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Evaluation of some Physical and Chemical Properties of Ground Water in Alshirqat District, Salaheddin province, Iraq

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ABSTRACT

The study carried out to evaluate some of the physical and chemical properties of the ground water samples from west of Alshirqat district, Salaheddin province, IRAQ. Six wells selected, sample of water collected every month for 6 months (October,2021 – March 2022). In each sample electric conductivity (EC), pH, total dissolved solid (TDS), dissolved oxygen (DO), biological oxygen demand (BOD), total hardness (TH), calcium hardness (Ca H), magnesium hardness (Mg H), sodium (Na), potassium (K), chloride (Cl), and sulphate (SO_4), were measured monthly. The results of ground water samples range of EC is (1308-6030) µ siemens, pH is (6.99- 7.95),TDS is (947-2670 mg./l), DO is (4- 6.7mg/l), BOD is (0.4-2.6 mg/l), TH is (500- 3200 mg/l), CaH is (300- 2000 mg/l) , Mg H is (20 -1800 mg/l), Na is (50- 2100 mg/l), K is (0.1- 7.2 mg/l), CL is (133.12- 2485mg/l), SO_4 is (12.71-375.6 mg/l) subsequently. The ground water in west of Alshirqat, Salaheddin, Iraq, contain very high level of total dissolved solid, total hardness, calcium hardness, magnesium hardness, sodium, chloride, and sulphate. The ground water is unsuitable to human consumption and domestic uses, for animal uses, irrigation except plant resistant to salinity, and many industries.

تقييم بعض الخواص الفيزيائية والكيميائية للمياه الجوفية في قضاء الشرقاط - محافظة صلاح الدين- العراق

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الخلاصة

أجريت هذه الدراسة لتقيم بعض الخواص الفيزيائية والكيميائية لنماذج مياه جوفية اخذت من الجانب الأيمن لقضاء الشرقاط محافظة صلاح الدين العراق تم اختيار سته ابار وجمعت نماذج من المياه شهريا ولمدة ستة اشهر ابتداء من شهر تشرين الأول 2021 الى شهر اذار 2022 اجري لكل نموذج فحوصات شهرية لقياس التوصيلية الكهربائية والاس الهيدروجيني , المواد الصلبة الذائبة الكلية ,الاوكسجين المذاب, المتطلب الحيوي للأوكسجين , العسرة الكلية ,عسرة الكالسيوم ,عسرة المغنسيوم , الصوديوم , البوتاسيوم ,الكلوريد ,الكبريتات .وكانت نتائج القياس للنماذج على التوالي تتراوح بين (6030-1308) مايكرو سيمنز

(7.95-6.99) ,(2670-947)ملغم /لتر ,(6.7-4) ملغم لتر , (2.6-0.4) ملغم /لتر , (3200-500) ملغم لتر , (2000-300) ملغم /لتر , (1800-20)ملغم /لتر , (2100-50) ملغم لتر ,(7.2-0.1) ملغم /لتر ,(2485-133.12)ملغم /لتر , (12.71-375.6) ملغم/ لتر .
ونستخلص من النتائج ان المياه الجوفية في الساحل الأيمن من قضاء الشرقاط تحتوي على مستوى عالي جدا من الاملاح الذائبة الكلية والعسرة الكلية، عسرة الكالسيوم، عسرة المغنسيوم، والصوديوم والكلوريد الكبريتات. وان المياه الجوفية غير صالحة للاستهلاك البشري والاستخدام المنزلي وسقي الحيوانات وللري النباتات عدا النباتات المقاومة للملوحة وغير صالح لعدد من الاستخدامات صناعية.

