Al-Kufa University Journal for Biology / VOL.13 / NO.1 / Year: 2021
Print ISSN: 2073-8854 Online ISSN: 2311-6544

Study of chemical pollution of well water in Doura area / south of Baghdad with some minor and heavy elements (Fe - Mn - Zn - Cu - Co - Pb - Cd and Ni)

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Abstract:

This study was conducted to find out the chemical contamination of some minor and heavy metals (iron, manganese, zinc, copper, cobalt, lead, cadmium and nickel) for well water in the Doura area south of Baghdad governorate, where eight wells were identified and selected, water samples were collected from them monthly starting from December 2018 to November 2019. The results indicated the presence of trace concentrations of the trace elements iron, manganese and zinc (0.09-0.29, 0.016-0.339 and 0.01-0.732 ppm), respectively. The values did not exceed the determinants of the World Health Organization for drinking water for the year 2011, as well as the standards specifications of the Central Organization for Standardization and Quality Control and the Iraqi Ministry of Environment. No concentrations of the micro-elements copper, cobalt, lead, cadmium and nickel were found in the water samples taken from the wells under study. The values of the pH function of water ranged from 7.13- 8.12, the electrical conductivity of 1.12-3.65 dS.m-1, and the values of the rate of sodium adsorption ranged between 1.14-3.98 The concentrations of positive and negative ions also varied according to the locations of the wells. The guide of the World Health Organization has been adopted for the permissible limits for the use of water for human use, and the values of concentrations of trace elements are less than the permissible limits in the guide. However, groundwater cannot be used for human uses because other specifications of the guide do not match and are not valid for other reasons unless it is treated in water treatment units.

Key words: well water - trace elements (Fe - Mn - Zn - Cu - Co - Pb - Cd and Ni)

Introduction :

