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Assessment OfGround Water Chemistry And Suitability For Drinking Purposes In The Western Part Of Jifarah Plain Area, Libya.

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Abstract:
Water is precious natural resources and essential factor for sustainability, Ground water resources is one of the key factors that play significant role in sustaining the socio – economic standards worldwide. The scarcity and pollution of ground water has become serious problem in the arid zones that should be addressed. The objective of the current study is to determine the key factors controlling the chemical elements of ground water and evaluate the suitability of ground water for human consumption in the rural and urban areas of Western part of Jifarah plain area. In this frame, a total of thirty – (30) ground water samples were collected during January 2023. The hydro – chemical elements such as pH, Electrical conductivity (EC), Total dissolved solids (TDS), Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), Chloride (Cl), Sulfate (SO4), and Bicarbonate (HOC3) were analyzed using standard procedures. The results showed that Ca in 90 % of the ground water wells, and Mg concentrations in 96.67 % of them are much higher than the guidelines set by World health organization and the Libyan National center for standardization and metrology. The results also showed that Cl levels in more than 60 %, K concentrations in 66.67 %, and SO4 concentrations in more than 53.33 % of the sampling sites were relatively higher than the recommended limits set by world health organization and Libyan National center for standardization and metrology. The current study revealed that the high values of the chemical characteristics are probably due to the seawater intrusion, chemical fertilizers application or due to the geological formations that comprised of rocks rich in the chemical elements. It's also revealed that these sampling sites are unsuitable for drinking purposes, whereas, the others are in agreement with the guidelines set by World health organization and the Libyan national center for standardization and metrology, and can be used for human consumption. We recommend that the installation of desalination plants is imperative to preserve and improve the ground water quality. We also recommend that the residents in the study area have to be educated environmental awareness on the health and water quality.
Keywords:Jifarah plain, ground water quality, pollution, Libya.*

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I. INTRODUCTION

Water is a valuable natural resource and essential factor for sustainability. Groundwater resource is one key factor that play important role in sustaining the socio-economic standards in any society. It supports various phases of development, including agriculture and industry. In arid and semi-arid regions, groundwater quality is considered a critical issue that is emphasized strongly in the governments' agendas. The shortage of precipitation, unsustainable human activities and environmental pollution, are few examples of the challenges faced in this region of the globe. The groundwater of the northwestern part of Libya is the major water supply for all daily applications. Specifically, the groundwater in the Jiffarah Plain Basin in this part of the Libyan geography, has been under heavily use over decades by the rapidly expanding development. This development has affected adversely the quality of the groundwater, in terms of chemical, physical and biological aspects.

Characterizing the properties of groundwater for specific application by its industrial or human consumption is considered vital for deciding the feasibility of the resource and its safeness for the public health and the environment. For human consumption, the chemical parameters of ground water should comply with the drinking water needs 1, 2, if these parameters exceeded the recommended values, the resource is considered unsafe. In many countries, different studies have been carried out to assess the suitability of ground water for human consumption.

For example, 3 assessed the suitability of ground water in the Marathon basin, NE Attica, Greece and found that the ground water resources are unsuitable for drinking purposes. The ground water are not suitable human consumption in the rural regions, Al – Hoceima, Province, and Northern Morocco 4. While, 5 studied the chemical characteristics of the ground water in the West of sidiAllalTazi, Gharb area, Morocco and concluded that the ground water of the study area has medium quality for drinking purposes. Most of ground water wells in the Western Nile Delta aquifer, Egypt were found unfit for the human consumption 6. 7 assessed the suitability of ground water quality for drinking purposes in the areas of Northwest of Morocco and found that a round 67% of the wells meet the requirements of the drinking water. 8 Studied some chemical properties of Bara basin aquifer, Kordofan State, Sudan, and concluded that the ground water wells are good for drinking purposes. 9 Found that the most of the ground water samples in sidiSlimane, Morocco, were poor are unfit for do not meet the requirements of the drinking water quality for the community. The results showed that the quality of ground water in Berrechid aquifer, Morocco, was polluted and unsuitable for domestic purposes 10. Whereas, 11 reported that the ground water wells in the area of LaayounePakhla, Southern Sahara, Morocco, were poor and cannot be used for drinking purposes. 12,evaluated the ground water quality in Mouqdadiya district, Diyala, Iraq, and found that most of the studied samples were above the Iraqi guidelines for drinking water. On the other hand, the quality of the ground water in Zamzam camp, North Darfur, Sudan, was found good for the domestic uses 13. 14 reported that the most of ground water wells in the western part of the River Nile, Elminia District, and Upper Egypt are unsuitable for human consumption due to anthropogenic sources. 15 assessed the ground water quality in Samrab, Dardog and Hattab Communities, Khartoum, North Sudan, and found that the water wells in Samrab and Dardog are suitable for drinking purposes, whereas, the wells in Hattab was poor and needs treatment.

16 studied the chemistry of ground water wells in the Southern of Tunisia, and reported that they are contaminated due to the agricultural activities. While, 17 carried out a study to investigate the ground water quality in Aswan, Egypt, and found that the water quality were good for different uses. The physical, chemical, and biological analysis of ground water in the Shaqlawa area, Erbil – KRI did not exceed the permissible limits recommended by the world health organization and the ground water wells are suitable for drinking purposes 18. Similarly, 19 assessed the ground water quality in the of Sohag, Egypt, and concluded that about 56 % of the collected samples were suitable for drinking purposes, whereas, the remains of the samples have poor quality due to the high salinity and total hardness. 20 studied the chemical characteristics of the ground water in the Southern suburb of the Omdurman City, Sudan, and reported that the significant variations between the samples in respect of the physical and chemical properties. They also, found that some parameters exceeded the recommended levels while, the others were

in agreement or below the permissible limits recommended by world health organization. The ground water quality in El – Rhawy and ManshiatRadwan, Giza, Egypt, was assessed, found that some wells are contaminated and unfit for drinking consumption 21. Correspondingly, 22 assessed the subsurface water quality in the North East of Cairo City, Egypt, and reported that a round 78.79 % of the studied wells are safe for human consumption. A study was carried out to assess the hydro chemical properties of different aquifers namely, Eocene carbonate, Nubian sandstone, and fractured basement. It was found that the ground water samples are unfit for domestic Purposes 23.