الكلمات المفتاحية: مياه جوفية، قضاء الشرقاط، العراق

INTRODUCTION

With climate changes, desertification, and shortage of Tigris River water in Iraq and especially Salaheddin province, there is increasing need for ground water for maintenance and development of this region (Sabia and Mohamed,2019). In Iraq, the ground water is the second source of water especially in areas far from superficial water resources, for domestic, animal, agricultural, industrial uses (Al- Zubedi,2022; Al-Sudani,2019). Ground water contain more dissolved minerals than rivers waters, for this pollution of areas around wells should be avoided and sometime ground water need extensive treatment before its uses (Raymond,1995). The value of ground water depends on its quality, the assessment and monitoring of water quality is essential part in the use of ground water wither for domestics, animals use or for irrigation and industries (Al- Zubedi,2022; WHO,2006). Many researchers study the ground water quality in adjacent region areas in Iraq (Jabarand AL-Obaedy,2011; Ali and Abdul Jabar,2014; Dalas, 2017; Dalaas and Abdul-Jabbar, 2018; Al-Araji, 2019).

Quality of water assessment depend on many criteria and indexes (Hamad, Abdul-Jabbar, 2022; APHA,1998). Bacteria, however, occasionally find their way into ground water, sometimes in dangerously high concentrations. Many dissolved materials and organic substances are found in ground water in different concentrations, some materials are harmful to humans, animals, and plants, and even few of them are highly toxic (WHO,2006). Microorganism, occasionally found in ground water, and this might be dangerous to the health of human and animals. (WHO,2006).

The aim of our study is to assess some physical and chemical properties of ground water in the wells, west of Alshirqat district, Salaheddin province, and to determine its suitability for different human uses.

MATERIALS and METHODS

Description of study area:

Alshirqat is the north district in Salaheddin province, the total area is 1515 km^2, the north boundary is Mosul district in Nineveh province, the west boundary is Alhathar district in Nineveh province, the south boundary is Beji district in Salaheddin province, the east boundary is Makmur district in Nineveh province and Al-Hawiegah district in Kirkuk province (fig-1). Alshirqat is about 300 kilometers to north of Baghdad, Tigris River divided the district to west and east bank. Alshirqat district situated in undulated area, in areas of ungranted rain fall, the average of annual rainfall in area of study was 183.5 mm, but in the period of study the rain fall is 46.7 mm (this mean that this year is dry year with low rainfall). The elevation of the area of study is 160 meter above sea level, the range of temperature in the area of study is 4.3 -43.8C̊. Data about climate, and rain drop, collected from the climate prediction center in Salaheddin- Iraq

