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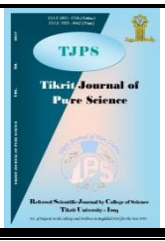

Evaluation of physical and chemical properties of water from some wells in Balad district within Salah al-Din governorate

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ABSTRACT

This study was conducted on water samples from 4 wells in the Balad district, Salah Al-Din Governorate, Iraq, to assess the water quality. Four wells were studied for the period from the month of November 2019 to February 2020, the chemical and physical analyzes were carried out in the Environmental Laboratory of the College of Science, Tikrit University.

Electrical conductivity values rates ranged between (590-3492)µs/cm.pH values rates ranged (7.02-7.85). The sulfate values ranged between (49.672-796.279) mg/L. Dissolved solids of well water were (753-3614) mg/L. Total alkalinity values were low during study period, as recorded (84.5-174.25) mg/L. The chloride ions values rates ranged between (52.5-241.25) mg/L. Reason of groundwater very hardness due to geological factors of study area ,Which was mostly the result of ion bicarbonates , ranging values of total hardness, calcium and magnesium hardness between (795-1905) mg / L, (610-1025) mg / L, (135-1010) mg/L respectively. As for heavy metals, the study recorded values for lead whose rates ranged between (0.355-0.509) mg/L, while zinc recorded values ranging between (0.033- 3.841) mg/L, The results of the study showed that the physicochemical parameters of well water were not conformity with the Iraqi and international specifications for drinking water, except for well 2. The research aims to assess the water quality of some groundwater wells and indicate its suitability for irrigation and drinking in the light of international and Iraqi standards.

Introduction

To indicate Since ancient times, man has realized the importance of water as an essential element in building human civilizations, groundwater is the second main source of water all over the world. Most countries depend on it as a water source that sometimes meets 90% of their water needs, especially the countries of the Arab region, specifically, countries that are devoid of surface water sources and have a desert climate and Peoples' needs for water are increasing with the increase in industrial, agricultural and urban progress, which has made most countries' attention lately to water[1]. In Iraq, in recent years, the interest and demand for groundwater has increased significantly, so groundwater has begun to occupy great importance as one of the natural water resources in the world, in addition groundwater constitutes an important tributary for survival in arid regions, given its importance as an important source, from the sources of water supply, the study explores and develops of this water has attracted the interest of researchers [2]. Groundwater constitutes approximately 30% of all natural water in the world, there is no exaggeration when say that almost all of the water that uses in agriculture, industry and drinking water is either groundwater or was groundwater in at some point, groundwater also plays an important roles in the environment and economy, it considers as the main support for rivers, lakes and wetlands, especially during the drier period when the direct inputs resulting from rainfall are less, in addition to the groundwater flow to Rivers as they seep through the river bed, known as downstream, are essential for wildlife and plants that live in the water, In addition to many reasons why groundwater is a

good source of water supply [3]. Groundwater is found in the ground, and aquifers usually consist of gravel, sand, sandstone, or broken rocks such as limestone, water can penetrate through these layers because they contain pores that make them permeable, and the speed with which groundwater flows depends on the size of the pores in the soil or rocks and the extent to which the layers are connected to each other. It is indicated that groundwater is found almost everywhere, and it may be at deep or shallow levels, and it may rise or fall according to a group of influencing factors, as heavy rain or snowmelt may cause the water level to rise, also, pumping large amounts of groundwater supplies can lead to a drop in the groundwater [1]. Therefore, Iraq suffers from a large water deficit for agricultural purposes as well as for human consumption, on this basis concerns were directed towards the use of water resources alternative to fresh and poor quality surface water for the purpose of agricultural expansion horizontally to secure food security, using saline water in order to develop an appropriate strategy for the economic use of this water[3]. The aims of this research is to assess the water quality of some groundwater wells and its suitability for irrigation and drinking in the light of international and Iraqi standards.