24 assessed the ground water quality in the Essaouira basin, Morocco and reported that the water quality in the study area is permissible, but not desirable for drinking purposes due to the high levels of chloride, which exceeded the world health organization and Moroccan guidelines. Similarly, 25 reported that the most ground water wells of quaternary aquifer at Qena, Egypt are not suitable for the human consumption. The hydro-geochemical properties of subsurface water in the Essaouira Synclinal basin in the Northwest Morocco were studied. The researchers concluded that only 3.3 % of the studied wells are fit for the drinking purposes 26. According to, 27 the ground waters in the South Africa, and Mozambique, were found bad quality and is not potable. They also recommended that the ground water should undergo suitable treatment to produce safe water. On the other hand, 28 reported that the ground water wells in Elfarshaya area, Southern Kordufan State, Sudan, were found safe and can be used for the drinking purposes. Likewise, 29 assessed the chemical parameters of the ground water in Assiut Province, Egypt, and reported that the ground water samples are poor water due to high concentrations of some chemical elements than the permissible limits recommended by the world health organization. 30assessed the underground quality in TwifoHemang Lower Denkyira District (THLDD) of the central region of Ghana. The researcher stated that the water wells are suitable for the human consumption and unlikely to pose a major health risk to the consumers.

Deterioration of water resources have negative effects on the human health and the biotic components of the ecosystem 31. In the developing countries, a round of 80 % of the diseases are due to the bad quality of the drinking water 32. Different sources of pollutants can affect the ground water aquifers worldwide. For example, 33 reported that the quality of ground water could be affected by the agricultural activities such as, Land use and fertilizer application. 34 stated that the most chemical elements in the ground water wells in the Central parts of Telangana crossed the limits recommended by world health organization. They also reported that the studied wells are unsuitable for drinking purposes. Whereas, 35 assessed the ground water quality in Northern Cyprus, and reported that the most studied samples are unsuitable for human consumption. The water samples, which were collected from the ground water wells in Alagilat area, were beyond the permissible limits recommended by the world health organization and the Libyan government, and unsuitable for drinking purposes 36.

However, in Libya, including the Northwestern region, the data similar to such studies are not made on a major scale in the country. Therefore, the current study aims to evaluate the ground water quality for drinking purposes at Jifarah plain area as a representative region to be a base line for subsequent studies and criteria for the health of the community.

II. MATERIALS AND METHODS

Jifarah plain area located between latitude 32° 30` and longitude 12° 30`, Northwest of Libya. It cover an area of 20000km2 and heavily populated along the coast. The area bounded on the north by the Mediterranean Sea coast; on the south by Nafusa, mountain .It also shares an international boundary with Tunisia to the west Fig 1. The area topographically is a low lying; its topography rises slowly from the sea level along the coast to 200 m at the foot of the escarpment of Nefusa Mountain. The maximum temperature is about 45°C and minimum 20°Cwith an average annual rainfall varies between 300 and 100mm. It has a dry climate with hot summer and cold winter. The Jifarah plain can be divided into geological formations, which comprised of rocks rich in minerals that may influence the chemistry of the ground water wells in the study area 37, 38.

The main aquifers, which play a major role in the ground water flow in the Jifarah plain are the Upper Miocene, Pliocene and Quaternary, the Middle and lower Miocene, and Triassic formation 39. Groundwater considered the main source of water supply in the area. The dominant soils are sandy, clay and salty soils. Economically, Jifarah plain is considered one of the most important plains in Libya, the described area is known as an urban and rural area that the society mostly depends on its land resource for the human consumption. A round 60% of the irrigated areas situated in this region. The agriculture considered one of the most important activities in the area where barley, wheat, peanuts, vegetables and fodder crops are grown.

No comprehensive studies have been done to assess the ground water quality for drinking purposes in the Jifarah plain area. The current study aims to evaluate the ground water quality for drinking purposes at Jifarah plain area as a representative region to be a base line for subsequent studies and criteria for the health of the community. The sites of the sample collection equally distributed between three locations of Jifarah plain area namely, in the Mountain of Nafusa, at the foot of Nafusa Mountain, and the Coastal plain area.

The Global-positioning system (Garmin`s GPS map 76CSx) was used to locate the ground water wells. Thirty ground water samples were collected in January 2023 from the Cities, and the Towns that are located on those sites. The samples collected from public wells, private wells, water sources in the health centers, and schools. First, the water left to run for few minutes from the wells to pump out the standing water before taking the final samples. The samples were collected in pre cleaned sterilized polyethylene plastic bottles of 1L capacity then the samples were placed in clean containers and immediately put in ice boxes. The boxes were transported to the national oil corporation, Libya, where the analyses were carried out in the laboratories of specific training center for oil industries, Alzawia. The samples were analyzed for some hydro- chemical parameters such as Calcium (Ca), Magnesium (Mg), Potassium (K), Sulfate (SO4), Chloride (Cl), Sodium (Na+), and Bicarbonate (HCO3) using standard techniques, Whereas the physical parameters like pH and Electrical conductivity (EC) were measured in situ using field kits. All chemical parameters were expressed in mg /l except pH and EC (µs /cm). The results were compared with the guidelines set by the world health organization and Libyan National center for standardization and metrology 1, 2.