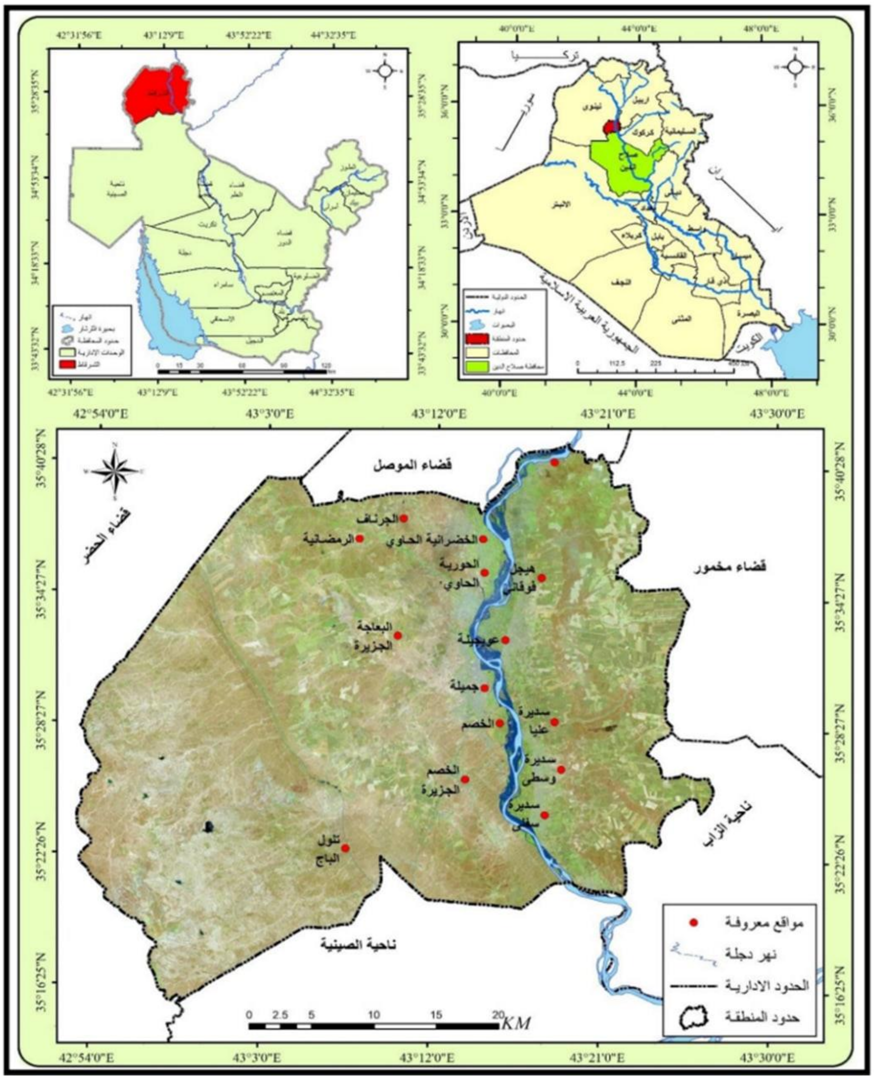

Fig.1- Map shows Alshirqat and Salaheddin in Iraq (map scale of Iraq is 1/million, Salaheddin is 1/250000, Alshirqat is 1/2500)

Six wells were selected in rural area of west bank of Alshirqat (table- 1), this study includes monthly collection of ground water samples. This study includes monthly changes in selected wells, which are located west of Tigris River. The site of wells determined by GPS system (fig-2) .

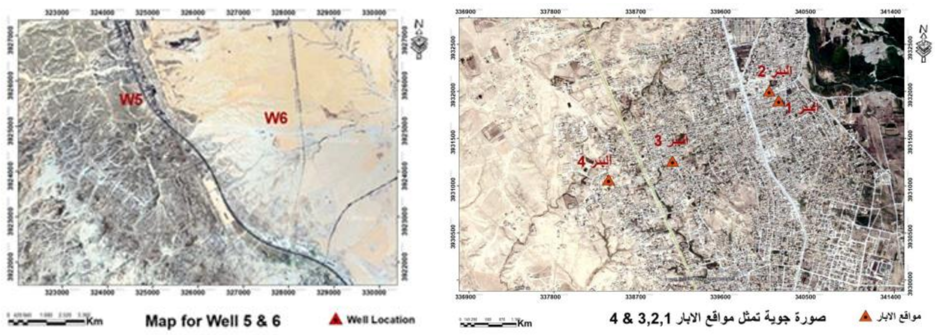

Fig.2- Satellite photos of the area of study with well's location (there is wide space between two photos) .

Table – 1: Table shows properties of wells in study.

Well number	Site of well in west of Alshirqat	Type	Date of digging	Depth in meters	Uses	Topography and elevation above sea level in meters
1st	Military discrete	Dogged automatically, closed	1992	7.5	Irrigation	160
2nd	Alsaddah in farm.	Dogged manually, partially open.	1960	8	Irrigation and animal uses	160
3rd	Altob	Dogged automatically, closed	2005	50	Irrigation and animal uses	180
4th	Altob Aljadedah	Dogged automatically, closed	2005	80	Irrigation and animal uses	180
5th	West of highway in Jazerat Aljumaila	Dogged automatically, closed	2005	50	Irrigation of olive and animal uses	250
6th	Jazerat Aljumaila	Dogged automatically, closed, depend on solar energy	2005	50	Irrigation and animal uses	220

Collection of samples: The water pumped by electrical pumps. The sample taken early in morning monthly after pumping of water for 10 **minutes** by clean polyethylene bottles after washing with same water for several times, at first of (October 2021 – March 2022). The temperature of water by amercing the thermometer in running water for two minutes and air temperature measured at time of sample taking. The rain falls and mean of temperatures in the area of study taken from Iraqi meteorological organization and seismology.

Table-2: Rain falls and temperatures in the area of study.