The ingress of sewage and industrial waste into aquifers is a clear source of groundwater quality deterioration and pollution. This poses a great danger to public health and calls for an urgent need to follow up on the physical, chemical and biological analyzes of groundwater samples. In order to determine its suitability for human consumption. (Sophocleous, MA 2004) Heavy elements are those elements that have an atomic number greater than 20 and a specific density greater than 5 g / cm3, and they are substances of natural origin and spread in nature very widely and move between parts of the environment and its components continuously from one place to another and from one form to another (Age, 2000). As for the microelements, they are called in the language of those interested in nutrition and soil fertility, Micronutrients. They are minerals or elements that all organisms need in small quantities to complete their life cycle, and they may be archaeological and are known as trace elements. elements) due to their presence in the tissues of living organisms in a small amount, but they have a physiological effect on the growth of living organisms. It has the ability to dissolve in water and is present in surface and ground water in very small quantities (Boyd, 2000). Estimating the concentration of microelements in water is very important to determine the quality of water because it is important in plant growth and agricultural production, and it is necessary for the growth of organisms and their impact on human health, but when their concentration exceeds certain limits, they are harmful and toxic. The elements get dissolved and mix with the water of streams, springs and rivers and move with the water according to the hydrological cycle, or its harmful concentration increases due to pollution and the expulsion of toxic substances into the water. , 2011). Heavy metals or heavy metals are thrown into rivers directly from heavy water intake stations to river water directly, causing pollution to surface and ground water and deteriorating human health due to an increase in their percentage above the limits permitted by the World Health Organization, the most dangerous of which are lead, chromium and nickel. Cunningham et al, 2007, Barakat, 2007, Stoker, 2008, and WHO, 2011). The scarcity of water with the increase in demand for it has prompted the human being to search for new alternative sources and with the advancement of technology and ease Obtaining well-drilling equipment and providing pumps to extract water. The best alternative is groundwater. The Tigris River is the only source of irrigation in the Dora area in Baghdad governorate, but the decline in the Tigris River levels in the last years of the previous decade and its continued scarcity in the current decade prompted farmers and owners of fish shops In the Dora area, they have to dig wells to obtain water, especially in the summer, when there is a shortage of water. Also, the owners of orchards, nurseries and residential houses with large gardens have dug wells in their properties to obtain water suitable for irrigation and reduce dependence on liquefied water alone and take advantage of groundwater at the lowest financial cost (Al-Qaysi et al., 2012). (Al-Hassani, 2003) dealt with in his study the environmental indicators of the filtered water in the Dora / Baghdad area. The results of the study showed that the water of the study area belongs to the sulfate group, except for the water of one of the wells representing the Al-Jazirah region, which was included in the bicarbonate group. The study showed the pollution of groundwater and river water The Tigris with lead and cadmium elements as well as iron and nickel for the water of some wells. The study indicated that some wells water are bacterial contaminated, and that the total number of bacteria exceeds the permissible limit for all wells water, which were analyzed, while the groundwater was found to be unfit for drinking purpose. By Barakat (2007) in measuring drinking water pollutants in some areas of Baghdad, as samples were taken from the Tigris River and compared with water samples from the Al-Wahda and Al-Qadisiyah water projects through the filtration stages to the homes. The concentrations of lead and cadmium exceeded the standard limits allowed in drinking water specified from The Central Organization for Standardization and Quality Control accepted the Iraqi Standard Specification 417 (Central Organization for Standardization and Quality Control, 2011) in all water models that were studied, while the The concentration of iron, nickel, chromium, zinc and copper elements within the permissible limits in all water samples according to the Iraqi Standard No. (417) (Barakat, 2007). In a study carried out by Al-Dulaimi (2011) to find out the chemical pollution resulting from the discharge of Fallujah sewage into the Euphrates River through the course of the river in the city of Fallujah, an increase in the concentrations of the trace elements iron, manganese, zinc and copper in the Euphrates River and an increase in the concentrations of heavy metals cadmium, nickel and lead After the last sewage plant on the course of the river due to the lack of treatment of sewage and its discharge to the river directly. Boyd (2000) indicated that iron, manganese, zinc and cobalt are among the micro-elements that exist in a state of equilibrium between the solid metal phase and the ionic phase dissolved in water. Concentrations of iron and manganese reach 0.25 mg/L and 0.25 mg/L, respectively, in surface waters in the United States of America. Iron and manganese are important for plants to complete their life cycle. As for zinc and copper, their concentration in water is very low at a reaction degree of 6-8 as The concentration of zinc is 0.062 mg/l at reaction point 7 and copper concentration is 0.028 mg/l at reaction point 7. As for cobalt, its presence in the earth's crust is very little, so the concentration of dissolved in water is very little, its dissolved concentration in water reaches 1-2 micrograms Also, the concentration of cadmium is low in the earth's crust, so its concentration in water does not exceed 1 microgram/liter. As for chromium, its concentration in the earth's crust is more than cadmium, so its concentration in water reaches 9.7 micrograms/liter, and the concentration of dissolved lead in Water is 1-10 micrograms/liter, and the dissolved nickel concentration in water is 2-10 micrograms/liter in surface waters in the United States of America (Boyd, 2000). In a study carried out by Jinwal et al. (2009) to investigate the presence of microelements (Fe, Mn, Cu, Zn, Co, Ni and others), which he considered important and necessary in the growth of living organisms, including humans, and that their deficiency causes disease symptoms, while other elements such as (Pb, As and Hg) (It is considered unnecessary and its presence is considered toxic to living things and humans, and they found some concentrations of these elements in the groundwater in the study area, but it did not reach the degree of danger and remained within the permissible limits according to the guide of the World Health Organization (Jinwal et al, 2009)), and a study showed that By Ayotte et al. (2011) to assess ground water in the United States to measure the concentration of microelements in samples taken from 1992 to 2003 as part of the National Geological Survey project and the Water Quality Assessment Program in the United States of America. The microelements boron, iron, lead, molybdenum, cadmium were measured , lithium, zinc and other minor elements. They found there is a difference and diversity in the concentration of the microelements that have been studied. The reasons are due to the geological diversity of the earth's crust that characterizes the United States of America. And they found an increase in the solubility of microelements in groundwater associated with a decrease in the pH of groundwater after pH 7.0 except for molybdenum, which increases in concentration and solubility at pH of more than 7.0 (Ayotte.et.al, 2011). Schauss (2012) also pointed out that water mixes homogeneously with many substances more than any other known solvent. All minerals required by our bodies to maintain its health. Therefore, the research aims to study the chemical pollution of small and heavy elements in groundwater in wells used by the citizens living in the Dora area and to know their impact on the health of**.**

