دراسة الخواص الفيزيائية والكيميائية لمياه الابار الكبريتية الساخنة في شمال غرب ليبيا

د .شعبان جاب الله سعيد ـ كلية علوم الزاوية ـ جامعة الزاوية
د . أمال الجواشي عبداللة الخراريب ــ الأكاديمية الليبية جنزور

Shaban G. Elosta[1], Amal G. Abulkrreb[2]
[1]Department of Chemistry, faculty of Science, University of Zawia, Libya
[2]The Libyan Academy, Janzour - Libya

الملخص :

أجريت الدراسة على آبار المياه الساخنة الكبريتية الواقعة في شمال غرب ليبيا، مع التركيز على الآبار في تاجوراء، العجيلات، العسة وبدر. حيث تم جمع 32 عينة من الآبار المذكورة أعلاه خلال فترات موسمية مختلفة للتحليل الفيزيائي والكيميائي، وأهمها: مجموع الأملاح الذائبة(TDS) ، أيونات الكبريتات (SO_4^{-2}) وتركيز الأيونات المعدنية (الأيونات الموجبة) مثل Mg^{+2} ، Ca^{+2} ، K^{+} ، Na^{+} والأيونات السالبة مثل Cl^{-} ، CO_3^{-2} ، HCO_3^{-} وNO_3^{-} . تم تسجيل بعض البيانات مباشرة بعد جمع العينات مثل درجة الحرارة وقيمة الأس الهيدروجيني والأملاح الذائبة الكلية والتوصيل الكهربائي.

أظهرت النتائج النهائية تباينا كبيرا في النتائج المتحصل عليها مقارنة بالمواصفات ليبيا. رقم (82) لسنة 1992 ومواصفات منظمة الصحة العالمية (WHO)حيث كانت هناك درجة عالية ملحوظة في درجة الحرارة وكمية الايونات الذائبة في مياه الآبار.

بعد تحليل النتائج إحصائيا، يبدو أن مياه الآبار الكبريتية الساخنة قد تلعب دورًا هامًا في علاج العديد من الأمراض الجلدية والعضلية والتهاب المفاصل وتخفيف الآلام وتسكينها بالاستحمام وفقًا للتعليمات الصحية، وذلك لأن آبار المياه تحتوي على تركيزات عالية. من العناصر المعدنية المذابة.

علاوة على ذلك فقد لوحظ من خلال النتائج أن هناك زيادة في تركيز العناصر المعدنية المذابة مثل الصوديوم والبوتاسيوم والمغنيسيوم والكالسيوم والكبريتات

والكلوريد والبيكربونات مما يجعلها غير صالحة للشرب. ومع ذلك، كانت تركيزات النترات ضمن النطاق المسموح به. كما لوحظ أن تركيز الحديد في مياه بئر بدر كان مرتفعاً خلال فصل الصيف حيث كان حوالي 8.85 ملجم / لتر مما تسبب في تغير لون وطعم الماء، فضلاً عن ارتفاع مستوى الحديد بسبب تآكل مواسير المياه والتشكيل الجيولوجي لطبقات صخرية تتشكل حول عمق البئر.

Study of the physical and chemical properties of hot sulfur well water in northwestern Libya

Shaban G. Elosta[1], Amal G. Abulkrreb[2]
[1]Department of Chemistry, faculty of Science, University of Zawia, Libya
[2]The Libyan Academy, Janzour - Libya

Abstract

The study was carried out on hot sulfate water located in the northwest of Libya, focusing on boreholes in Tajura, Ajailat, Al-Assa, and Badr; Wherein 32 samples were collected from the aforementioned boreholes throughout different seasonal periods for physical and chemical analyses, and the most important of which are: the total of dissolved salts (TDS), sulfate ions (SO_4^{-2} and mineral ions' concentration (positive ions), such as Mg^{+2}, Ca^{+2}, K^+, Na^+, and negative ions such as, Cl^-, CO_3^{-2}, HCO_3^- and NO_3^-.
Some data has been recorded directly after collecting the samples like the temperature, pH level, the full amount of dissolved salts, and the electric conductivity.

The final results have shown a vast change in the results obtained in comparison with Libya's specifications n. (82) for the year 1992 and the specifications of the World Health Organization (WHO), wherein there was a noticeable high-grade in the temperature and the amount of dissolved ions in the well water.

After the results' analysis, discussion, and graphic illustration, water wells seem to have a significant role in curing many skin and muscle illnesses, arthritis, mitigating and killing pain by bathing according to health instructions, and that is because water wells contain high concentrations of dissolved mineral elements.

Moreover, it has been noticed through the results that there is an increase in dissolved mineral elements concentration like Sodium, Potassium, magnesium, calcium, sulphates, chloride, and bicarbonates, thus making them unsuitable for drinking; however, nitrate concentrations were within the permitted range. It also has been noticed that the concentration of iron in the Badr well water was high during the summer ranging around 8.85 mg/L, which caused a change in the color and taste of water, as well as an increase in the level of iron due to erosion of water pipes and the geological construction of rock layers that are formed around the depth of the well.

Key words: Sulfur hot water, Physical properties, Chemical properties.