Months	October	November	December	January	February	March
Rain fall in (mm).	0.0	0.7	7.3	21.6	33.7	5.8
Mean of temperature in C°.	25	16.9	11.1	9.5	11.6	16.2

The physical and chemical tests done in laboratories of college of sciences; Tikrit university as early as possible (APHA,2003; APHA,2017). Electrical conductivity Ec, and total dissolved solid TDS, measured by microprocessor conductivity meter. pH is measured by pH- meter after titration with organized buffer solution. Dissolved oxygen DO measure by Winkler A method (APHA,2017), and results presented by mgL^{-1}. Biological Oxygen Demand (BOD) measured by Winkler Azide method from sample collected in dark tubes preserved for 5day in 25 C̊ temperature for 5 day and results presented by mgL^{-1} (APHA,2003). Total hardness, calcium hardness, and magnesium hardness are measured after titration, and results presented by mgL^{-1}. (APHA,2017; IQS,2009). Chloride is measured, and results presented by mgL^{-1} (APHA,2017). Sulphate measured by Spectrophotometer and results presented by mgL^{-1} (APHA,2017). Sodium Na and potassium K ions concentration measured by flame Spectrophotometer and results presented by mgL^{-1} (APHA,2017). The suitability of ground water assessed by tables of Iraqi water s quality index and WHO Quality index· (WHO,2006; IQS,2009).

Statistical analysis

The statistical analysis carried out by Special Program of Statistical System SPSS (version 27), by Analysis of Variance (ANOVA) test, and using Duncan test. The correlation tests carried out by Pearson's test. The test regarded as significant if result is < 0.05.

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RESULTS AND DISCISSION

The temperature of ground water and air at samples taking site is measured by centigrade. The temperature is important factor in chemical, photosynthesis of algae, chemical and physical reaction, and it affect dissolving oxygen and other gases in water (Dalaas and Abdul-Jabbar, 2018)

Table- 3: Temperature of ground water in centigrade.

Well number	Months					
	October	November	December	January	February	March
1	25	23	23	22	22	23
2	21.3	22	20	16	18	20
3	24.2	23	24	23	22	23
4	24.9	22	22	22	21	22
5	25	22	21	22	20	21
6	25	22	21	22	20	22

The ground water temperature in our study ranged between 16- 25 C̊(table-3), it is approximately constant in most of samples except well 2 which is partially exposed, this result is like that of other researchers (Dalas, 2017; Dalaas and Abdul-Jabbar, 2018; Al-Araji, 2019). By ANOVA test, there is no significant difference between wells. There is no relation between ground water temperature and the depth of wells. The air temperature ranged between 3-30 C̊, it varied according to the climate changes and seasonal variation and because the sample collection takes about 4 hours during which the temperature varies (table-3). The electrical conductivity of ground water samples is ranged between (1308-6030 µ Siemens), (table- 4).

Table – 4: Electrical conductivity (µ Siemens). in ground water samples.

Wells number	**Months**					
	October	**November**	**December**	**January**	**February**	**March**
1	2371	2251	2280	1893	2101	2098
2	2380	2740	2754	3330	3300	3100
3	2925	2338	2004	2591	2813	2599
4	2888	2330	1308	2062	2000	2358
5	3680	2824	2546	2766	2143	2879
6	6030	2066	3420	5330	5080	4710

The statistical analysis by ANOVA test shows significant differences spatial $P \leq 0.05$, with no temporal differences. Duncan test divided the wells in two groups, the first group is well 1,2, 3,4, 5 and second group is well 6. The correlation test by Pearson's formula shows significant positive correlation $P \leq 0.01$ between electrical conductivity and position of well. The Iraqi standard for water quality for human uses 2009 should be less than 1500 (IQS,2009) our results indicate that ground water in our study not suitable for human uses, because the region of study contains high salinity. This reported by another researcher (Ali and Abdul Jabar,2014; Amen et al., 2019; Aljuboori,2016) The high salinity of ground water depend on geology of area, and direction of water movement in depth. The total dissolved solid TDS is ranged between (947-2670) mgL^{-1}, (table- 5).

Table - 5: Total dissolved solid substances (mgL^{-1}) in samples of ground water.