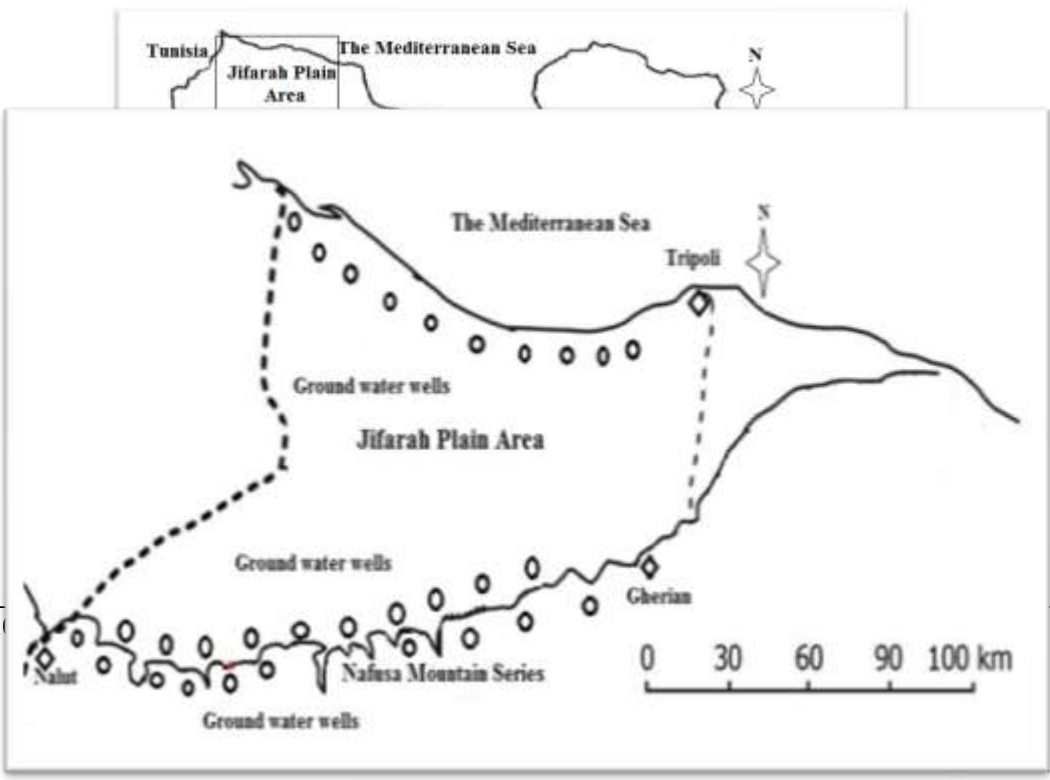

Fig 1:

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Map of Libya showing the sampling sites (Jifarah plain area)

III. RESULTS AND DISCUSSION

The summary statistics of the chemical parameters in the ground water of the study area are presented in Table 1. The figures from 2 to 11 demonstrate the results of the current study. As can be seen the Cations of Calcium and Magnesium are important of water hardness, and have significant effect on the chemical characteristics of ground water. The calcium levels in the ground water wells ranged between 180 mg / l and 1800 mg /l with an average of 803.67mg /l. The highest value was seen in the Abukammash Town, whereas, the lowest one was measured in the Towns of Arrayainah and Jado. The Magnesium concentrations varied from 20 mg /l to 8040 mg /l. The maximum value was detected in Wazzin Town, the minimum value measured in the Town of Omaljersan, and the average of the concentration was 1001.33 mg /l. The levels of Magnesium and Calcium in the ground water of the study area were very high, and the reason is probably geogenic as the geologic formations contained of rocks rich in limestone, dolomite and gypsum, which contain high a mounts of Magnesium and calcium [37, 38]. As can be seen from Table 1 and the graphs 2 and 3 more than 90 % of the sampling sites showed significant a mounts of Magnesium and Calcium in the ground water wells than the permissible limit recommended by world health organization and the Libyan Center for standardization & metrology 1,2.

The range of Sodium and potassium in the water wells in the study area varied from 4.10 to 111 mg /l and 2.6 to 31.4 mg /l respectively. The highest concentration of Sodium was noticed in the City of Shakshuk and the lowest one was in the City of Surman. Whereas, the lowest value of Potassium was seen in Shakshuk Town and the highest value was measured in the City of Nalut. It is clear from Tables 1 and the graphs 4 and 5 all-sampling sites have values of sodium in the ground water lower than the safe limit recommended by world health organization and the Libyan center for standardization and metrology. Regarding the Potassium level, around 66.67 % 0f, the studied wells were higher than the guidelines recommended by the world health organization, but according to the Libyan guidelines only 20 % of the sites showed high levels of Potassium. The presence of high values of Na and K are probably due to a natural source or due to domestic wastes. The pH values of the ground water wells ranged between 7.17 and 8.54 with a mean value of 7.78. The lowest and the highest values were noticed in Towns of Abukammash and Kiklah respectively. The pH values of all sampling sites were in the safe limit described by the world health organization and the Libyan center for standardization and metrology 1, 2.

The values of the electrical conductivity (EC) for the studied wells were in the range of 516 and 14630 µs /cm with an average of 3612.57µ s / cm. The maximum value was noticed in Algmail City, and the minimum one was seen in the City of Alzawia. Most of the sampling sites exceeded the guidelines set up by the world health organization and the Libyan center for standardization and metrology. The high values of EC indicate the presence of high concentrations of cations and anions, and the origin of the cations and anions probably due to the seawater intrusion or due to the geological formation that contain minerals rich in the chemical elements37,38.

The chloride concentration was found between 287.83 and 3989.40 mg /l with a mean value of 988.38 mg /l. The maximum value was seen in the City of Algmail and the minimum was noticed in the Town of Jado. As can be seen from Table 1 and graph 8 the levels of chloride are relatively high, compared to other cations and anions. The high levels of chloride probably due to the influence of the marine environment on the aquifer system, or due to the agricultural activities such as chemical fertilizers applications. Around 60 % of the collected samples were beyond the permissible limits of chloride recommended by the world health organization. On the other hand, all sampling sites have levels of it crossed the limit suggested by the Libyan center for standardization and metrology.

The Sulfate concentration in the studied wells ranged between 65.89 and 2356.44 mg /l with an average of 693.34 mg /l. The lowest and the highest of its concentration were measured in the Town of Jado and the City of Algmail respectively Fig 9. The high levels of Sulfate indicate that the marine sources have significant effect. Furthermore, the geologic formations that contain rocks rich in gypsum that might have influence on the sulfate levels in the ground water wells of the study area. In the current study, about 50 % and 30 % of the sampling sites have levels of sulfate higher than guidelines set up by the world health organization and the Libyan center for standardization and metrology respectively 1, 2.

