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PHYSICAL AND CHEMICAL PROPERTIES OF SOME BABYLON PROVINCE WELLS WATER AND CONFORMITY TO STANDARD DRINKING WATER OF IRAQ

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Abstract

The current study was conducted to identify the groundwater quality of three sites in Babil governorate (Al-Hamzah Al-Gharbi, Al-Mahaweel, Al-Shomali) and their suitability for human and plant use. The study included the measurement of some physical and chemical properties. The water temperature in the well were ranged between (24.11-26.66C0) and were within the permissible limits for Iraqi drinking water (1998). The dissolved oxygen level was ranged between (1.87-5.54 mg/l). The BOD was ranged from (0.28-1.55 mg/l) and were within the limits permitted by the Central Organization for Standardization and Quality Control (2001).

The water's pH (7.26-7.69) in the wells were within the allowed Iraqi borders (2001). The wells water hardness rang was between (604.66-116.88 mg/l) which is higher than the limits allowed for human drinking. The electrical conductivity rang was between (1554.77-3505.55ms/ cm) and exceeded all the Iraqi determinants (1998). The water wells can be classified within the category of salinity, where the salinity level has to be ranged between (0.69-1.68ppt). Total dissolved solids rang was between (1011.33-24083 mg /l) and exceeded the Iraqi and international limits, While plant nutrients rang was between (imperceptible - 0.24 micrograms/liter) which is less than the limits allowed. Nitrate rang was between (1.53-5.24 mcg/l). The phosphorus level in water's well was low and ranged from (imperceptible -0.43 mcg /l). Calcium concentration was from (107.08-289.06 mg/l) which is higher than the permissible limits for Iraqi drinking water (1996). The magnesium concentration in the well water was ranged between (64.2-139.8 mg). Sodium concentration was between (176.88-652.44 mg/l) and exceeded the Iraqi limits allowed for drinking by the standardization and quality control system (2001). The study recorded potassium levels ranging from (5-16.22 mg/l) and was observed to be among the standard determinants of Iraqi drinking water (1996). Chloride percentage in the wells studied were ranged from (164.77-474.66 mg/l) and the majority were not compliant with the Iraqi drinking water standards (1996). The sodium adsorption rate was high (16.38-58.57mE /l). The values of (temp, EC, salinity, PO_4, Ca, mg, Na, K, Cl, SAR, T.D.S) were higher than those observed in adjacent river waters, while The values of (Do, pH, NO_2, NO_3) were lower in the wells studied than in neighboring river waters.

Key words : Physical and chemical properties, groundwater, Babylon, Iraq.

Introduction

Water is a main natural resource. However, in nature, water resources can be in different forms such as rivers, lakes, glaciers, rainwater, groundwater, etc. Besides the need for drinking water, water resources can play a vital role in various fields of the economy such as agriculture, livestock, forests, and in industry, such as power generation, fisheries and others. The abundance and quality of water resources, whether surface or terrestrial, have deteriorated for several important factors attributable to the increase in population, industries, urbanization and city construction (Shweta *et al.,* 2013). Properties are detrimental to human health if they exceed the limits set and therefore has been developed global and Iraqi indicators of the suitability of water for use. The Water Quality Index (WQI) is one of the most effective ways of describing its quality. It uses water data and helps to modify policies developed by various environmental monitoring agencies. It has been shown that the use of an individual water quality variable to describe it cannot be understood by the general public is easily accessible so WQI has the ability to reduce and express the bulk of information in a simplified and logical

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way (Babaei, *et al.,* 2011) (Bharti, and Katyal, 2011). Groundwater is a preferred source of water because it is often unnecessary to treat it and because its temperature and relative density are almost constant throughout the year as it has helped to provide cheap water as major source of drinking (Al-Saadi & Maulood, 1991; Ahmed, 1993), due to the importance of groundwater and the scarcity of the Tigris and Euphrates rivers in recent times and the increase of modern residential areas that have not been equipped with liquefaction stations in addition to the sharp decline in the supply of electricity, which limits the work of filtering stations and pumping drinking water to residential areas all these reasons lead to increased dependence on water Wells in some areas and their adoption as a primary source for various use, so the aim of the study is to determine the quality and suitability of water for some wells of the province of Babylon to drink according to the results obtained compared with Iraqi indicators.