Wells number	**Months**					
	October	**November**	**December**	**January**	**February**	**March**
1	1185	1285	1158	947	1050	1050
2	1344	1404	1380	1089	1650	1600
3	1465	1330	1005	1295	1406	1299
4	1379	1294	947	1032	1040	1180
5	1264	1411	1291	1389	1068	1434
6	2388	1321	1221	2670	2540	2420

The statistical analysis by ANOVA test shows significant differences spatial $P \leq 0.05$, with no temporal differences. Dunkin test divided the wells in two groups, the first group is well 1,2, 3,4, 5 and second group is well 6. The person's correlation test shows positive significant correlation $P \leq 0.01$ between total dissolved solid substances and position of well $r = 0.507$, and electrical conductivity. The TDS above 1000 made ground water unsuitable for human uses and limit its use for agricultures (Alexander et al.,2019) .The elevation of results in well 6 can be explained by direction of ground water movement in depth and its local geology. The ground water samples pH is ranged between (6.99- 7.95), (table-6).

Table-6: The pH of ground water samples

Wells number	**Months**					
	October	**November**	**December**	**January**	**February**	**March**
1	7.8	7.23	7.92	7.34	7.08	6.99
2	7.95	7.63	7.62	7.67	7.37	7.3
3	7.79	7.54	7.41	7.61	7.4	7.4
4	7.8	7.55	7.54	7.68	7.52	7.4
5	7.5	7.38	7.25	7.59	7.44	7.45
6	7.23	7.53	7.69	7.65	7.64	7.65

The statistical analysis by ANOVA test shows temporal significant differences in pH $P \leq 0.05$, with no spatial differences. Duncan test divided the wells samples in three groups, the first group is well November, December, and January, and second group February and March, the third group is October. There is no significant correlation between pH of water sample and all changes studied. The range of pH is acceptable in all samples of ground water (WHO,2006; Alexander et al .,2019) Our results are like that of other reports . (Dalaas and Abdul-Jabbar, 2018; Aljuboori,2016; Alexander et al.,2019) The dissolved oxygen DO in ground water samples is ranged between (4- 6.7.), mgL^{-1} (table-7).

Table – 7: Dissolved oxygen DO (mgL^{-1}) in samples of ground water

Wells number	**Months**					
	October	**November**	**December**	**January**	**February**	**March**
1	4.9	6.2	5.8	6	5.7	5.9
2	5.2	6.2	6.3	6.1	6.3	5.7
3	5.3	5.1	5.8	5.7	6.1	5.9
4	5.1	5.5	5.7	5.1	6.4	5.8
5	5.3	6.7	6.2	5.2	5.8	6.6
6	4	6.1	6.5	6.7	5.1	5.9

The statistical analysis by ANOVA test shows temporal significant differences in dissolved oxygen $P \leq 0.05$, with no spatial differences. Duncan test divided the wells samples in two groups, the first group is well November, December, and January, February, and March, the second group is October. There are significant negative correlation $P \leq 0.05$ between dissolved oxygen of ground water sample and temperature of areas around the wells (r= -0.367), and temperature of areas around the wells (r= -0.367). This is reflecting the growth of microorganism with increase of temperature (Alkam et al.,2009; Fadaee et al.,2020; Jabari and, Al –Beity ,2021). The dissolved oxygen is important criteria in water to dissolve the organic material and oxidation of toxin and bad odor (Mahdiand Al-Juboory,2021), Our results are like other reports (Abdul Jabarand AL-Obaedy,2011; Mahdiand Al-Juboory,2021; Salaudeen et al.,2018). The biological oxygen demand in ground water samples ranged between (0.4-2.6) mgL^{-1} (Table- 8).

