = \frac{V_{\text{Na2EDTA}} \times N_{\text{Na2EDTA}} \times 1000 \times \text{M.W as CaCO3}}{V_{\text{Sample}}}$$

Determination of Magnesium ion:

Magnesium ion was estimated by the difference between total hardness and hardness of calcium as expressed in the following equation:

Magnesium hardness Mg (mg / L) = Total hardness $CaCO_3$ (mg/L) - Calcium hardness (mg / L)

Determination of ions (Na^+, K^+, Ba^{+2} and Li^+):

The Concentrations of different ions (Na^+, K^+, Ba^{+2}, and Li^+) were measured using flame photometer equipment. The device depends on the Flame Photo Meter on a solution containing metal ions in the flame.

RESULTS

The chemical parameters measured to electrical conductivity, total dissolved solids and some cations from groundwater wells were precisely analyzed and compared with the regulatory standards set by the World Health Organization and Libyan Standards Specification. According to the amount the cations Na+, and K+ were measured using Flame Photometer. Whereas Ca2+, Mg2+, and total hardness which determined by titration methods. The results reveal that the mean values of cation concentrations in groundwater samples studies were quite variable which are illustrated in Tables (1-6). From the results, that illustrated in Table 1, the conductivity and total dissolved solids of well samples in Ajdabya City were not within the allowable limit to Libya Standard Specification NO.82 for drinking water (750 -1200) (500-1000), all of which have high values (1309- 2810) (1083-1570). As noted in Table 2 the conductivity and total dissolved solids of wells water samples in the Zuwaytinah area were higher than the permissible limit. Except in well NO. 4, which the conductivity average and total dissolved solids values are approximately 770 mg/L and 340 mg/L respectively. Table 3 shows the conductivity and total dissolved solids of wells water samples in the Sultan area were very high values (3390-1361) (2243- 1077).

Table 1: The analytical results of wells water samples for conductivity and total dissolved solids (mg/L) in Ajdabya City.

Well site	1	2	3	4	5
EC	2810 ±0.153	1309 ±0.0743	1487 ±0.0653	1438 ±0.0272	1979 ±0.0840
TDS	1570 ±0.0048	1083±0.0574	1284±0.0761	1103±0.0032	1489±0.0659

Mean ± SD

Table 2: The analytical results of wells water samples for conductivity and total dissolved solids (mg/L) in Zuwaytinah area.

Well site	1	2	3	4	5
EC	1530±0.077	1155±0.603	1430±0.541	770±0.0967	3530±2,0455
TDS	1150±0.073	1030±0.037	1109±0.033	340±0.0043	1993 ±0.0436

Mean ± SD

Table 3: The analytical results of wells water samples for conductivity and total dissolved solids (mg/L) in Sultan area.

Well site	1	2	3	4	5
EC	3256 ±1.069	2690±0,322	3390±2.851	1876±0.0438	1361±0.0711
TDS	1860±0.055	1498±0.0908	2243±0.377	1366±0.0421	1077±0.033

Mean ± SD

The maximum concentrations of total hardness of wells water samples in Table 4 at Ajdabya City were not within the allowable limit according to Libya Standard Specification NO.82 for drinking water (200-500 mg/L). Except for groundwater samples of well site NO. 2, the amount of water hardness was nearly 450 mg/L, which was match of the allowable limit. Table 5 recorded the amount of total hardness of wells water samples in the Zuwaytinah area was higher than the permissible limit. Except in wells NO. 2 and 4 which were average of total hardness values approximately 472 mg/L and 380 mg/L respectively.

Table 6 also showed the concentration of water hardness in the Sultan area's well samples, all of which were found to be over the allowable limit. Variations in the amount of heavy rain, leachate drainage from agricultural fields, and the use of well water for farming and gardening all had an impact on the total hydrocarbon (TH) content of groundwater. Water samples are classified as soft (>1–70 mg/L), moderately hard (75–150 mg/L), hard (150–300 mg/L), and extremely hard (> 300 mg/L) based on TH (Boyd, 2003). The groundwater wells under analysis had levels of lead above the permissible 500 mg/L drinking water limit. The water samples were deemed excessively hard and not fit for domestic use or consumption. Table 7 shows the comparison of the Libya standard NO.82 limits for Cations in water with WHO limits (mg/L).

Table 4: The analytical results of wells water samples for cations concentration (mg/L) in Ajdabya City.

Well site	TH	Ca	Mg	Na	K	Li
1	1226±0.588	812±0.011	414±0.009	390±0.965	60±0.003	10±0.007
2	450±0.065	226±0.022	224±0.0744	230±0.005	10±0.011	10±0.0322
3	592±0.081	320±1.012	272±0.090	320±0.076	200±0.015	30±0.099
4	632±0.172	360±0.0134	272±0.011	280±0.524	20±0.006	30±0.0322
5	773±0.987	426±0.832	347±0.004	340±0.099	20±0.0943	20±0.066

Mean ±SD. TH = Total Hardness

Table 5: The analytical results of wells water samples for cations concentration (mg/L) in Zuwaytinah area.