Materials& Methods

Sampling Method

Samples were collected from water wells from December 2018 to March 2019 by pumping water from the well for ten minutes before taking the sample to make sure that the sample represents the quality of groundwater that feeds the well where the temperature and electrical conductivity and pH were measured in the field using a mercury thermometer included Conductivity meters and pH meters, respectively, samples of water were brought by polyethylene bottles (5L) for laboratory tests (chemical and physical).

Temperature

The temperature of the well water was measured directly in the field using a mercury thermometer of (0-100°C).

Dissolved Oxygen

The dissolved oxygen was measured according to the method adopted by the American Health Association (APHA, 1998), the Azide Modification method to determine the amount of dissolved oxygen after stabilization in the field by correcting it with sodium thiosulfate (0.025 N) and expressing the results in mg/l.

Biological Oxygen Demand

The Oxygen Biological Requirements were calculated according to the Winkler method (APHA, 2003) for measuring oxygen. Winkler bottles of Opaque color which were not fixed for 5 days were incubated under 20°C and BOD5 calculated according to the equation below: - Biological Oxygen Requirement (mg/l) = (primitive dissolved oxygen before cuddling) - (final dissolved oxygen after cuddling).

PH

The PH of the water was calculated in the field using pH meter manufactured by the Lovi bond Model (SD300pH) after calibration with a buffer solution of pH 4, 7, 9.

Total Hardness

The hardness was measured according to the method (Lind, 1979) and described in (APHA, 2003) by correction with Ethylene Diamine Tetra Acetic (disodium salt) (EDTA 2Na) where Erichrome Black T (EBT) was used as evidence and the product was expressed in calcium carbonate mg/ L was calculated by the following equation: -

$$\text{Total hardness (as } CaCO_3 \text{ mg/L)} = (A \times B \times 1000) / \text{mL of sample}$$

A: represents the EDTA 2Na size used for correction.

B: grams of calcium carbonate equation for one ml of EDTA

Electrical conductivity & Salinity

Electrical conductivity was measured using HANNA Conductivity Meter (Cond 7110). German origin, which contains a cathode electrode attached to a sensor in addition to that it contains a digital screen that expresses the results in microsomes/cm (M.S/Cm), Salinity values were calculated and expressed in part bear thousand in terms of electrical conductivity (APHA, 1998).

Total Dissolved Solids

Measured according to the method described by the American Health Association (APHA, 2003) by filtering (100 ml) of the sample water with filter paper (0.45 micron) and then collected the filtrate in his eyelid of known weight (B) The filtrate was fumigated in a furnace temperature 103 -105°C and then the vessel was weighed with its contents (A) and the total dissolved solids (TDS) were calculated by the following equation: -

$$\text{T.D.S} = (A - B) \times 1000/\text{volume of sample (ml)}.$$

The results were expressed in mg / l.

Nitrite

The method (Parsons *et al.,* 1984) using Spectrophotometer Spectronic-601 manufactured by the German company (Bausch and Lomb) with a wavelength of (543 nm) was used to calculate the nitrite concentration which is directly proportional to the intensity of the resulting pink color and expressed the results. With micrograms/liter

Nitrate

Nitrate concentrations were measured using the method (parson's *et al.*, 1984) referred to in (Wood *et al.,* 1967), where NO_3 is reduced to NO_2 by cadmium copper column and using a (543 nm) wavelength spectrometer to measure nitrate concentration. The results are expressed in mcg/l.

Phosphate

Effective phosphate was measured according to the method described in (Parsons *et al.,* 1984) using a spectrophotometer at a wavelength of (885 nm) and expressed results in mcg/l.

Calcium

The calcium concentration was measured according to the method proposed by the American Public Health Association (APHA, 2003) by correction with 2N EDTA solution after the addition of NaOH (1 N) the use of Murexid dye as a guide and expressed in units of calcium carbonate / liter.

$$= (A \times B \times 400.8) / \text{mL of sample}$$

It represents the size of EDTA 2Na used for correction.