2- Materials and methods

Study area:

District of Balad locates in the south of Salah al-Din Governorate. It covers an area about 3539 square kilometers [1, 2], it locates between latitudes 1533-38 and 11-1534 north and longitudes 5043-2 St. 44-2745 east. Its population is the highest compared to other regions in Salah al-Din Governorate, where they number 370,000 people [4].The main district are Balad, Dujail, Ishaqi, Naba' and Yathrib. The climate is dry with an average rainfall about 14.5 mm[5] .The minimum of temperature is 4.6C during the winter season (December-February) and the maximum temperature is 48C during the summer (June-August), the wind is mostly northwesterly at a speed of 1.7-3.5 km/hour, and the moisture in the study area is dry or semi-dry. Dry as it does not exceed 23% in the summer in when the maximum moisture does not reach 60%, about 70% of the population live in these rural areas and work as farmers because the soil is suitable for agriculture [6]. And the other reason behind the fertility of the soil is its origin from the sediments of rivers that formed the alluvial plain from the north of Balad city thousands of years ago. Samples were selected on the basis of depth and nature of use, as well as the age of the well

Well 1: Location of this well is in Dujail, depth of this well was 35m. It is from the closed wells those used for irrigation. It has been used for about 20 years.

Well 2: Is located in the Balad at a depth of 10m and it is of the open type and used for crops irrigation. It has been used for about 14 years.

Well 3: Is located in AL-Abetar village a depth of 48m, and it is of a closed type and used to irrigate crops and cattle drinking. It has been used for about 23 years

Well 4:, Is located in Al-Zuhairi a village that is used to irrigate crops, at a depth of 63m.

Studying stations

Electrical conductivity

The ability of water to conduct electric current was measured upon arrival in the laboratory for study samples. The results have been were recorded using (CE CONSORT C830 multi-parameter analyzer made in Belgium).

Measurement of TDS

Total dissolved solids were measured in well water according to the method presented in [7].

pH measurement

the same device used for measuring TDS to measure the pH after calibrating it with Buffer solution of pH (9.7.4) at the beginning of each process.

Measurement of Sulfate SO_4

The sulfate ions were determined by the Turbidimetric Method described in [8].

Total Alkalinity

The total alkalinity was determined according to the method described [9].

Total Hardness

The total hardness was measured according to the method described by him [10].

Calcium Hardness Ca

Calcium hardness was determined according to the method given in [10].

Magnesium Hardness Mg

According to [7], as it was estimated by the difference between the total hardness and the calcium hardness, as stated in the equation:

Magnesium hardness Mg (mg/L) $CaCO_3$ = total hardness (mg/L) at $CaCO_3$ - calcium hardness Ca (mg/L) $CaCO_3$.

Chloride Cl- ion measurement

The chloride was measured depending on [11].

Measurement of Sulfate SO_4

The sulfate ions were determined by the Turbidimetric Method described in [12].

Heavy Metal Measurement

The atomic absorption technique was used to estimate heavy metals (Zn and Pb).[12].

Statistical analysis

It was done using a computer through statistical program (SPSS) Special Program for Statistical System.

Results and discussion

Electrical conductivity

The current study recorded values of electrical conductivity in Table (1), whose rates ranged between (3492-590)µs/cm in both well 2 and 4, respectively in the month of January. These results were higher than results obtained by other researcher [13] in her study to assess the quality of groundwater in the area of the Musayyib project and determine its suitability for irrigation, as it recorded values that ranged between (1555-3210) µs/cm in both wells 5 and 1 respectively. And lowest results obtained by [14]. In his study to assess the groundwater of some wells in the village of Al-Khafajia in Anbar Governorate. It ranged (3930-7100) µs/cm in wells 7 and 5. Differences in geological formations between regions maybe cause this discrepancy in the results. Another probable reason is the proximity of wells and their distance from water sources. The results showed no significant differences at ($p \leq 0.05$) of the statistical analysis using the analysis of variance. The results of the electrical conductivity values of the studied wells did not conform to the Iraqi specifications [15,16]. which amounted to 1600 µs/cm except for well 2.

Table 1: Monthly and locational changes in EC in groundwater during study period (µs/cm)

Months / well number	November	December	January	February	The average
1	2028	1719	2032	2122	1.901
2	565	652	560	584	590.25
3	1074	2770	931	1086	1.465
4	3875	3775	3087	3154	3.472

pH

The results of the current study showed that the averages of pH values in Table (2) ranged between (7.02-7.85) in wells 1 and 2, where highest value was recorded (8.6) in December in well 3, while the lowest value was recorded 7 in well 4 in the month of November. There was a note during results recorded in the current study. It is the range of variation in pH values is narrow and reason of that maybe due to the regulatory capacity of the water containing bicarbonate and carbonate compounds, in addition to what enters the water from the surrounding soil, considering that the Iraqi soil is rich in these compounds. Which works on acidity equation when it enters the water [17], as well as the fact that most of studied wells are of deep one, therefore, waters of wells are far from direct atmospheric changes, which cause them to dissolve CO_2 in water, as well as the hardness and alkalinity rich in bicarbonates, which resist the change in pH [18] and pH has a significant impact on salinity, electrical conductivity, living things and the rest of micro-organisms [19].