The total dissolved solids (TDS) were remarkably high and ranged between 330.24 and 9363.2 mg/l with an average of 2312.04 mg /l. The minimum level was noticed in the City of Alzawia and the maximum one was seen in Algmail City Fig 10. In this study, some sampling sites showed high values of TDS, which indicate the occurrence of high a mounts of soluble salts that make water unfit for drinking purposes. Furthermore, the TDS concentrations in more than 50 % of the sampling sites crossed the permissible limits recommended by the world health organization and the Libyan center for standardization and metrology 1, 2. The origin of the TDS is probably due to the intrusion of the seawater with the ground water or due to the geological location of the aquifer. The content of bicarbonate varied from 76.87 to 183.17 mg/l, and the mean value was 125.93 mg / l Table 1, Fig11. The highest value was measured in Aljawsh Town and the lowest reading was observed in the Town of Jado.

The current results showed an agreement with the results obtained by 23,25,28,31. On the other hand, 16, 26 reported in their studies that the levels of the chemical characteristics in the ground water were lower than the chemical properties that obtained in the present study and the ground water was suitable for drinking purposes.

Table.1. Summary statistic of the chemical parameters in ground water of the study area

Parameter	Min	Mean	Max	SD	WHO	Libyan
Ca	180	803.67	1800	524.57	200	200
K	2.6	15.15	31.4	6.8	12	20
Na	4.1	77.43	111	31.35	200	200
Mg	20	1001.33	8040	1461.24	150	150
Cl	287.83	988.38	3989.4	909.47	600	250
SO4	65.89	693.34	2356.44	596.6	400	250
TDS	330.24	2312.04	9363.2	2258.05	1500	1200
HCO3	76.87	125.93	183.17	30.14	-	-
EC	516	3612.57	14630	3528.2	-	-
pH	7.17	7.78	8.54	0.36	6.5 - 8.5	6.5 - 8.5