Introduction

The quality of water varies in its natural and chemical characteristics from one region to another, according to the natural and geological characteristics of the area in which it seeps. These properties can be identified by studying the geological origin of the components of rocks and soil originally composed of rocks, which are sometimes known as incoherent rocks (Al-Jadidi, 1986).

Groundwater is found in the earth's layers at different depths between rocks or soil. There is the surface layer, which is the least deep and closest to the surface. Its depth ranges from (20-25 m), and its thickness does not exceed three meters in the western part and in the eastern part of Libya. More than (50 m), and water is found in the semi-artesian layer at a depth of 25 m from the first layer, and its thickness is about (20 m) and separated by a layer of limestone and clay rocks, and the water of this layer is abundant and more fresh than the water of the first layer. This is because it is far from pollution by sea water, and the artesian layer is found at depths ranging from (250-450 m). and despite its abundance of water, it is of lower quality than the previous one, and this made it not suitable for drinking or direct irrigation due to its high temperature and salinity, and it contains some minerals such as sulfur (Sharaf, 1971).

There are underground water springs, some of which are used for drinking and others are used for bathing only. Mineral water springs with curative properties are spread in many countries of Europe, such as Kar Lovi

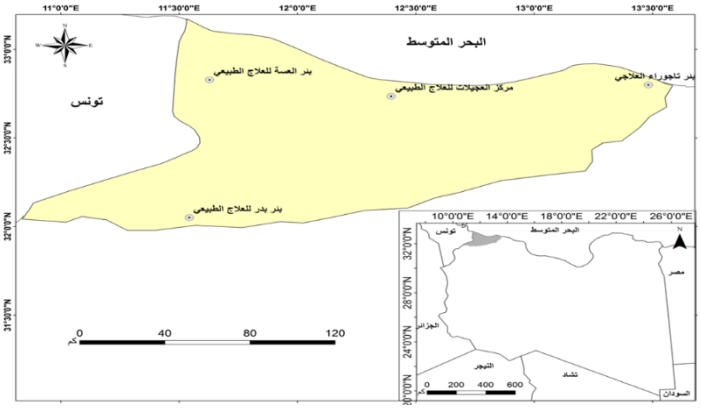
Fadi in the Czech Republic, Hungary, France and Germany, as well as in Egypt in the Helwan region, where they are used for drinking and there is a type that is used for bathing, there are springs for treatment, such as the bath of our master Moses in southern Sinai (Hamida, 1991).

The source of heat for water is the hot igneous rocks, as they heat the water and the water comes out loaded with different materials, the most important of which is calcium carbonate, and during its arrival to the surface of the earth, gases come out of it, forming holes and pores in it (Sawalha, 2005).

It has been found through mineral exploration and drilling of oil wells that the temperature increases with depth at a rate of two degrees Celsius for every hundred meters. It expands the water and thus reaches the surface under less pressure and turns into water vapor, after which the cold groundwater seeps into the ground again to start the cycle again, and the hot water has a great ability to dissolve from cold water, and therefore it carries many dissolved substances such as silica and precipitate Around the well, travertine is a type of calcite that is characterized by hot water springs in limestone areas. As for spring water containing sulfur, it tastes unpleasant to drink and emits the smell of rotten eggs, which is the smell of sulfur gas (Sulaiman et al., 1984).

The geological structure of this region is a result of the earth's movements that occur in the ground from earthquakes and volcanoes, through which springs and hot fountains were formed. The oldest geological formations in the Jafara Plain go back to the Triassic and Jurassic periods. The foot of the mountain is composed of dolomitic limestone sandstones that may be pure clay or mixed with it (Sharata, 2018). The second consists of sandstone and limestone rocks, and there are animal nodes that appear on the sides of the deep valleys sloping from the slopes of the western mountain towards the plain (Ajina, 2002).

The sulfur waters are found in the northwest of Libya in the areas of Tajoura, Al-Ajeilat, Al-Assa and Badr as shown in map (1).



Map (1) the location of the study area

These areas contain wells of high-temperature sulfur water and an increase in its content of dissolved salts. These areas are rich in hot sulfur water suitable for bathing to relieve pain and treat many skin, muscular and nervous diseases, especially rheumatism (Ansir, 2014). However, this sulfur water has not been subjected to studies, scientific research and periodic checks for its chemical and physical properties to ensure the safety of its water from pollutants that affect public health (Al-Himyari.2006)

This study aims to identify the physical and chemical properties of sulfur water wells in the areas of Tajoura, Al-Ajeilat, Al-Assa and Badr. It is suitable for treating and relieving the pain of articular cartilage diseases (osteoarthritis, rheumatic, fibro and muscle, paralysis of all kinds, nervous inflammation, muscle relaxation), respiratory diseases (sinusitis, asthma), skin diseases (scabies, psoriasis and chronic eczema), by taking a shower. in it (Assaf, 2007).

Method, chemicals and Instruments

Chemicals:

Sulfuric Acid H_2SO_4, Methyl orange, Ph.Ph, Sulfur Nitrate $AgNO_3$, Potassium Chromate K_2CrO_4, EDTA, Sodium Cyanide NaCN, Tri Ethanolamine, Buffer Solution (NH4CL, NH_4OH), Eriochrome black T, Murexide, Sodium Hydroxide NaOH.

Instruments:

Portable multifunctional instrument (HQ40d, DR/3900 spectrophotometer), flame photometer BWB XP.