Well site	TH	Ca	Mg	Na	K	Li
1	747±0.0867	162±0.0944	585±0.0521	720±0.0965	100±1.094	60±0.0063
2	472±0.076	226±0.073	246±0.098	430±0.134	90±0.055	60±0.0433
3	735±0.0023	226±0.986	509±0.0547	570±0.861	80±0.997	60±0.033
4	380±0.943	160±1.009	220±0.022	390±0.654	60±1.066	60±0.643
5	3448±2.985	746±0.873	2702±0.512	4050±0.032	300±0.009	300±0.055

Mean ±SD. TH = Total Hardness

Table 6: The analytical results of wells water samples for cations concentration (mg/L) in Sultan area.

Well site	TH	Ca	Mg	Na	K	Li
1	1853±0.044	426±0.0941	1427±0.991	3500±2.054	200±0.006	200±0.031
2	1226±0.0376	240±0.33	986±0.721	600±0.0766	240±0.741	60±0.132
3	3228±1.381	692±0.806	2536±1.873	7150±2.965	350±0.0464	80±0.0877
4	772±0.055	226±0.070	546±0.543	640±0.135	40±0.733	30±0.125
5	720±0.0041	182±0.866	538±0.114	510±0.955	40±0.883	30±0.667

Mean ±SD. TH = Total Hardness

Table 7: Comparison of the Libya standard NO.82 limits for Cations in water with WHO limits (mg/L).

Major Ion	Libya standard NO.82 (mg/L)	WHO limit (mg/L)
TDS	500-1000	1000
TH	200-500	500
Ca^{2+}	75-200	200
Mg^{2+}	30-150	150
Na^{+}	20-200	200
K^{+}	10-40	100
Li^{+}	0-0.7	-

DISCUSSION

(812 mg/L). In addition, the present data illustrated that the lowest concentration of Ca2+ was found in wells NO. 1 and 4 of the Zuwaytinah area which were 162 mg/L and 160 mg/L respectively. While the other wells were not within the permissible limit. Whereas Ca2+ values in the Sultan area as shown in Table 6 find that all wells were not within the permissible limit, except well NO. 5 Ca2+ amount was within the permissible limit which was approximately 182 mg/L. The abundance of Ca2+ in water is mostly due to its usual presence in Earth's crust (Deshpande et al., 2012). Most of the groundwater wells had a high distribution of Ca2+, exceeding the WHO-recommended limit for drinking water (WHO, 2004). The main water chemistry of the groundwater wells may reflect the geology of the area. The total concentration of Ca2+ is the main factor that increases the hardness of water (Sadat-Noori et al., 2014). According to study results of magnesium concentration of wells water samples in Ajdabya City, note that all readings were higher than the permissible limit which is (30 mg/L -150 mg/L). Where the reading of the analytical results is nearly (224mg/L-414 mg/L). The highest values of magnesium ions in the Zuwaytinah area, which ranging 220mg/L to 2702mg/L. In addition, the present data illustrated that the highest concentration of Mg2+ in the Sultan area was found in all wells, which were nearly from 538 mg/L to 2536mg/L. The abundance of Mg2+ in the groundwater wells referred to the dissolution of all solids and rocks but mostly from limestone, dolomite, and gypsum, which are found in large quantities in some brines (Basem et al., 2010; Chenini et al., 2010).

Sultan area of all wells water samples were above of permitted limit which ranging from (20mg/L – 200mg/L). The presented information shows that potassium ion concentration in all wells water samples of Ajdabya City was within the permissible limit which is (10mg/L – 40mg/L). except in well NO. 1 the result obtained was nearly 60mg/L which overtook permissible limit. According to the results obtained in the present work, the K+ content in the Zuwaytinah area was not within permissible limits in all wells water samples. Whereas, found that the amount of K+ of both wells NO. 4 and 5 in of Sultan area which were within the permitted limit. while the highest average values of K+ content were found in wells NO. 1, 2, and 3 which outran the permitted limit. Potassium may primarily come from rock weathering in addition to solid and liquid wastes (Tikle et al., 2012; Belkhiri & Narany, 2015).

Tables delineate that Li+ concentration in Ajdabya City, Zuwaytinah area, and Sultan area of all wells water samples was above the permitted limit which ranging from (0 mg/L – 0.7 mg/L). Groundwater is a major source of freshwater in the Arab world, and in most cases, fresh groundwater originates from leakage and vertical precipitation of fresh rainwater, rivers, and lakes through cracks, fractures, and sedimentary rock layers into the aquifer. Groundwater is saltier than surface water, salt concentrations may be higher than some of the taste, color, and hardness of the water below the surface of the earth, whether in saturated areas is the area filled with their water, or unsaturated which are directly below the surface of the earth and contain geological materials that makeup water and air in the spaces between the soil granules. Ions seeped out of rocks and soils and dissolved in water as a result of weathering and water circulation. The main elements affecting the geochemistry of the water are the geological formations, the water-rock interaction, and the relative mobility of ions (Yousef et al., 2009). It is important to consider major ions and their ratios when attempting to deduce how rock chemistry affects water composition (Shaltami et al., 2017).

CONCLUSION

In summary, most the results obtained in this study was higher than the Libya standard and WHO limit. Groundwater is saltier than surface water, salt concentrations may be higher than area to another. That are primarily come from rock nature in addition to solid and liquid wastes.

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