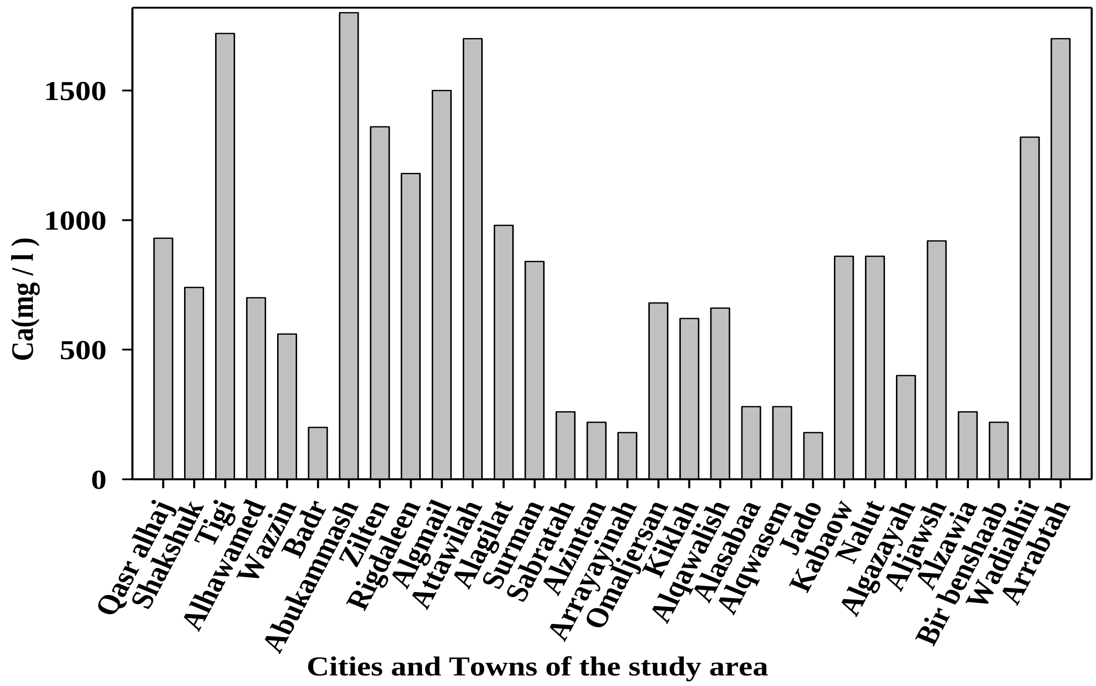


Fig 2: Calcium concentrations in the ground water in the sampling

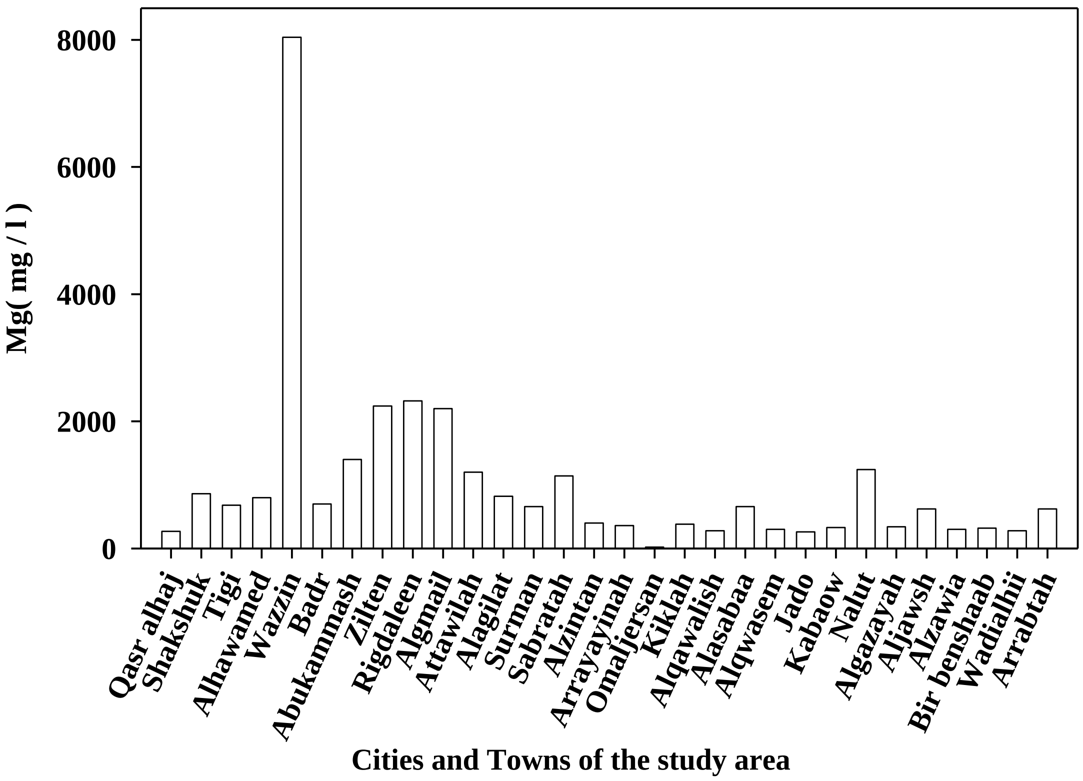


Fig 3: Magnesium concentrations in the ground water in the sampling sites

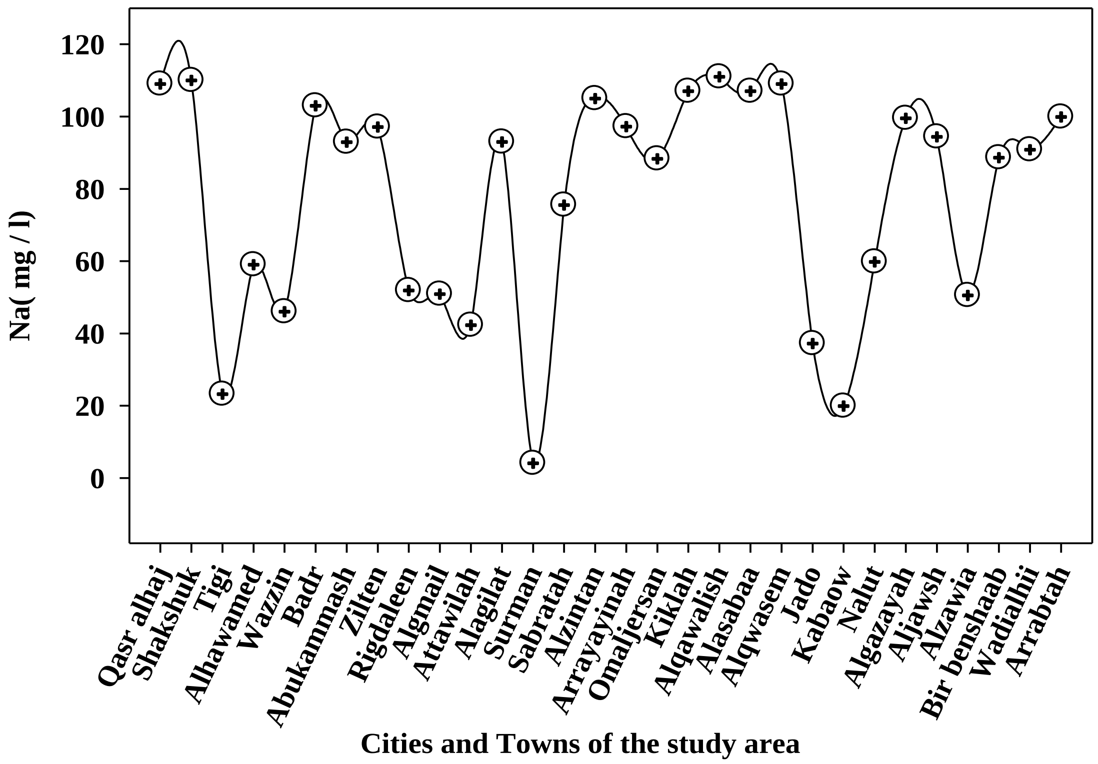