Table – 8: Biological oxygen demand (mgL^{-1}) in ground water sample

Wells number	**Months**					
	October	**November**	**December**	**January**	**February**	**March**
1	1.5	1	1.2	1.1	1.3	1.4
2	0.8	0.6	1.8	1.2	0.7	0.9
3	1.2	1.1	2.4	1.6	1.2	1.2
4	1.3	1.7	2	2.7	2	1.9
5	0.9	0.8	0.9	1.3	2	0.8
6	1.7	0.4	1	0.8	1.3	1.3

The statistical analysis by ANOVA test shows spatial significant differences in biological oxygen demand $P \leq 0.05$, with no temporal differences. Duncan test divided the wells samples in two groups, the first group is well 1, 2, 3, 5 ,6 and second group well 4. There is significant negative correlation by Pearson's test $P \leq 0.05$ ($r = -0.367$) between biological oxygen demand and water salinity, and dissolved oxygen of water sample ($r = -0.331$), this explained by inhibition microorganism growth (Salih et al.,2019). Our results are like other reports· (Abdul Jabarand AL-Obaedy,2011; Salaudeen et al.,2018; Abbas and Ali ,2020) The chloride in ground water samples is ranged between (133.12- 2485) mgL^{-1}, (table- 9).

Table -9: Chloride (mgL^{-1}) in ground water samples

Wells number	**Months**					
	October	**November**	**December**	**January**	**February**	**March**
1	230.75	266.25	266.25	532.5	204.12	221
2	377.18	443.75	355	710	310.62	355
3	142	532.5	177.5	532.5	221.87	266.25
4	142.25	355	133.12	532.5	222.1	177.5
5	177.5	443.75	266.25	710	266.25	266
6	798.75	887.5	798.75	2485	710	798.75

The statistical analysis by ANOVA test shows temporal and spatial significant differences in chloride $P \leq 0.05$. Duncan test divided the wells temporally in two groups, the first group is October, November, December, February, and march, the second group is January. Duncan test divided the wells spatially in well 1 ,2, 3,4, 5 and second group is well 6. The Pearson's correlation test shows positive significant correlation $P \leq 0.01$ ($r = 0.444$) between Chloride concentration and position of well, and air temperature around wells, electrical conductivity $P \leq 0.01$ ($r =- 0.358$), and total dissolved solid $P < 0.01$ ($r = 0.604$). This might explain by fact that, in the dry years there is increase in temperature and decreased rain fall and this increased the dissolving of salt around ground water in depth and this increased chloride in water in dry years like the year of our study. The average chloride in all ground water samples is unsuitable for human uses (WHO,2006; Alexander et al.,2019). The total hardness in ground water samples is ranged between (500- 3200) mgL^{-1}, (table- 10).

Table – 10: Total hardness (mgL^{-1}) in samples of ground water

Wells number	**Months**					
	October	**November**	**December**	**January**	**February**	**March**
1	750	2000	1200	1200	1200	1100
2	1400	3200	1900	1000	1300	500
3	1230	2600	1600	1900	1950	1950
4	1020	2400	1800	2000	2100	1900
5	1320	3000	2400	2200	2500	2500
6	1350	3200	1900	2400	2400	2400

The statistical analysis by ANOVA test shows temporal and spatial significant differences in total hardness $P \leq 0.05$. Dunkin test divided the wells temporally in three groups, the first group is October, December, January, and march, the second group is February, and third group is November. Duncan test divided the wells spatially in two group, first group is well 1, 2, 3,4, and second group is well 5, and 6. The Pearson's correlation test shows positive significant correlation $P \leq 0.01$ ($r = 0.549$) between total hardness of ground water and dissolved oxygen in ground water. The total hardness made ground water unsuitable for human uses and some of agricultures and industrial uses (WHO,2006; Alexander et al.,2019). Our results is like that of other reports (Abdul Jabarand AL-Obaedy,2011; Ali and Abdul Jabar,2014; Hamad, Abdul-Jabbar, 2022; Aljuboori,2016). The calcium hardness in ground water samples ranged between (300- 2000) mgL^{-1}**,** (table- 11).