Sample collection:

The study was conducted between February and November of the year (2019-2020). (32) samples of sulfur water were collected from the wells of Tajoura, Al-Ajeelat, Al-Assa and Badr, with depths and distances ranging from 1549 - 904 m), following the scientific method of collecting samples to study the physical and chemical properties

Results and discussion:

1- pH

The pH was measured using a portable multifunctional device type (HQ40d) directly at the site (the place where the sample was taken). The results shown in Table (1) and Figure (1) indicate that the pH values during the seasons of the sulfur water wells for the wells (Tajoura, Al-Ajeelat and Al-Assa) and Badr) were (6.7, 7.8, 7.0, and 7.6) respectively, as it showed a discrepancy in the values of (pH) according to regions, where it was high in Well Al-Ajeilat and its annual average was (7.8), and the highest rate was recorded during the autumn season (8.0), The lowest rate was recorded in the Tajoura region, where it reached (6.7), and the highest rate during the summer was (6.9).

It is noted that the results of the pH of the waters of the region were in the permissible rate according to the Libyan standard specifications No. / 82 for drinking water and international ones, in which the values range between (6.5 - 8.5), and by comparing these results with the results of the Syrian Atomic Energy Authority for the chemical and radiological analyzes of some mineral and sulfur springs. In it, it was found that the results were somewhat similar, as the pH value of the Zenobia quarries well was about 6.8, the Ras Ain sulfur spring was 7.3, and the Drakeish spring was 7.8.

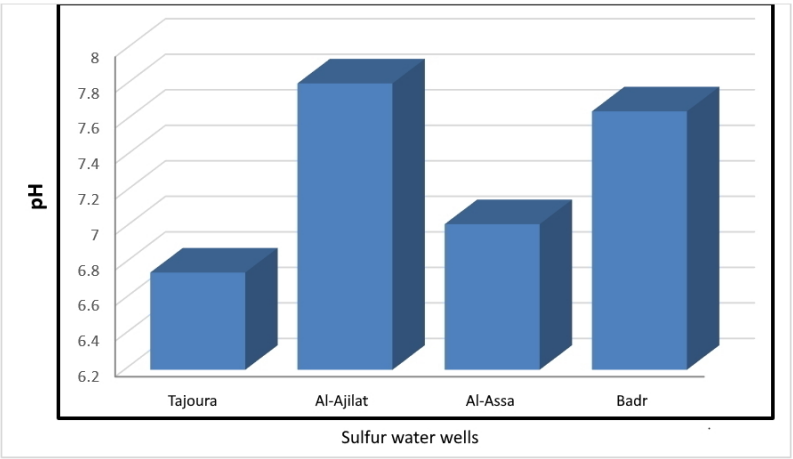


Figure (1) shows the pH values for the wells

Table (1) shows the results of physical analyzes and total dissolved salts of water samples from sulfur wells in northwestern Libya.

physical properties	Location	Seasonal classes				
		Summer	Autumn	Winter	Spring	Annual rate
pH	Tajura	6.9	6.7	6.7	6.7	6.75
	Ajailat	7.6	8.0	7.8	7.8	7.81
	Al-Assa	7.3	6.9	6.9	6.9	7.02
	Badr	7.5	7.4	7.8	7.9	7.65
overall average (annual)						7.30
Electrical conductivity (EC) µS/cm	Tajura	5281	5480	5280	5280	5330
	Ajailat	6340	5230	4600	8600	6193
	Al-Assa	8207	8620	8400	8400	8407
	Badr	6942	5480	3198	4910	5133
overall average (annual)						6266
Total dissolved solids (TDS) Mg/l	Tajura	3380	3562	3430	3430	3451
	Ajailat	4438	3399	3830	5830	4374
	Al-Assa	5253	5603	5460	5460	5444
	Badr	4443	3562	3490	5460	4239
overall average (annual)						4377

2- Electrical conductivity (EC)

The results presented in Table (1) and Figure (2) showed that the electrical conductivity rates (EC) in the sulfur water wells in the regions of (Tajoura, Al-Ajeelat, Al-Assa and Badr) during the seasons ranged between 5133 - 8407µS/cm, as there was a discrepancy whereby an increase appeared In the well of al-Assa, which reached the annual rate of 8407 µS/cm, the highest rate was recorded during the autumn season, 8620 µS/cm, and the lowest annual rate was recorded in the well of Badr, which reached 5133 µS/cm, and the highest value recorded during the summer was 6942 µS/cm.

It is noted that the rates of electrical conductivity (EC) in sulfur water in the wells studied were varied during the year and higher than the internationally permissible limits, which amount to about 1000 µS/cm. The high degree of water conduction to electricity depends on the amount of dissolved salts in the water. By comparing these results with the results of the Syrian Atomic Energy Authority for the chemical and radiological analyzes of some mineral and sulfur springs in them, we noticed that the electrical conductivity values were in the Zenobia quarries well: 1795 µS/cm, the Palmyra sulfur spring 936 µS/cm, and Drakeish 237 µS/cm, which is much less than the electrical conduction results obtained.