Materials and methods:

Eight wells were selected distributed in separate residential neighborhoods in the Doura area, south of Baghdad governorate, their depths ranged between 15 and 20 meters. The field work included conducting field tours of the study area, which included collecting water samples from the wells spread in the area. Water samples were taken from these wells monthly for a period of one year, starting from December 2018 to October 2019. Where two samples were collected for each site for the purpose of chemical analysis, and then the results of the tests were taken as a quarterly average, i.e. an average of three months. Plastic bottles with a capacity of (1000 cm3) were used to collect and store samples at 4°C according to (Abbawi, 1990) and APHA 1998) APHA, 1998). A sample of the water of the Tigris River was taken monthly near the electrical cycle station for the purpose of conducting the analysis on it and comparing it with the results. The concentration of small (Fe, Zn, Mn, Cu) and heavy (Pb, Co, Ni, Cd) elements was measured by an atomic absorption device (BUKE SCIENTIFIC) according to the methods contained therein and the wavelengths of each element (BUCK, 2006). set out in Table 1.

Table (1) shows the elements and wavelengths that were marked when measuring (BUCK, 2006)

Ni	Cd	Pb	Co	Cu	Zn	Mn	Fe	Element
232	228.9	217	240.7	324.8	213.9	279	248.3	Wavelength ηm

The pH value was measured with a pH meter. Hana type, and electrical conductivity measurement device. The sodium and potassium ions were measured with a flame photometer, Optima model 3000Sp. It also expressed the concentration of sodium to calcium and magnesium by the sodium adsorption ratio SAR (Winer, 2007). While the chloride concentration was measured by scaling method with silver nitrate AgNO3. Sulfate ions SO4 = SO4 in water samples were estimated by precipitating them as barium sulfate with barium chloride. The dissolved carbonates were estimated by scavenging with sulfuric acid (1N) using the phenonphthalein reagent, and bicarbonates in water models by scaling with sulfuric acid (1N) using the methyl orange reagent (APHA, 1998). TDS was measured using the gravimetric method, according to what was stated in the American Health Association (APHA, 1998).

Results and discussion :

It is evident from the quarterly averages of the concentrations of minor and heavy elements that were diagnosed in the well water samples under study for the period from December 2018 to November 2019 in sequence Table No. 2 Average months of December 2018, January 2019 and February 2019 Table No. 3 Average months March, April and May 2019 and Table No. 4 Average months June, July and August 2019 Table No. 5 Average months September, October and November 2019. The last column in the tables shows the specific values of the concentration of these elements for potable water according to the World Health Organization (WHO, 2011) guide, which considers an increase in the concentration of these elements harmful and poisonous to humans. Basic measurements were also made to assess water quality to determine its suitability for civil and agricultural uses and to calculate the values of sodium adsorption ratio. The chemical analyzes of water samples taken from wells showed archaeological concentrations of iron as shown in Table (2) that the iron concentration ranged (0.10 - 0.31 parts per million) in some samples taken from well water during the months of December 2018, January and February 2019. It did not appear Any concentrations of iron in successive months, which are less than the values specified by the World Health Organization, 0.3 parts per million. Iron is one of the important elements for humans. Its deficiency causes anemia, but its presence in water in excess of the permissible limit 0.3-1.0 parts per million causes toxicity and bad water taste (Janwal .et al, 2009). While archaeological concentrations of manganese (0.47 parts per billion) were found in the months of December 2018, January and February 2019, the highest concentration (398 parts per billion) appeared in the months of October and November 2019 (table (5)). And all of them fall within the permissible limits according to the guide of the World Health Organization (WHO., 2011). As for zinc, which was present in concentrations that ranged (0.44-0.13 parts per million) in December 2018, with different concentrations in successive months, but it also fell within the limits of the World Health Organization (3.0 ppm). Zinc is necessary for plant and human growth and is added as fertilizers in agriculture (Al-Amri et al., 2006), and the results showed the absence of concentrations of copper, cobalt, lead, cadmium and nickel in the samples taken from the wells under study, and there was no trace of these elements in the samples taken from the Tigris River. The results do not agree with Barakat (2007) in measuring The concentration of microelements from the Tigris River, as the measured concentrations of small and heavy elements did not exceed the standard limits allowed in drinking water specified by the Central Organization for Standardization and Quality Control Standard Specification 417 (Central Organization for Standardization and Quality Control, 2011), but groundwater cannot be used for human uses Other specifications of the manual do not match and are not valid for other reasons unless they are treated in water treatment units (Al-Qaisi et al. 2012). The values of the concentrations of elements and dissolved ions for samples taken from well water can be compared with their concentrations for a sample of water taken from the Tigris River, which was included in the penultimate column in the tables.