Fig 4: Sodium concentrations in the ground water in the sampling sites

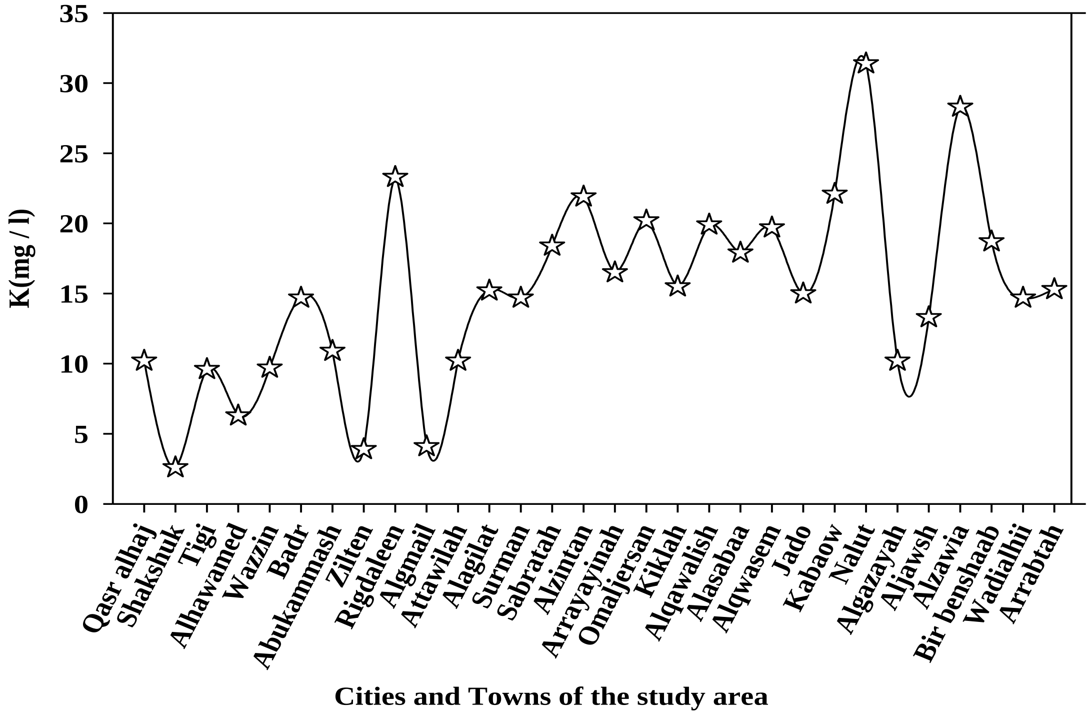


Fig 5: Potassium concentrations in the ground water in the sampling sites

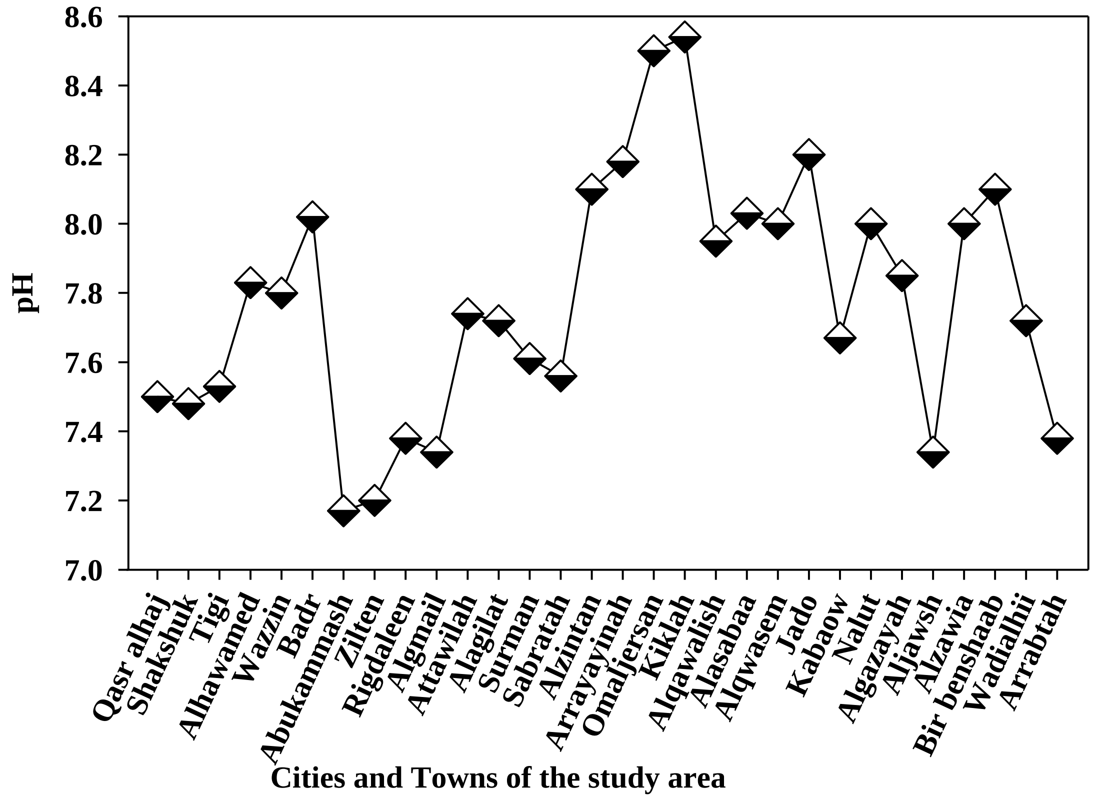


Fig 6: pH values in the ground water in the sampling sites