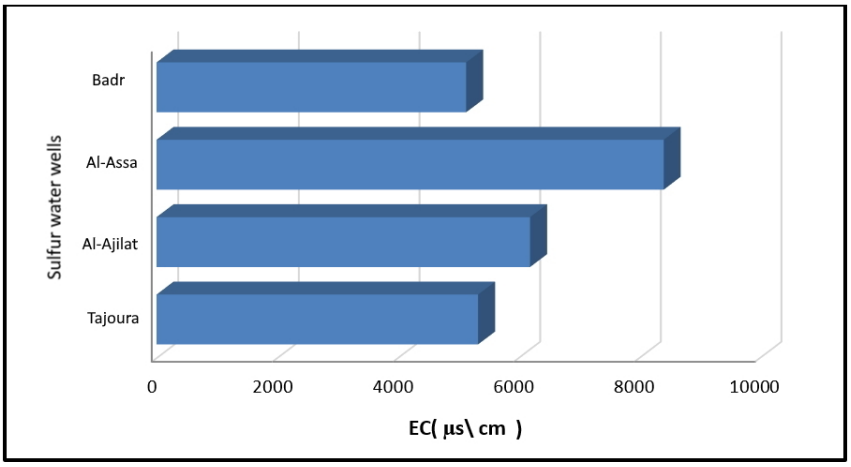


Figure (2) shows the electrical conductivity values (EC (µs/cm) for the wells

3- Total dissolved salts (TDS)

Through the results in Table No. (1) and Figure (3), it was found that the rates of total dissolved salts (TDS) during the seasons of the year in the sulfur water wells (Tajoura, Al-Ajeelat, Al-Asa and Badr) ranged between (3451 and 5444) mg / liter, as the discrepancy appeared in Concentration rates of total dissolved salts (TDS) between wells, which showed an increase in the Al-Asa well, which reached an annual rate of (5444 mg /l) and the highest rate recorded during the autumn season, at a rate of (5603 mg /l), and the lowest annual rate recorded in the Tajoura region, where It reached (3451 mg/l), and the highest rate was recorded during the fall season, and it reached (3562 mg/l).

It is noted that the percentage of total dissolved salts was relatively high, and more than the permissible limit for drinking water according to the Libyan standards, as well as the international ones, which is less than (1000 mg /l). Therefore, it is water that is not suitable for drinking and is used for bathing only. The salts treat many diseases. Diseases such as joint pain, rheumatism, allergies and dermatitis, and by comparing the previous results with the results of the Syrian Atomic Energy Authority of chemical and radiological analyzes of some mineral and sulfur springs in them, we noticed that the value of the total dissolved salts was in the Zenobia quarries well, Palmyra sulfur spring (906 mg /l), and Drakeish spring (221 mg/l), which is much lower than the obtained results.

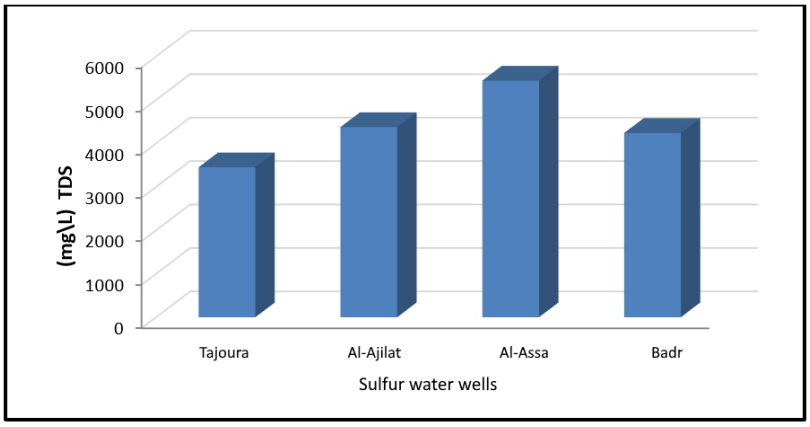


Figure (3) shows the values of total dissolved salts (TDS) in sulfur well water (mg/l).

4- Calcium ion

Through the previous results in Table No. (2) and Figure (4), it was found that the calcium ion concentration rates (Ca^{+2}) during the seasons of the year in sulfur water wells (Tajoura, Al-Ajeelat, Al-Asa and Badr) were (277, 434, 426, 221 mg /l), as there was a difference in the concentration rates of calcium ion according to the wells, and it showed an increase in the well of Al-Ajeilat, where the annual rate reached (434 mg / l), and the highest ion rate was recorded during the winter and spring seasons, at a concentration rate of (624 mg /l), and the lowest annual rate of ion was recorded in the well of Badr, where it reached (221 mg /l), and the highest concentration of ion was recorded during the spring, when the concentration of the element was (320 mg / l).

It was noted that the calcium ion concentration rates in the sulfur waters of the wells were uneven and higher than the internationally permissible limit for drinking water, which is in the range of (200 mg /l).

From the results, it was found that sulfur wells are rich in calcium due to the geological structure of the layers of the earth that make up these wells. Calcium plays a role in treating cases of osteoporosis and muscle spasms, prevents tooth decay, regulates heartbeat and reduces high blood pressure, and by comparing these results with the results of the Syrian Atomic Energy Authority For the chemical and radiological analyzes of some mineral and sulfur springs in them, we noticed that the calcium ion concentration values in the Zenobia quarries well were 68 mg/l, Palmyra sulfur spring 196 mg/l, and Drakeish spring 33 mg/l, which is much lower than the results obtained.