B: Gr Calcium carbonate equation for one ml of 2 Na. EDTA

Magnesium

The magnesium values were calculated using the calculation method and the equations shown from

(Lind, 1979): -

$$\text{Mg (mg / l)} = 12, 16 \times (\text{mEg hardness per liter} - \text{mEg Ca per liter})$$

$$\text{Mg Eg hardness per liter} = \text{mg hardness per liter} \times 0, 01998$$

$$\text{Mg Eg Ca} + 2\text{perliter} = \text{mg Ca} + 2\text{per liter} \times 0,499$$

The results were expressed in mg/l

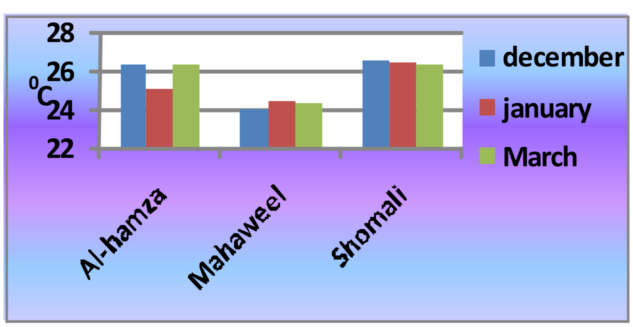

Fig. 1: Monthly and location changes in water temperature rates in the wells studied.

Sodium and potassium

Sodium and potassium concentrations were calculated using flame photometer (pep7) and the results were expressed in mg/l (APHA, 2003).

Chloride

Chloride was measured according to the method described by APHA, (2003) by taking 5 mL of the sample and then supplementing to (25ml) with distilled water and then adding 1.25 mL of the potassium chromate solution to the model and correcting with the standard silver nitrate solution 0.0141 and then adding the same amount of potassium chromate solution To the distilled water placed in another beaker, the samples are flushed for both the sample and distilled water with the standard silver nitrate solution and the correction stops when the reddish-brown color appears.

$$\text{Chlorides Mg / L} = (A - B) \times N \times 35450 / \text{Model size in ml}$$

A – (ml) volume of silver nitrate solution used to correct the model

B – (ml) volume of silver nitrate solution used to correct distilled water.

N - Standard (silver nitrate used in correction) is 0.0141 N

Sodium Adsorption Ratio (SAR)

This ratio reflects the effectiveness of sodium ion relative to calcium and magnesium ions and is calculated according to (APHA, 2003).

$$SAR = Na / \text{“}Ca + Mg / 2$$

Results and Discussion

Water temperature

The highest average water temperature was (26.66 C0) in water wells Alshomali water during December 2018 and the lowest rate was (24.11C0) in Al Mahaweel water wells during the same month. (Fig. 1). The water temperature is higher than that recorded in adjacent river

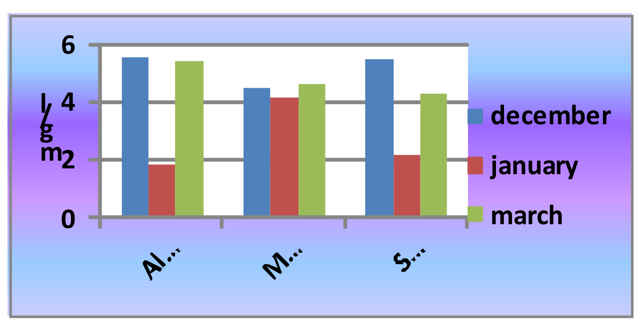

Fig. 2: Monthly and location changes of dissolved oxygen rates in the wells studied.

water. This may be due to sampling time, solar radiation, river depth, runoff, and air movement (Ezekiel *et al.,* 2011). The temperature values of the wells studied were within the permissible limits of Iraqi drinking water (Iraqi Environmental Legislation, 1998). The study is consistent with the study of Mohammed (2018) for some wells of Kader Karam district.

Dissolved oxygen

The highest rate of dissolved oxygen reached (5.54 mg/l) in Hamza wells water during December 2018 and the lowest rate of (1.87 mg/l) in wells water itself during January 2019 (Fig. 2). This leads to a quantitative and qualitative overlap between the surface water of the river and the groundwater of the wells (Khazraji, 2011). The results of the present study are consistent with Fadhil's study (2014), and the results came at times and other times lower than the allowed Iraqi borders for drinking purposes (2001), which is lower than observed in the neighboring river water, due to the algal blooms and aquatic plants in winter and thus increase the process Photosynthesis, Solomon *et al.,* 2009, Olele and Ekelemu, 2008).