Table- 11: Calcium hardness (mgL^{-1}) in ground water samples

Wells number	**Months**					
	October	**November**	**December**	**January**	**February**	**March**
1	700	1000	700	700	800	600
2	1000	1400	900	900	1000	300
3	1000	1500	1200	1100	1200	1000
4	1000	1400	1000	1000	1100	1000
5	1050	2000	1400	1600	1600	1600
6	800	1400	1000	1200	1200	1200

The statistical analysis by ANOVA test shows temporal and spatial significant differences in calcium hardness $P \leq 0.05$. Duncan test divided the wells temporally in two groups, the first group is October, December, January, February, and march, the second group is November. The Pearson's correlation test shows positive significant correlation between calcium hardness of ground water and position of well $P \leq 0.01$ ($r = 0.552$), and total hardness, $P \leq 0.01$ ($r = 0.842$). Our results are calcium hardness is very high made ground water unsuitable for human uses, animal uses, most of agricultures and industrial uses (WHO,2006; Alexander et al.,2019). Same results reported by other work (Ali and Abdul Jabar,2014). The magnesium hardness in ground water samples is ranged between (20 -1800) mgL^{-1} (table- 12).

Table- 12: Magnesium hardness in ground water samples.

Well number	Months					
	October	**November**	**December**	**January**	**February**	**March**
1	50	1000	500	500	400	500
2	400	1800	1000	100	300	200
3	230	1100	400	800	750	950
4	20	1000	800	1000	1000	900
5	270	1000	1000	600	900	900
6	550	1800	900	1200	1200	1200

The statistical analysis by ANOVA test shows temporal and spatial significant differences in magnesium hardness $P \leq 0.05$. Duncan test divided the wells temporally in two groups, the first group is November, December, January, February, and march, the second group is October. Dunkin test divided the wells spatially in two group, first group is well 1, 2, 3,4, 5 and second group is well 6. The Pearson's correlation test shows positive significant correlation $P \leq 0.01$ (r = - 0.376) between magnesium hardness of ground water and temperature of ground water, dissolved oxygen $P \leq 0.01$ (r = 0.403), total hardness $P \leq 0.01$ (r = - 0. 585), and calcium hardness $P \leq 0.01$ (r = 0.375). Our results in calcium hardness are very high made ground water unsuitable for human uses, animal uses, most of agricultures and industrial uses (WHO,2006; Alexander et al.,2019). The sodium Na ion in ground water samples is ranged between (50- 2100) mgL^{-1} (table- 13).

Table – 13: Sodium concentration ($mgL^{-1)}$ in ground water samples.

Wells number	Months					
	October	**November**	**December**	**January**	**February**	**March**
1	150	300	200	250	500	500
2	50	400	350	400	850	900
3	100	150	150	200	600	350
4	300	150	100	250	250	400
5	400	200	200	300	300	400
6	100	1000	950	750	1700	2100

The statistical analysis by ANOVA test shows temporal and spatial significant differences in magnesium hardness $P \leq 0.05$. Duncan test divided the wells temporally in two groups, the first group is October, November, December, January, February, the second group is march. Duncan test divided the wells spatially in two group, first group is well 1, 2, 3,4, 5 and second group is well 6. The Pearson's correlation test shows positive significant correlation between sodium of ground water and position of well $P \leq 0.01$ (r = - 0.376), electrical conductivity $P \leq 0.01$ (r = 0.514), total dissolved solid $P \leq 0.01$ (r = - 0. 605), water salinity $P \leq 0.01$ (r = - 0. 507), chloride $P \leq 0.01$ (r = 0.355), and magnesium $P \leq 0.01$ (r = 0.359). The high level of sodium made most ground water samples unsuitable for human uses (Alexander et al.,2019; Fadaee et al.,2020). Our results are like other reports (Amen et al., 2019; Mahdiand Al-Juboory,2021; Nisaf and Jwad,2015; Salih et al.,2019). The potassium ion K concentration in ground water samples is ranged between (o.1- 7.2), mgL^{-1} (table- 14).

Table – 14: Potassium concentration (mgL^{-1}) in ground water samples

Wells number	Months					
	October	**November**	**December**	**January**	**February**	**March**
1	0.6	1	7.2	7.4	0.3	0.9
2	0.4	0.3	1.5	0.9	0.1	1
3	0.6	0.3	1.3	1.7	0.4	0.1
4	0.3	0.1	1.9	0.6	0.4	0.3
5	0.3	0.4	1.9	2.5	0.6	0.4
6	0.5	0.6	1.7	2	0.4	0.2

The statistical analysis by ANOVA test shows temporal and spatial significant differences in potassium $P\leq 0.05$. Duncan test divided the wells temporally in two groups, the first group is October, November, February, and march, the second group is December and January. Duncan test divided the wells spatially in two group, first group is well 2, 3,4, 5, 6 and second group is well 1. The Pearson's correlation test shows positive significant correlation between potassium of ground water and air temperature $P\leq 0.01$ ($r = - 0.496$). The potassium is low in all wells of our study (Alexander et al.,2019; Alkam et al.,2009). Our results are like other reports (Hamad and Abdul-Jabbar, 2022; Amen et al., 2019). The sulphate in ground water samples is ranged between (12.71-375.6) mgL^{-1}, (table- 15).