Table (2) Results of positive ions for sulfur water wells in northwestern Libya

Positive ions	Locations	Seasonal classes				
		Summer	Autumn	Winter	Spring	Annual rate
Ca^{+2} mg/l	Tajoura	150	351	304	304	277
	Al-Ajeilat	197	291	624	624	434
	Al-Assa	247	179	624	655	426
	Badr	200	179	184	320	221

overall average (annual)						339.6
Mg^{+2} mg/l	Tajoura	36	181	70	70	89
	Al-Ajeilat	98	155	185	185	156
	Al-Assa	98	112	185	180	144
	Badr	49	181	39	55	81
overall average (annual)						117.4
Na^{+} mg/l	Tajoura	944	530	625	625	681
	Al-Ajeilat	1158	510	960	960	897
	Al-Assa	1356	840	960	900	1014
	Badr	1257	530	960	1100	962
overall average (annual)						888.5
K^{+} mg/l	Tajoura	59	50	56	56	55
	Al-Ajeilat	53	49	41	41	46
	Al-Asa	61	54	41	53	52
	Badr	68	50	46	56	55
overall average (annual)						52

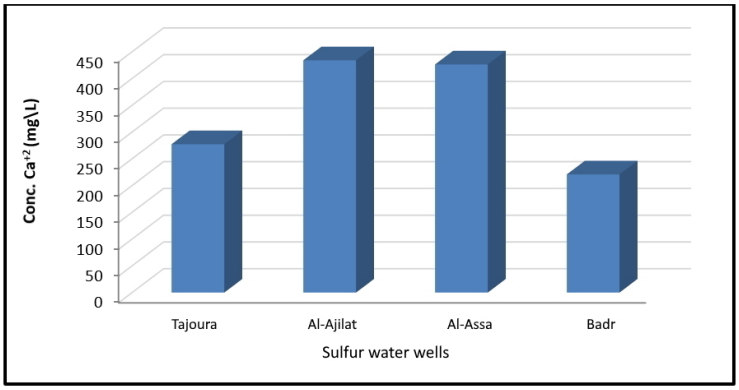


Figure (4) Calcium ion concentration (Ca^{+2}) in sulfur well water (mg/l)

5- Magnesium Ion

The results presented in Table (2) and Figure (5) indicate that the concentration rates of magnesium ion (Mg^{+2}) during the seasons of the sulfur

water wells (Tajoura, Al-Ajeelat, Al-Assa and Badr) range from (81 to 156 mg /l), and a variation appeared in the Magnesium ion concentration rates for the wells, where the high magnesium ion appeared in Al-Ajeelat well, as the annual rate was (156) mg /l), and the highest rate of ion was recorded during the winter and spring seasons, at a concentration rate of (185 mg /l), and the lowest rate recorded In Badr Well, where it reached (81 mg /l), and the highest concentration of ion during the fall season was (181 mg /l), and thus it is higher than the internationally permissible limit for drinking water, which is within (50 mg /l) and by comparing these results with the results of The Syrian Atomic Energy Authority for chemical and radiological analyzes of some mineral and sulfur springs in them.

The magnesium ion concentration values were in the Zenobia quarries well (59 mg /l), Palmyra sulfur spring (80 mg /l), and Drakeish spring about (12 mg /l), It is much less than the results obtained.

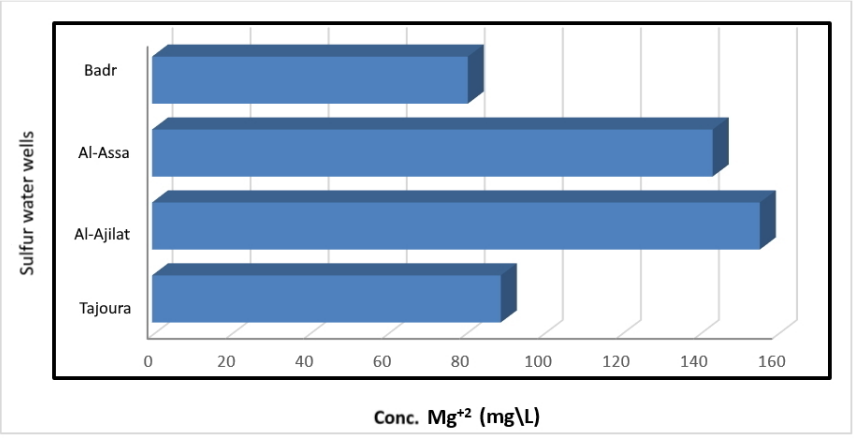


Figure (5) The concentration of magnesium ion (Mg^{+2})) in sulfur well water (mg/l)

It is noted that well water is rich in magnesium due to the geological structure of the layers of the earth and the rocks that make up the wells. The element is used in the treatment of asthma, enhancing the role of insulin, skin treatments, fixing minerals in the bones, strengthening the immune system, adjusting blood pressure, employing sugars in the blood, and helping to heal from atherosclerosis and heart attacks.