Biological oxygen demand

The results of the current study showed that the highest rate of oxygen biological requirement was (1.55 mg/l) in Al-Hamza water wells during December 2018 and the lowest rate of (0.28 mg/l) in Al-Shomali water during January 2019 (Fig. 3). Due to the increased amount of oxygen available for consumption by microorganisms. The current study is comparable to the study (Obeidi, 2009) and less than the study (Dellys, 2017), that the above values are within the limits allowed by the Central Organization for Standardization and Quality Control (2001). Which is much lower than observed in the waters of neighboring rivers.

PH

The highest pH value in Mahawil wells was recorded in January 2019 as it reached (7.69) and the lowest value was (7.26) in Shomali wells during December 2018 (Fig. 4). The current study is in line with Abdullah 2016 for groundwater in Fallujah. It is within the limits permitted by the Central Organization for Standardization and Quality Control (2001), which is lower than that recorded in adjacent river waters.

Total hardness

The highest rate of total hardness in the wells studied was 1168.88 mg / l in the wells of Shomali during March 2019 and the lowest rate was 604.66 mg / l in the wells of Al-Hamza wells during January of the same year (Fig. 5) and was classified as very hard (Todd, 1980). It is consistent with Hussein and Salem (2017) study of groundwater quality north of Mosul. It is higher than the limits allowed for drinking by the Central Organization for Standardization and Quality Control (2001). It is also

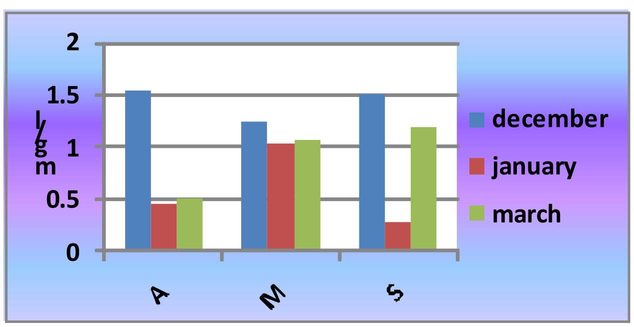

Fig. 3: Monthly and location changes in (BOD) in Wells Water.

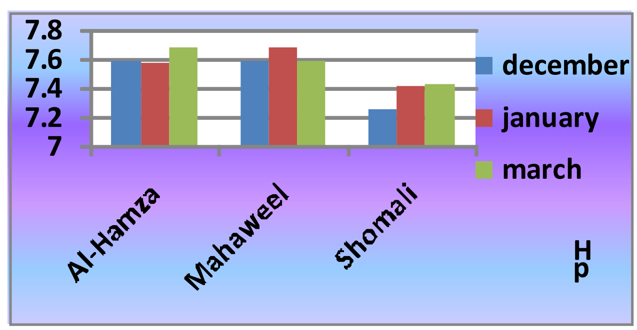

Fig. 4: Monthly and location changes in pH Rates in Wells Water studied.

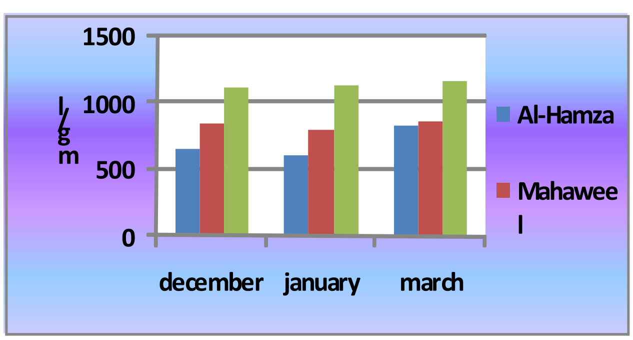

Fig. 5: Monthly and location changes in the total hardness rates in the wells studied.