Table – 15: Sulphate (mgL^{-1}) in ground water samples

Wells number	Months					
	October	**November**	**December**	**January**	**February**	**March**
1	16.68	16.73	72.05	80.75	354	242
2	18.96	14.41	87.5	80.35	335.4	375.6
3	16.37	19.74	95.25	87.2	341.4	334.6
4	19.46	17.1	84.6	86.95	334	324
5	15.09	13.58	90.5	84.5	357	353
6	15.5	12.67	74.35	86.95	362	373

The statistical analysis by ANOVA test shows temporal significant differences in sulphate of ground water $P\leq 0.05$. Duncan test divided the wells temporally in three groups, the first group is October, November, and second group is December and January, third group is February, and march, there is no spatial differences. The sulphate is acceptable except February and March (Alexander et al.,2019; Alkam et al.,2009). Our results are like other reports (Salaudeen et al.,2018; Al-Ansari et al.,2021).

Suitability of ground water:

There are many systems and ways to assess the suitability of ground water for human uses (WHO,2006; Alexander et al.,2019). The simplest is that presented in (table- 14). The ground water samples of all wells are not suitable for human use. The ground water in west of Alshirqat, Salaheddin, Iraq, contain very high level of salinity, total dissolved solid, total hardness, calcium hardness, magnesium hardness, sodium, chloride, and sulphate. Similar results had been reported by many researchers. (Aljuboori,2016; Alexander et al.,2019; Mahdiand Al-Juboory,2021; Nisaf and Jwad,2015; Al-Ansari et al.,2021; Al-Mudafar and Aldufaylee,2014).

Table – 16: Comparison of our ground water results with Iraqi water quality standard and WHO water quality standard for human uses.

Elements	WHO Quality 2004	Iraqi water s quality 2009	Range of element concentration and mean in our study	Suitability
E c	1530	1500	1308- 6030 (2841 µ Siemens)	Unsuitable
pH	6.5 -8.5	6.5 -8.5	6.99-7.9 (7.515)	-
T D S	1000	1000	947- 2670 (1395.3)	Unsuitable
T H	500	500	500- 3200 (1854.5 mgL^{-1})	Unsuitable
Ca H	75	50	300- 2000 (1098.61 mgL^{-1})	Unsuitable
Mg H	125	50	20- 1800 (831 mgL^{-1})	Unsuitable
Na	200	200	50- 2100 (451.3 mgL^{-1})	Unsuitable
K	12	-	01- 7.4 (1.14 mgL^{-1})	-
CL	250	250	124- 2485 (453.22 mgL^{-1})	Unsuitable
SO_4	250	250	15.5- 375.6 (147.03 mgL^{-1})	-

By reviewing the tables proposed to different uses of ground water, the ground water samples regarded unsuitable for animals uses, the ground water in our study had high salinity and can used only for agricultures resistant to salinity, the samples of ground water in our study are also not suitable for industry of cement, food industry and canning, textile industry, and petroleum industry (Mahdiand Al-Juboory,2021; Al-Mudafar and Aldufaylee, 2014; Abbawi and Hassan, 1990) .

CONCLUSION

The ground water in west of Alshirqat, Salaheddin, Iraq, contain very high level of salinity, total dissolved solid, total hardness, calcium hardness, magnesium hardness, sodium, chloride, and sulphate, it also contains plant nutrients including (silica, phosphate, nitrite, and nitrate). It is unsuitable to human consumption, domestic uses, for animal uses, irrigation except plant resistant to salinity, and many industries.

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