6- Sodium Ion Na^+

It is clear from the results presented in Table No. (2) and Figure No. (6) that the concentration rates of sodium ion (Na^+) during the seasons in the wells (Tajoura, Al-Ajeelat, Al-Assa and Badr) range from (681 to 1014 mg/l), where there is a discrepancy in Sodium ion concentration rates in Al-Assa well, where the annual rate was (1014 mg /l), the highest rate recorded during the summer, where it reached (1356 mg /l), and the lowest annual rate of ion was recorded in the well of Tajoura, where it reached (681 mg /l), and the highest concentration of ion was recorded during the summer at a rate of (944 mg /l).

By comparing these results with the results of the Syrian Atomic Energy Authority for the chemical and radiological analyzes of some mineral and sulfur springs in them, we noticed that the rate of sodium ion concentration was in the Zenobia quarries well (140 mg /l), the Palmyra sulfur spring (300 mg /l), and Drakeish spring (9.8 mg/l), which is much lower than the results of to get it.

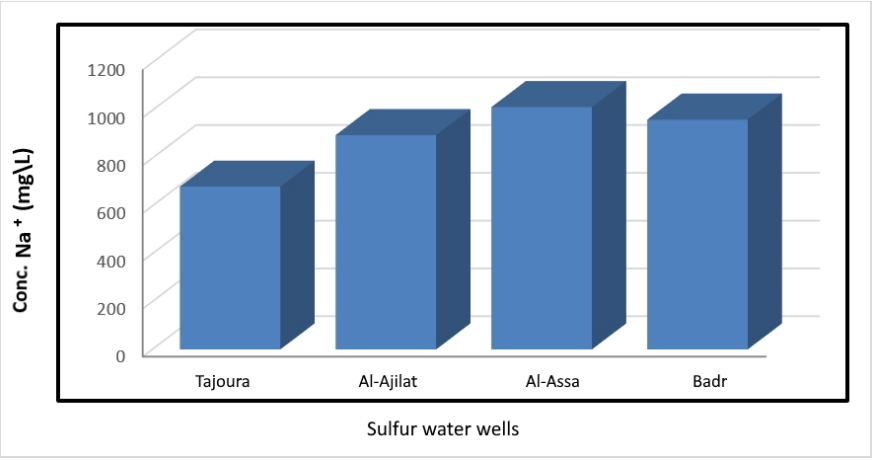


Figure (6) shows the concentration of sodium ion (Na^+) in sulfur well water (mg/l).

7- Potassium Ion K^+

It is evident from Table No. (2) and Figure No. (7) that the potassium ion concentration rates (K^+) during the seasons in the wells (Tajoura, Al-Ajeelat, Al-Assa and Badr) ranged from (46 to 55 mg /l), and it showed a variation in the concentration rates Potassium ion Tajoura, where the annual

rate was (55 mg /l) and the highest rate was recorded during the summer with a concentration rate of (59 mg /l), and the lowest annual rate was recorded in Al-Ajeilat Well, where it reached (46mg /l) and the highest concentration The ion was recorded during the summer and amounted to (53 mg /l), and by comparing these results with the results of the Syrian Atomic Energy Authority for the chemical and radiological analyzes of some mineral and sulfur springs in them, we noticed that the potassium ion concentration values were in the Zenobia quarries well and Palmyra sulfur spring (15 mg/l), and Drakesh spring (1.0mg /l), which is much lower than the results obtained.

Table (3) Results of negative ions for sulfur water wells in northwestern Libya

Negative ions	Locations	Seasonal classes				
		Summer	Autumn	Winter	Spring	Annual rate
HCO_3^-	Tajoura	156	526	287	287	314
	Al-Ajeilat	159	282	556	256	313
	Al-Asa	170	248	256	153	207
	Badr	167	526	281	245	305
overall average (annual)						285
SO_4^{-2}	Tajoura	1192	1220	640	640	923
	Al-Ajeilat	1874	1900	2040	1963	1944
	Al-Asa	2321	2523	2040	1650	2133
	Badr	1461	1522	92	85	790
overall average (annual)						1448
Cl^-	Tajoura	841	910	1098	1098	987
	Al-Ajeilat	908	996	1516	1516	1234
	Al-Asa	999	1649	1516	1748	1478
	Badr	1236	1715	1785	1010	1436
overall average (annual)						1284
No^{-3}	Tajoura	1.8	0.0	0.0	0.0	0.45

	Al-Ajeilat	1.7	1.6	0.0	0.0	0.83
	Al-Asa	1.9	1.0	0.0	0.0	0.73
	Badr	4.4	0.0	0.0	0.0	1.1
overall average (annual)						0.777

8- Bicarbonate HCO^{-3}

The results presented in Table No. (3) and Figure (8) indicated that the concentration rates of the bicarbonate ion (HCO^{-3}) during the seasons in the wells (Tajoura, Al-Ajailat, Al-Assa and Badr) ranged from (207 to 314 mg /l), and it showed a variation in the concentration rates of Bicarbonate at Tajoura well, where the annual rate was (314 mg /l), the highest ion rate was recorded during the autumn season (526 mg /l), and the lowest annual ion rate was recorded in the well of Al-Assa where it reached (207 mg /l) and the highest concentration of ion It was recorded during the winter season that it reached (256 mg /l), which is higher than the internationally permissible limit for drinking water, which is located within (200 mg /l). In the stomach and intestines.