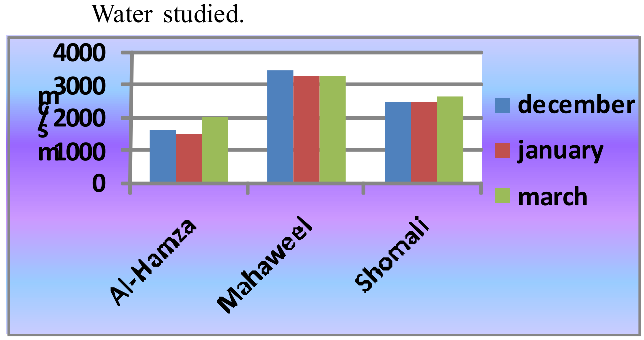

Fig. 6: Monthly and location changes of electrical conductivity Rates in Wells Waters.

higher than that recorded in neighboring river waters. The low overall hardness rates in river water may be attributed to high water levels due to high rainfall during the study period and its overlap with River water is thus diluted (Tomas, 2007).

Electrical conductivity

Electrical conductivity rates ranged between the highest value of (3505.55Ms/cm) in the water wells of Mahawil during the month of December 2018, while the lowest rate of (1554.77 Ms/cm) in the water wells of Al-Hamza during the month of January 2019 (Fig. 6), The results of the present study showed an increase in the values of electrical conductivity in the water of all wells studied. The reason for the increase may be attributed to the irrigation water washing with which salts are washed into the groundwater. This is demonstrated by the Hutchison study (1957). The values of electrical conductivity exceeded the Iraqi determinants for drinking purpose (1998). The present study agreed with the study of Shawani (2014), and that the values of electrical conductivity were more than recorded in the adjacent river water.

Salinity

The highest salinity rate was (1.68 ppt) in Al-Mahawil water wells during December 2018 and the lowest rate was (0.69 ppt) in Al-Hamza water wells during the same month (Fig. 7). The results of the current study are consistent with those recorded in the results of Al-Kaabi (2013) in his study of the water of some wells of Al-Qadisiyah governorate. And lower than recorded Khazraji (2011), which is higher than the salinity values recorded in the waters of neighboring rivers. This may be due to the high levels of river water due to heavy rainfall during the study period, which prompted the concerned authorities to release large quantities of stored water to the rivers, which contributed to the reduction of salinity in the studied river water (Laskar and Gupta, 2009).

Total dissolved solid

The total dissolved solids rates for the studied wells ranged between the highest rate of (2408 mg/l) in the water of the wells of Mahawil during January 2019 and the lowest rate of (1011.33 mg/l) in the water of Hamza wells during the same month (Fig. 8). All the values of the wells studied were higher than the limits allowed by the Central Organization for Standardization and Quality Control (2001), and the results were similar to Abdullah and Majeed (2015) and less than Hussin (2017). The rates of total dissolved solids in the wells studied are higher than in nearby river waters. This can be attributed to the fact that total soluble solids are reduced when rainfall is caused by dilution or by increased river discharge (Floder & Burn, 2004).

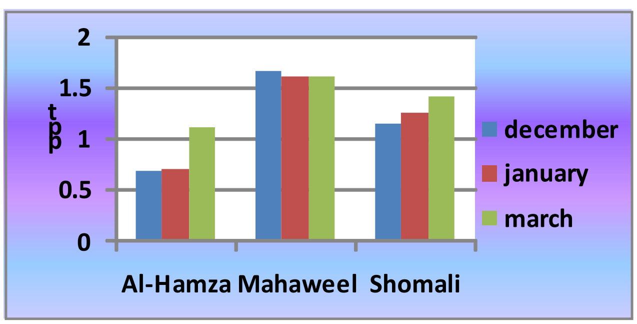

Fig. 7: Monthly and location changes in Salinity Rates in Well Study.

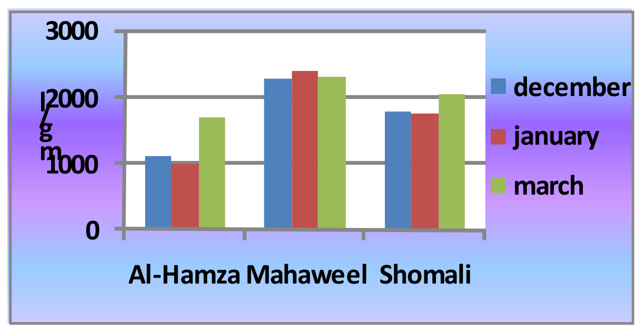

Fig. 8: Monthly and location changes of total dissolved Salts in the Wells Water.