Results of statistical analysis depending on analysis of variance test showed that there were no significant differences between pH values and months of the study (November and December) and between the months (January and February), while at the level of significance ($p \leq 0.05$).The pH results in current study were with standard specifications of Iraqi drinking water (Central Organization for Standardization and Quality Control, 1996), and world (CEOH, 2003; US-EPA, 2002; WHO, 1999). Which ranged between (8.5-6.6), as well as the proposed limits for irrigation water issued by the Food and Agriculture Organization of the World (FAO, 1986), amounting to (8.4-6.5).

Table 2: Monthly and local changes of pH in groundwater during study period

Months / well number	November	December	January	February	The average
1	7.5	6.6	6.8	7.2	7.02
2	7.6	8	7.5	7.6	7.67
3	8.1	8.6	7.5	7.2	7.85
4	7	7.5	7.1	7.4	7.25

Sulfate SO_4

The results of Sulfate in Table (3) showed that concentration rate of SO_4 were (49.672-796.279) mg/ L in both wells 2 and 4, respectively, where the highest number was 820.16 mg / liter in the water of wells 4 in the month of December and the lowest value It was recorded 51 mg / L in the water of well 2 in the month of January. This variation in the values of sulfate ion concentrations in groundwater between the wells in the current study may be due to the types of rocks that the water passed through and the bacteriological activities in the soil layers that play an important role in oxidation reactions to reduce sulfur phases. The concentration of sulfate ions in groundwater often increases with increasing depth my be due to the possibility of melting the rocks of the evaporates in contact with it [20]. The high value of the sulfate ion in well 4 for all months of the study may be due to the process of watering the crops, as most of the sulfate compounds have the ability to dissolve in the irrigation water and the increase of that water works to wash the soil and increase the solutes in the soil water or the water that is pumped

back, which works to increase Dissolved materials and over time the effect of the process increases and affects the groundwater. The results of the statistical analysis showed that there were no significant spatial differences in the sulfate values between the wells during the study period at the level of significance ($P \leq 0.05$). The results showed that the water of wells 2 and 3 of the study matched the sulfate concentrations in with, the proposed standards for Iraqi drinking water, and the global one amounting to 250 mg / liter, while wells 1 and 4 did not meet those specifications.

Table 3: Monthly and locational changes of sulfates in groundwater during study period mg / L

Months / well number	November	December	January	February	The average
1	370	340.26	362	305	344.315
2	40.61	42.08	51	65	49.672
3	260	185	208	194	211.75
4	780	820.16	805	780	796.29

TDS

The results in Table (4) showed that rates of (TDS) values were (753-3614) mg/L, with the highest value being 4091 mg/L in December in well water [4], while lowest number was 553. mg/l in the month of November in well water (2). Wells 2 and 3 recorded values close to the permissible limits of 1000 mg / liter, while the rest of the studied wells recorded values that exceeded these limits, to the formations of Fatha and Anjana, rich in soluble salts [18] or because of the of rainfall in the winter season, which dissolves and erodes the salts in soil and the lands surrounding the wells. The probable reason for low values of total dissolved materials in wells [1,2], it may be attributed to the quality of the storage rocks for these wells. Also here results of the statistics showed that there were no significant temporal differences between the values of total dissolved solids in well water during the last three months, compared to the first month. Water of the wells studied 1 and 4 is not suitable for human because it does not conform to the standard specifications which range between (1000-450) mg/L, except for wells 2 and 3, which during those months recorded values less than 1000 mg/L.

Table 4: Monthly and site changes TDS in groundwater during the study period (mg/L)

Months / well number	November	December	January	February	The average
1	1701	2223	2566	2671	2290
2	553	860	832	767	753
3	870	784	845	805	826
4	3078	4091	3656	3632	3614

Total Alkalinity

The natural source of alkalinity is limestone and dolomite rocks, from which carbonates and bicarbonates of sodium, calcium and magnesium are generated, and bicarbonates represent the general and predominant form of alkaline compounds. 174.25) mg / L as $CaCo_3$ in wells 4 and 1, respectively, where the highest number was (197) mg / L as $CaCo_3$ in well 3 in month of January, and the lowest was (60) mg / L as $CaCo_3$ in the water of the well number 4 in the month of November. The reason for this increase in well 3 in January maybe belong to the high rates of decomposition of organic matter by bacteria and the resulting increase in (CO_2), which lead to the formation of bicarbonates [21]. As for the decrease in the total base values of most of the study wells, the reason may be due to the geological nature and the quality of the rocks that make up the groundwater basins. The statistical results showed that there were significant temporal differences in the alkalinity values during the months of the study at the level of significance ($P \leq 0.05$).