The results were compared with the results of the Syrian Atomic Energy Authority for the chemical and radiological analyzes of some mineral and sulfur springs in them, we noticed that the bicarbonate ion concentration values were in the Zenobia quarries well (439 mg /l), Palmyra sulfur spring (220 mg /l), and Drakeish spring (140 mg /l), which is much lower than the results obtained.

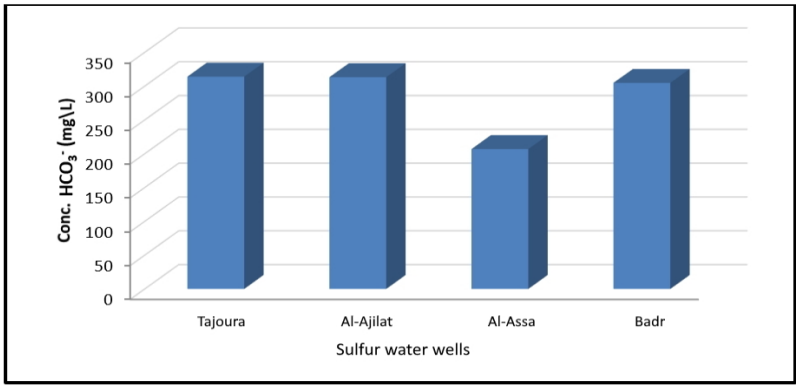


Figure (8) shows the bicarbonate ion concentration (HCO^{-3}) in hot sulfur well water (mg/l)

9- Sulfate (SO_4^{-2})

Through the results of Table No. (3) and Figure (9), it is clear that the concentration rates of sulfate ion (SO_4^{-2}) during the seasons in the wells (Tajoura, Al-Ajeelat, Al-Assa and Badr) range from (790 to 2133 mg /l), and it showed a variation in the rates of The concentration of (SO_4^{-2}) as it rises in the Al-Assa well, as the rate reached (2133 mg /l) and the highest rate is in the autumn season (2523 mg /l), and the lowest rate is in the Badr well (790 mg /l) and the highest concentration of ion occurs during the summer season. Autumn, which is (1522 mg /l), and by comparing these results with the results of the Syrian Atomic Energy Authority of chemical and radiological analyzes of some mineral and sulfur springs in them, we noticed that the values of sulfate ion concentration were in Zenobia quarries well (342 mg /l), and Palmyra sulfur spring (38.5 mg/l), and Drakesh spring (1.8 mg/l), which are much lower than the obtained results.

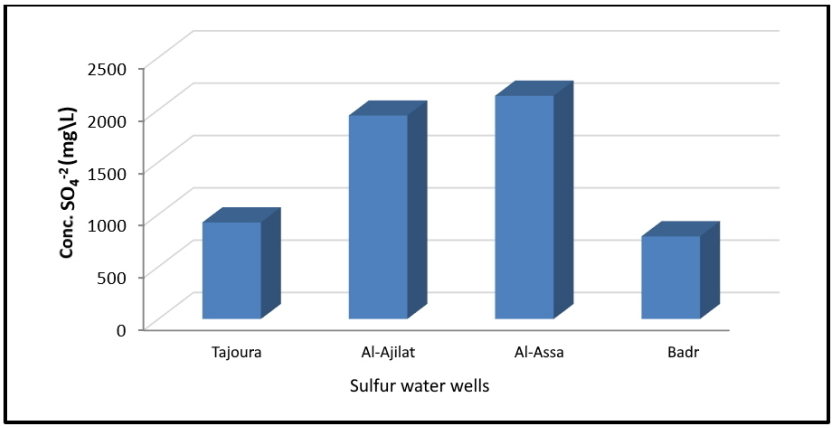


Figure (9) shows the concentration of sulfate ion (SO_4^{-2}) in hot sulfur well water (mg/l)

10- Chloride (Cl^-)

It appears from the results of Table No. (3) and Figure (10) that the concentration rates of chloride ion (Cl^-) during the seasons of the year in sulfur water wells (Tajoura, Al-Ajeelat, Al-Asa and Badr) range from (987 to 1478 mg /l), and the rise appears in the area Alasah averaged (1478 mg/l), and the highest rate was recorded during the spring with a concentration rate of (1748 mg/l), and the lowest rate was recorded in Tajoura well (987 mg/l),

and the highest concentration of ion was during the winter and spring seasons, where the concentration of the element reached (1098 mg /l), which is higher than the internationally and globally permissible limit for drinking water specified (250 mg /l), and it is noted that wells water is rich in chloride, due to the increase in depth, and chloride is important in regulating the amount of fluid in the body and adjusting the acid and base balance in it. By comparing these results with the results of the Syrian Atomic Energy Authority for the chemical and radiological analyzes of some mineral and sulfur springs in them, we noticed that the chloride ion concentration values were in the Zenobia quarries well (193 mg/l), Palmyra sulfur spring (510 mg/l), and Drakeish spring (15 mg/l), which is much lower than the results obtained.