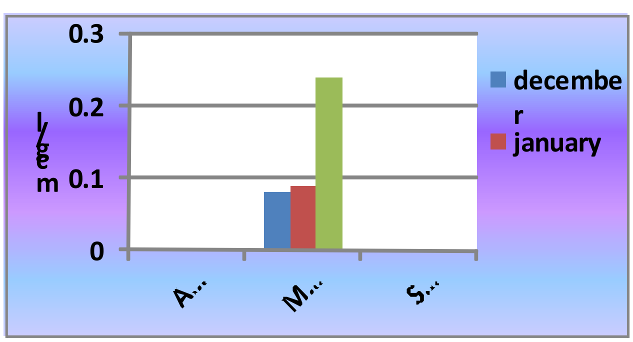

Fig. 9: Monthly and location Nitrite changes in the Wells Waters studied.

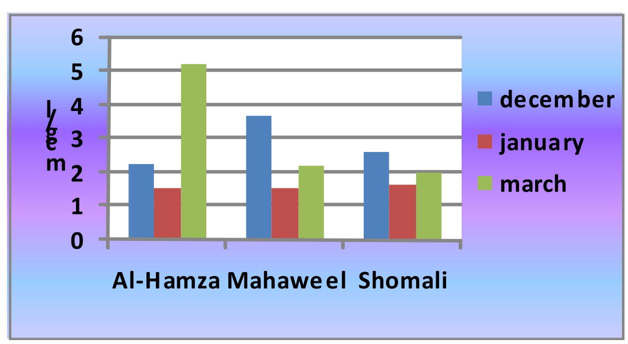

Fig.10: Monthly and location changes of Nitrate in Wells Waters studied.

Nitrite

The highest rate of nitrite was (0.24 mcg/l) in Al-Mahaweel water wells during March 2019, whereas in Al-Hamzeh and Al-Shomali wells it was not recorded in all the study months (Fig. 9). The low nitrite values are attributed to the oxidation of nitrite to nitrate by oxygenation of air between the soil pores (Menmi, 2002). The results of the study were well below the limits allowed by the Central Organization for Standardization and Quality Control (2001). This study is consistent with the study of al-Obeidi and Abdul Jabbar (2016) of the physical and chemical characteristics of groundwater in Tuz district and less than the study of Khazraji (2011).

Nitrate

The results of the present study showed that the highest nitrate rate was (5.24 mcg/L) in Al-Hamza wells water during March 2019 and the lowest rate was (1.53 mg/L) in Al-Hamza wells water during January of the same year (Fig: 10). An increase in nitrate concentrations was observed in March, possibly due to the availability of dissolved oxygen that converts nitrite to nitrate (Maulood, 1993). It was also found that all the wells under study in the Iraqi drinking water standard (2001), which is much lower than recorded in the nearby river water, may be due to rainfall which leads to increased solubility of nitrogen oxides found in the upper atmosphere layers of nitrification process (Goldman & Horne, 1983).

Phosphorus

The highest rate of phosphorus was (0.43 m/l) in Al-Mahawil wells during March 2019 and the lowest rate in all sites during December was insignificant (Fig. 11). In general, phosphorus values at all sites were low and this was consistent with what was confirmed (Ruttner, 1973). Most of the results of the present study were in conformity with the limits allowed by the Central Organization for Standardization and Quality Control (2001), except for the location of Mahawil during the month of March and therefore do not pose a health hazard. It is higher than recorded in nearby river water, and may be due to or that phosphate is consumed by phytoplankton by a process called omnivorous feeding, where phytoplankton stores excessive amounts in their cells (Goldman and Horn, 1983). The current study is consistent with Obeidi and Abdul Jabbar (2016) and less than Ali (2010).

Calcium

Calcium levels ranged between the highest rate of (289.06 mg/l) water wells Al-Shomali during December 2018 and the lowest rate (107.08 mg/l) in the water wells Al-Mahawil during the month of January 2019 (Fig. 12). Most of the calcium values in the study wells were higher than the permissible limits for Iraqi drinking water (Central Organization for Standardization and Quality Control 1996). It is also higher than the rates recorded in the adjacent rivers, and may be due to the decrease of calcium values in river water as a result of consumption by some aquatic organisms used in the construction of structures and the growth of eggs (Wetzel, 2001).