Table (5) Monthly and locational changes of alkalinity in groundwater during study period (mg / L) as $CaCo_3$

Months / well number	November	December	January	February	The average
1	180	160	165	192	174.25
2	80	136	72	78	91.50
3	120	160	197	178	163.75
4	60	120	75	83	84.5

Chloride

Table (6) showed chloride values, their rates were between (52.5-241.25) mg/L in wells 3 and 1, where highest value of chloride was 272 mg/L in well water 1 in November, and the lowest value was 31 mg/L. In well water 3 in the month of February. Results indicated that there are differences in chloride values, which may be belong to dilution of well water with rain water during the study period. The chloride values showed a rise of the chloride ion and this correspond with the high values of EC because electrical conductivity values are directly proportional to the concentration of the elements, including chloride ions [22]. The results of the statistical analysis showed that there were no significant temporal differences at the level of significance ($P \leq 0.05$).

Table 6: Monthly and locational changes of chloride in groundwater during study period (mg/L)

Months / well number	November	December	January	February	The average
1	272	251	211	231	241.25
2	92	52	112	51	76.75
3	32	72	75	31	52.5
4	270	232	128	250	220

Total Hardness

The results in Table (7) showed that total hardness values were between (795-1905) mg/L as $CaCo_3$ in wells 2 and 4, respectively, and that highest value of the total hardness was 2220 mg/L as $CaCo_3$ in February in well water 4 and lowest value was 600 mg/L as $CaCo_3$ in the month of December in well water 2. The increase in the value of the total hardness in well 4 in the spring season may be attributed to the rainfall, which results in the dredging of salts from the neighboring soils. As for its decrease in well 3, it may be attributed to the lack of rain in January, in addition to the fact that well 2 is a deep well, so it is less affected. With rain, if any. The results of the statistics showed that there were significant temporal differences at the same level.

Table 7: Monthly and locational changes of total hardness in groundwater during study period (mg / L) as $CaCo_3$

Months / well number	November	December	January	February	The average
1	1300	1200	2200	1240	4235
2	660	600	1200	720	795
3	720	660	1500	1200	1020
4	1400	1800	2200	2220	1905

Calcium hardness

The results of the current study showed in Table (8) that the calcium hardness values ranged between (610-1025) mg / L as $CaCo_3$ in wells 2 and 4, respectively. The highest value was 1600 mg/L as $CaCo_3$ in January in well water 1, while the lowest value was 460 mg/L as $CaCo_3$ in February in well water 2. The high values may be due to nature of the geology of the area in which well 4, as for its decrease in the winter season in the rest of the wells, it may be a result of an increase in the rate of rainfall during the study period, which led to a decrease in its concentrations, and this was explained by [23]. The results of analysis of variance showed that there were significant temporal differences.

Table 8: Monthly and location changes of calcium hardness in groundwater during study period (mg/L) as $CaCo_3$

Months / well number	November	December	January	February	The average
1	500	500	1600	660	815
2	480	500	1000	460	610
3	640	520	1400	980	885
4	800	600	1200	1500	10.25

Magnesium hardness

Magnesium hardness rates were between (135-1010) mg/L as $CaCo_3$ in wells 3 and 4, as in table (9). The highest value of magnesium hardness was 1240 mg/L as $CaCo_3$ in well water 4 in February, and the lowest value was recorded at 80 mg/liter. liter in well 3 in the month of November, and the reason for the high values of magnesium in February because increase in water levels, which lead to dissolving CO_2 in water and the formation of carbonic acid, which helps in

dissolving magnesium salts, or because of the high salinity of the water, which increases the presence of magnesium ions in larger quantities [24]. There were significant temporal differences at the level of significance ($P \leq 0.05$).