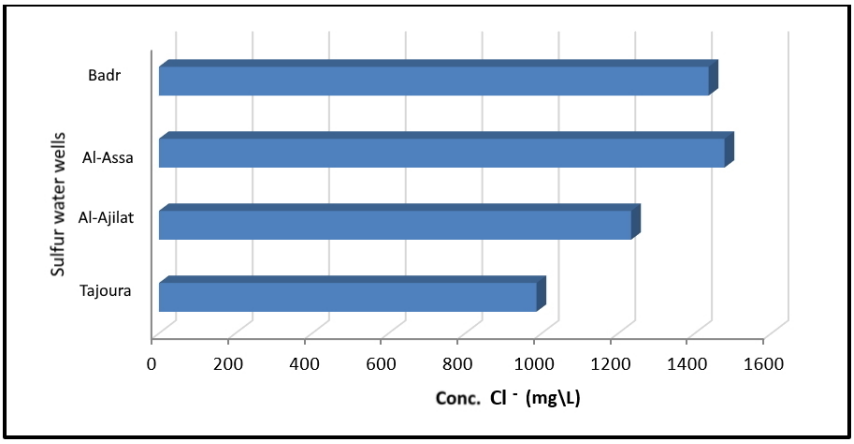


Figure (10) shows the concentration of chloride ion ((Cl$^-$) in sulfur well water (mg/l)

11- Nitrate (NO_3^-)

It appears from the results presented in Table No. (3) and Figure No. (11) that the concentration rates of nitrate (NO_3^-) during the seasons in the sulfur water wells (Tajoura, Al-Ajeelat, Al-Asa and Badr) range from (0.45 to 1.1 mg /l), and that there are Variation in the rates of nitrate concentration in the wells, where the rate appears high in Badr area (1.1 mg /l), and the highest rate of the element was recorded during the summer (4.4 mg /l), and the lowest rate was in the Tajoura area (0.45 mg /l), and the highest concentration of the element was recorded In the summer (1.81 mg /l), which is less than the international and international permissible rate for drinking

water, which is (45 mg /l). The presence of nitrates in large quantities in the water is considered unhealthy, especially for infants.

By comparing these results with the results of the Syrian Atomic Energy Authority of chemical and radiological analyzes of some mineral and sulfur springs in them, we noticed that the nitrate ion concentration values were in the Zenobia quarries well of (7 mg /l), and the Palmyra spring Sulfur (0.6 mg/l), and Drakeish spring (8 mg/l), thus being higher than the obtained results.

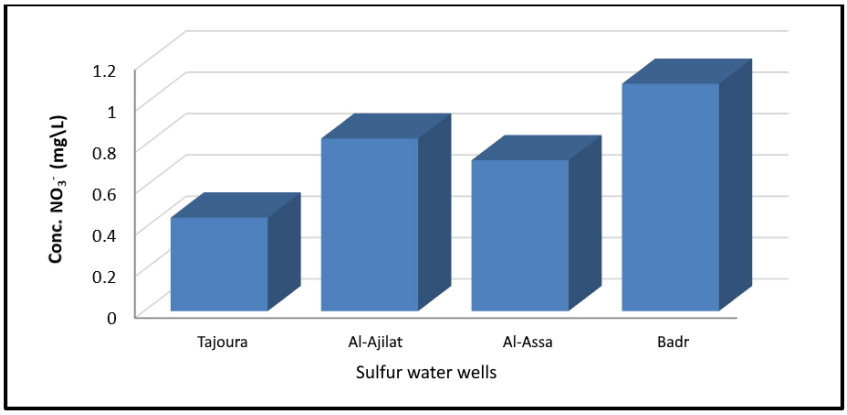


Figure (11) shows the concentration of nitrate ion (NO_3^-) in hot sulfur well water (mg/l)

Conclusion

During the study of the results of physical and chemical analyzes conducted on hot sulfur well water in northwestern Libya (Tajoura, Al-Ajeilat, Badr, and Al-Assa), it was clear that there was an increase in the concentrations of dissolved ions represented by (positive ions) such as (K^+, Na^+, Ca^{+2}, and Mg^{+2}) and negative ions such as (HCO_3^-, SO_4^- CI^-). Also the total dissolved salts and the electrical conductivity is above the permissible limits according to the Libyan Standard Specifications for Drinking Water No 82, 1992 and WHO.

Thus, it becomes clear that sulfur well water is not suitable for drinking, agriculture, and industry because of its high temperature and the percentage of dissolved salts in it, and it is suitable for the treatment of many diseases of the muscular system, rheumatism and skin diseases, and sulfur water has a stable and healthy composition for the human body, and surface water does

not mix so its characteristics do not change Chemical and physical, it is safe and free of bacteria and does not need chemical treatment.

Where the general rate of electrical conductivity was (6266 µs/cm), total dissolved salts were (4377 mg /l), sulfate ion (1448 mg /l), chloride ion (1284 mg /l), sodium ion (888.5 mg /l), and chloride ion (1284 mg /l). Calcium (339.5 mg /l), bicarbonate ion (285 mg /l), magnesium ion (117.5 mg /l), potassium ion (52 mg /l), pH (7.31), and the lowest concentration was for nitrate ion (0.77 mg /l).

Recommendations

1- Paying attention to sulfur water wells and building swimming pools on them, as they are considered one of the recreational and therapeutic tourist attractions.

2- Increased interest in geological studies related to the study areas and other areas.

3- Continuing to conduct research on sulfur water in the study areas, observing the changes that may occur there, and trying to find appropriate solutions to mitigate the effects of the problem.

4-The study recommends studying the radioactive effect of sulfur water on health, especially radon and radium, which are naturally present around us.

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