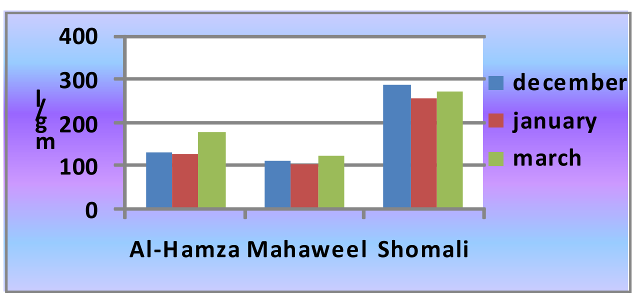

Fig.11: Monthly and location changes in Phosphorus Wells Waters studied.

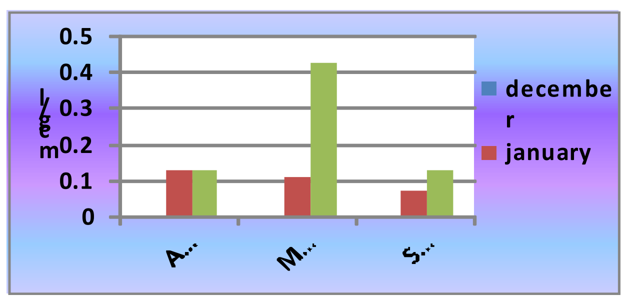

Fig.12: Monthly and location changes of Calcium in Wells Waters studied.

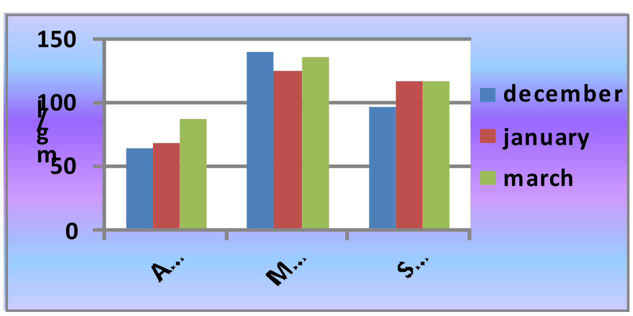

Fig.13: Monthly and location changes of Magnesium in the Wells studied.

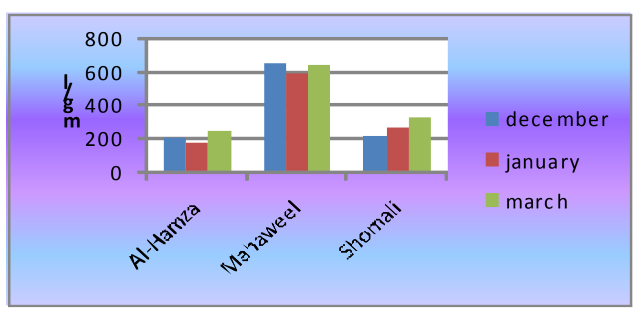

Fig.14: Monthly and location changes of Sodium in Wells Water studied.

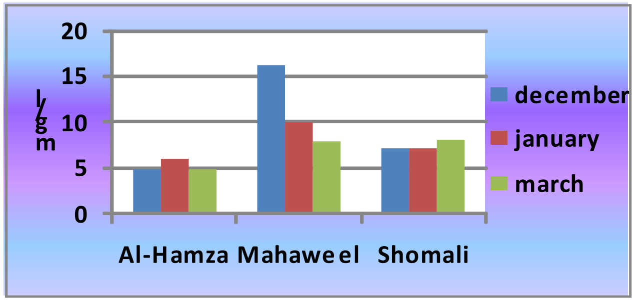

Fig.15: Monthly and location Potassium changes in Wells Water studied.

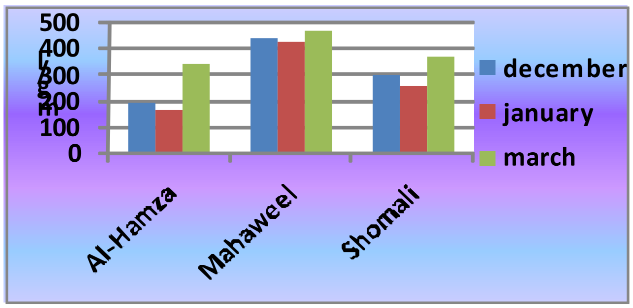

Fig.16: Monthly and location changes of Chloride in Wells Water studied.