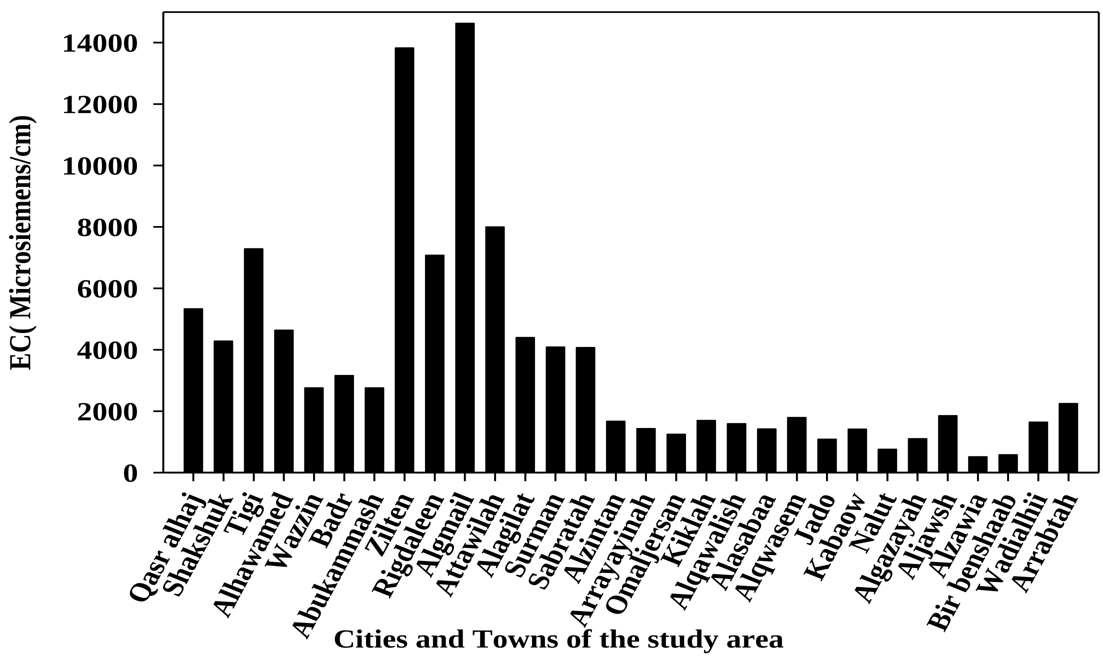
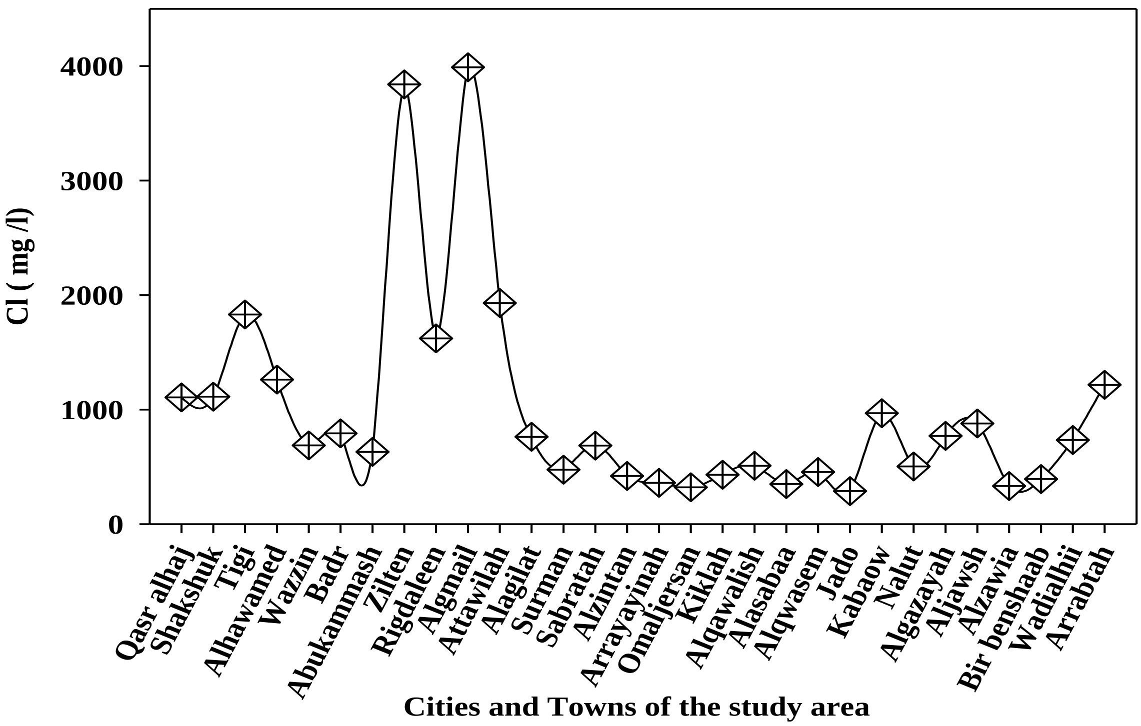


Fig 7: EC concentrations in the ground water in the sampling sites



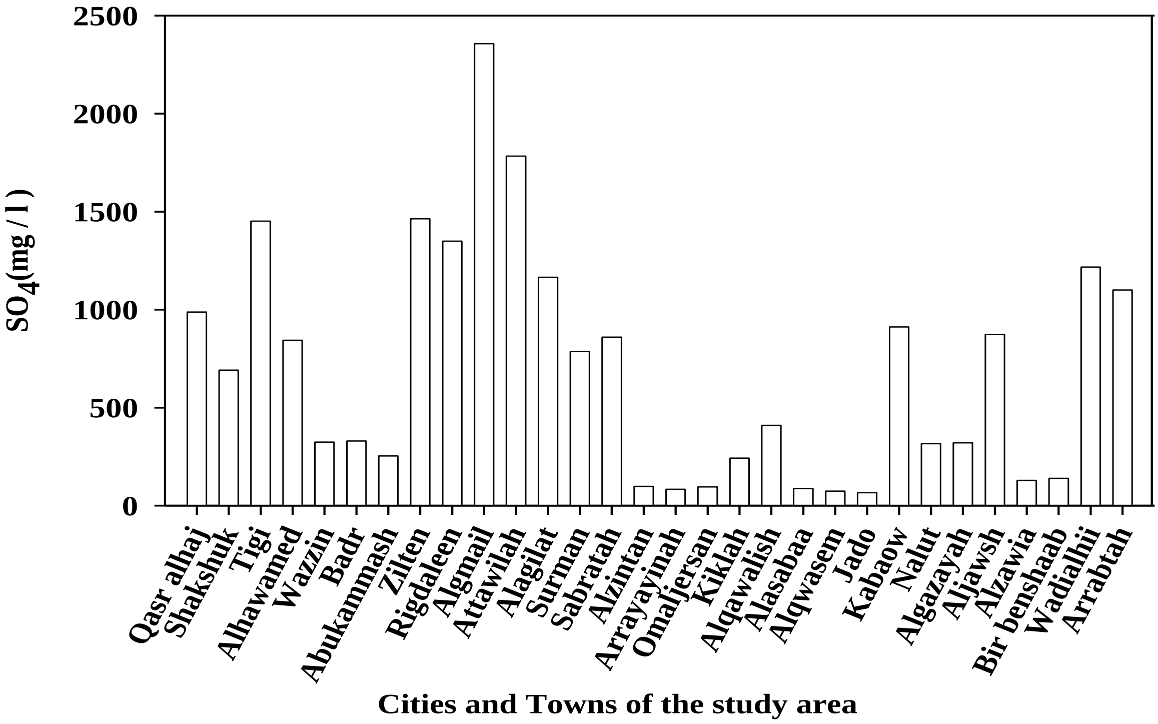
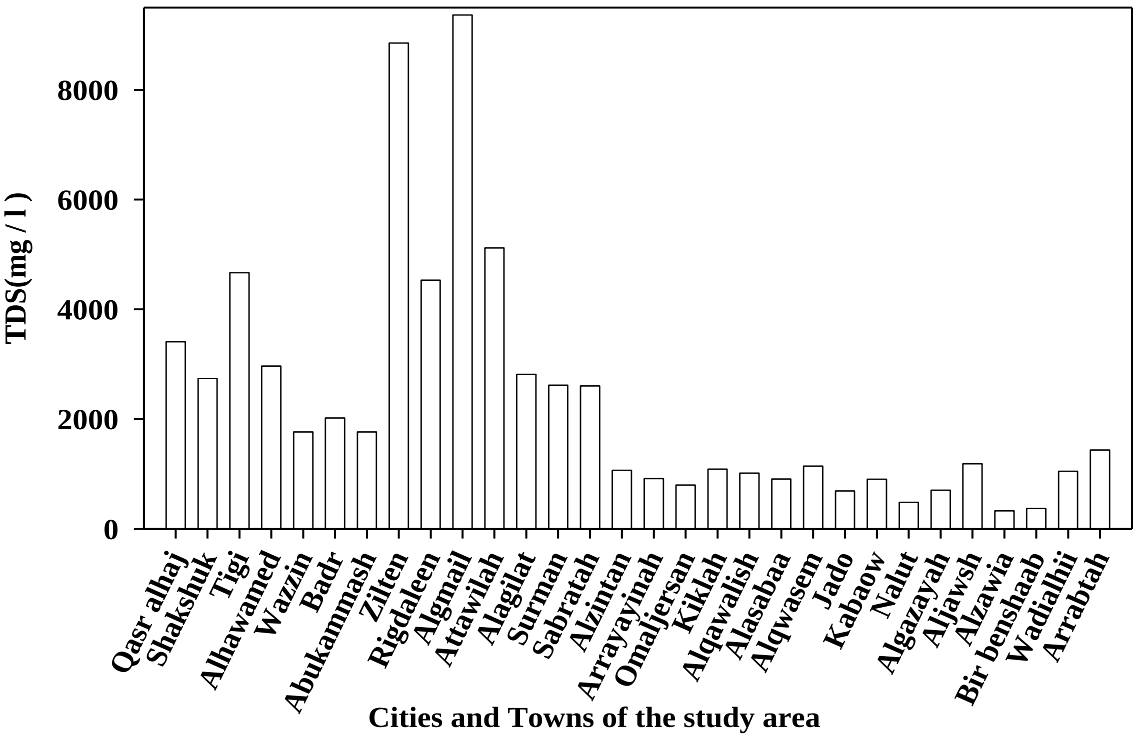