Table 9: Monthly and locational changes of magnesium hardness in groundwater during study period(mg / L) as $CaCo_3$

Months / well number	November	December	January	February	The average
1	800	700	600	580	670
2	180	100	200	260	185
3	80	140	100	220	135
4	600	1200	1000	1240	1010

Heavy metals

1- lead Pb

Table (10) showed that rate values of lead were between (0.355-0.509) mg/L in wells 4 and 2. The highest one was 0.682 mg/l in January in well water 2, while lowest value was 0.104 mg / liter in November in well water 3. The reason for the high values of lead in the studied well water may be attributed to the possibility of lead entering the water as a result of corrosion of pipes, connections and pumps used to raise water, in addition to the possibility of lead arriving from soil contaminated with lead or from vehicle exhaust, especially in crowded places [25]. The results of the statistical analysis using the analysis of variance test showed that there were significant temporal differences at the level of significance ($P \leq 0.05$).

Table 10: Monthly and location changes of lead in groundwater during the study period (mg/L)

Months / well number	November	December	January	February	The average
1	0.621	0.347	0.306	0.368	0.410
2	0.491	0.378	0.682	0.488	0.509
3	0.104	0.450	0.490	0.579	0.405
4	0.262	0.343	0.395	0.423	0.355

2- Zinc Zn

Zinc rate values as shown in table (11) ranged between (0.033- 3.841) mg / liter in wells 3 and 1, respectively. The highest value was recorded at 6.562 mg / liter in December in well water 4, while the lowest value was 0.02 mg / liter in the month of January in well water 3. Values of zinc concentration in well water during months of January and February showed a noticeable decrease, and the reason for this is due to the abundance of rain that reduces the concentration of zinc in well water [25]. Results of the statistical analysis showed the presence of significant time differences at level of significance ($P \leq 0.05$).

Table 11: Monthly and location changes of zinc in groundwater during the study period (mg/L)

months / well number	November	December	January	February	The average
1	3.375	4.343	3.997	3.652	3.841
2	0.011	0.031	0.052	0.04	0.033
3	0.05	0.042	0.02	0.021	0.033
4	2.325	6.562	2.210	2.434	3.382

Conclusions

1- We conclude the high concentration of positive and negative ions and salts in some wells studied, which causes to consume soap, especially because of the difficulty of foam formation

2- The results showed a decrease in the values of heavy concentrations in the wells are studied.

3-1- The results of the study showed that the physical and chemical properties of the water wells were not in conformity with the Iraqi and international specifications, except for well No. 2

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تقييم الخصائص الفيزيائية والكيميائية لمياه بعض الابار في قضاء بلد ضمن محافظة صلاح الدين

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[3]مديرية صلاح الدين ، وزارة التربية والتعليم ، تكريت ، العراق

الملخص

اجريت هذه الدراسة على عينات مياه4 ابار في قضاء بلد ضمن محافظة صلاح الدين – العراق لتقييم نوعية المياه خلال فترة 4 اشهر اعتبارا من شهر كانون الثاني 2019 ولغاية شهر شباط 2020 بواقع عينة واحدة شهريا حيث اجريت التحاليل الكيميائية والفيزيائية في مختبر البيئة في كلية العلوم جامعة تكريت, بالإضافة الى بعض الفحوصات الموقعية, حيث وجد ان قيم التوصيلية الكهربائية قد تراوحت معدلاتها بين (3492–590) مايكروسمنس/ سم والآس الهيدروجيني (7.02– 7.85) وان قيم معدلات تركيز ايونات الكبريتات تراوحت ما بين (796.279–49.672) ملغم/لتر والمواد الصلبة الذائبة الكلية لمياه الآبار تراوحت ما بين (753– 3614) ملغم /لتر, أن قيم القاعدية الكلية كانت منخفضة طيلة مدة الدراسة اذ سجلت قيما تراوحت معدلاتها (84.5– 174.25) ملغم/لتر, بينما تراوحت قيم العسرة الكلية ما بين (795 –1905) ملغم/لتر وقيم الكلوريد تراوحت معدلاتها ما بين (241.25–52.5) ملغم/لتر, اما المعادن الثقيلة فقد سجلت الدراسة قيم لعنصر الرصاص تراوحت معدلاتها ما بين (0.509 –0.355) ملغم/لتر بينما سجلت الزنك قيما تراوحت معدلاتها ما بين (0.033– 3.841) ملغم/لتر, اظهرت نتائج الدراسة ان الخصائص الفيزيائية والكيميائية لمياه الابار كانت غير مطابقة للمواصفات العراقية والعالمية باستثناء البئر رقم 2 يهدف البحث الى تقييم جودة مياه بعض الابار الجوفية وبيان مدى صلاحيتها للري والشرب على ضوء المواصفات العالمية والعراقية.