Magnesium

The results showed that the highest rate of magnesium was (139.89 mg/l) in Al Mahawil wells during December 2018 and the lowest rate was (64.2 mg/l) in Al Hamza wells during the same month (Fig. 13). The results of the current study agree with Salman and Mahdawi (2016) and less than recorded in the study Hillo (2013). The values of magnesium in all wells studied were in accordance with the permissible limits of Iraqi drinking water (1998). The magnesium values in the wells studied were significantly higher than in the adjacent rivers waters.

Sodium

The highest rate of sodium in the studied wells was (652.44 mg/l) in Mahawil wells during December 2018 and the lowest rate was (176.88 mg/l) in Al-Hamza wells during January 2019 (Fig. 14). The sodium values of the studied wells were higher than the limits allowed for drinking by the Central Organization for Standardization and Quality Control (2001). It is significantly higher than the sodium values in the adjacent rivers water, and the results of the study were comparable with the study Al-Mansori (2017) and higher than the record Al-Hadithi (2018)

Potassium

Potassium levels ranged from the highest average of (16.22 mg/l) in Al Mahawil wells during December 2018, while the lowest rate was (5 mg/l) in Al Hamza wells during December and March (Fig. 15). The low potassium values may be due to the fact that plants absorb potassium ions from soil water (Saulus, 2002). Potassium values were among the standard determinants of Iraqi drinking water (1996). It is more than observed in adjacent river waters, and the study agrees with Al-Salim & Salih (2001) and less than Mansori (2017).

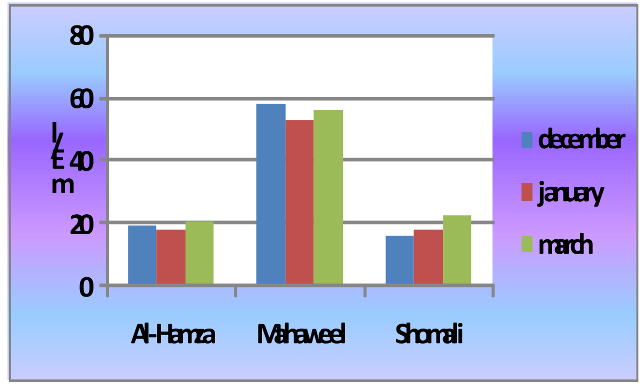

Fig.17: Monthly and location changes of Sodium Adsorption in Wells Water studied.

Chloride

The highest rate of chloride was (474.66 mg/l) in Al Mahawil wells during March 2019 while the lowest rate was (164.77 mg/l) in Al Hamza wells during January of the same year (Fig. 16). The majority of the water in the wells of the present study did not comply with the Iraqi drinking water standards (1996). It was noted that their values in the wells of the studied wells are higher than that observed in the waters of neighboring rivers.

Sodium Adsorption Ratio

The highest value of sodium adsorption was recorded in Al Mahawil wells water at (58.57 mE/l) during December 2018 and the lowest value was (16.38 mE /l) in Al Shomali wells in the same month (Fig. 17). The results of the current study are consistent with Al-Kaabi (2013) and higher than Hadithi and Al-Afasi (2016). It is much higher than in nearby river waters.

Conclusions

1. High and low water levels in the Euphrates River have been shown to have a clear effect on the physical, chemical and biological characteristics of wells and studied rivers.
2. It was observed when the well was left for a shorter period of use during the study period, the higher electrical conductivity, salinity, which was observed in the water wells during the month of December.
3. It was noted that most of the wells are not suitable for human drinking, but they may be suitable for irrigation of some crops resistant to salinity.

Recommendations

1. Take into account the choice of the location of the well when drilling and it is best not to dig near the riverbeds or low areas.
2. Conducting other wells studies in the area and conducting periodic inspection of existing wells.
3. Keeping wells as far as possible from animal's husbandry fields.
4. The use of plastic pipes to lining wells instead of steel pipes to prevent oxidation of iron and the resulting harmful results.

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