Fig 8: Chloride concentrations in the ground water in the sampling sites

Fig 9: Sulphate concentrations in the ground water in the sampling sites



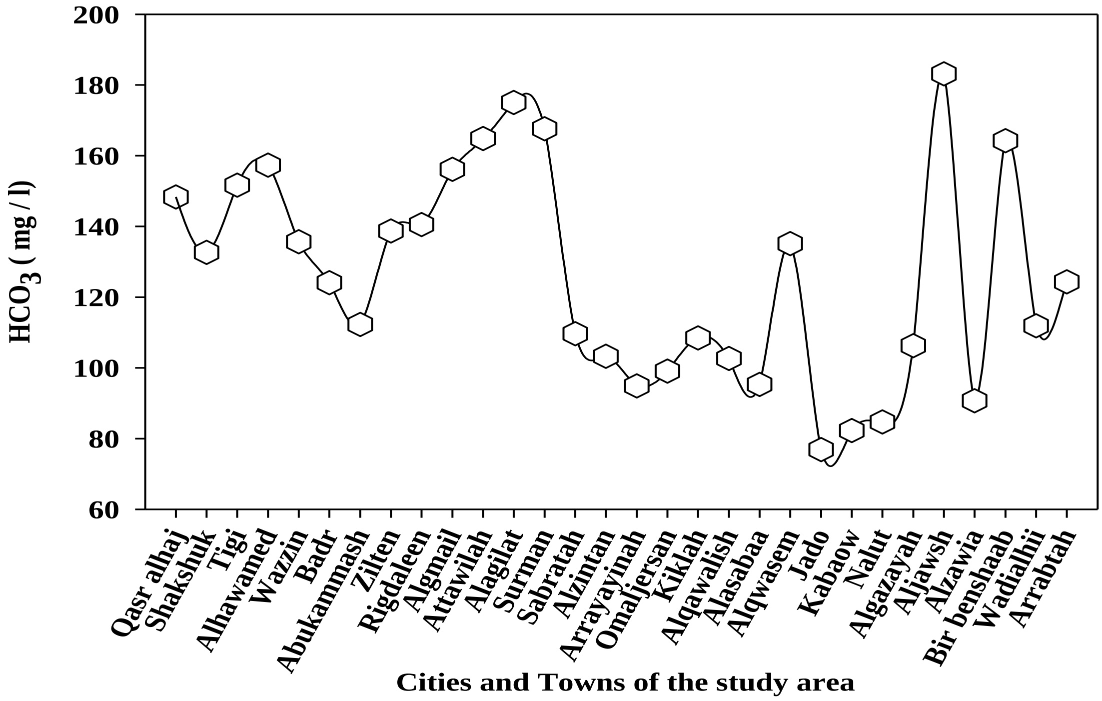


Fig 10: TDS concentrations in the ground water in the sampling sites

Fig 11: Bicarbonate concentrations in the ground water in the sampling sites

IV. CONCULSION AND RECOMMENDATIONS

On the bases of the present results, we can conclude that Ca in 90 % of the wells, and Mg concentrations in 96.67 % of them are much higher than the guidelines set by World health organization and the Libyan national center for standardization and metrology. The results also showed that Cl levels in more than 60 %, K concentrations in 66.67 %, and SO4 concentrations in more than 53.33 % of the studied wells were relatively higher than the recommended limits set by world health organization and Libyan National center for standardization and metrology. It is also can be concluded that the high values of the chemical characteristics are probably due to the seawater intrusion, agricultural activities such as, chemical fertilizers application or due to the geological formations that comprised of rocks rich in the chemical elements. The ground water wells that had high concentrations of the chemical parameters are unfit for drinking purposes, whereas, the other water wells that had low levels of the parameters are nearly, in agreement with the guidelines set by the world health organization and the Libyan national center for standardization and metrology, and can be used for human consumption. We recommend that desalination plants should be installed to preserve and improve the ground water quality. We also recommend that the media should be employed to educate the residents environmental awareness on the health and water quality, and a consistent analysis should be carried out to monitor the ground water quality in the study area.

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