Table No. (2) Average concentration of minor and heavy elements in the water samples of wells in Dora region for the months December 2018, January and February 2019 for eight wells

Standard values WHO ppm	Tigris river water	Well 8	Well 7	Well 6	Well 5	Well 4	Well 3	Well 2	Well 1	unit	Element
0.3	ND	0.31	0.25	0.15	0.14	0.16	0.11	0.10	0.13	ppm	Fe
0.5	ND	ND	ND	ND	ND	ND	ND	ND	0.47	ppb	Mn
3.0	ND	0.44	0.25	0.13	0.22	0.24	0.15	0.25	0.23	ppm	Zn
2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Cu
-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Co
0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Pb
0.003	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Cd
0.02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Ni
8.5-6.5	7.44	7.90	7.36	7.42	7.72	7.33	7.29	7.21	7.26		pH
0.75 dS/m	1.87	1.21	1.76	1.23	2.62	2.75	1.53	2.13	1.60	dS/m	EC
500.0	789	890	1240	845	1250	1340	1200	1210	1030	ppm	TDS
50.0	63.0	103.0	75.0	160.0	125.0	146.0	102.0	121.0	140.0	ppm	Ca++
50.0	18.6	140.1	67.8	25.70	21.60	21.4	50.2	105.3	90.0	ppm	Mg++
200.0	57.6	121.0	152.0	101.0	115.0	60.2	76.5	141.0	130.0	ppm	Na+
-	1.9	76.54	93.64	41.86	13.75	88.00	53.76	41.66	10.30	ppm	K^+
250.0	143.5	152.2	145.4	103.7	114.4	100.3	144.3	172.4	150.6	ppm	Cl^-
500.0	73.6	714.6	566.8	297.4	285.9	843.6	374.5	511.2	554.3	ppm	SO_4^{--}
-	102.4	766.5	543.8	810.5	588.9	234.8	688.0	840.0	728.0	ppm	HCO_3^-
-	2.57	1.91	3.87	1.52	3.82	1.76	1.53	2.31	1.28	-	SAR

Table No. (3) Average concentration of minor and heavy elements in the water samples of wells in Dora region for the months March, April and May 2019 for eight wells

Standard values WHO ppm	Tigris river water	Well 8	Well 7	Well 6	Well 5	Well 4	Well 3	Well 2	Well 1	unit	Element
0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Fe
0.5	ND	26.76	ND	17.98	ND	23.98	ND	20.00	37.00	ppb	Mn
3.0	ND	41.00	16.86	54.12	35.66	25.77	34.98	27.00	39.41	ppb	Zn
2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Cu
-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Co
0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Pb
0.003	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Cd
0.02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Ni
8.5-6.5	7.5	8.12	7.24	7.45	7.73	7.06	7.14	7.56	7.15		pH
0.75 dS/m	2.33	1.53	3.45	2.64	1.43	2.74	2.76	2.61	2.21	dS/m	EC
500.0	744	866	1259	914	876	1976	856	1328	1226	ppm	TDS
50.0	93.0	87.00	115.0	131.0	147.0	267.0	131.0	300.0	147.0	ppm	Ca^{++}
50.0	24.6	57.7	94.2	62.8	141.1	73.42	58.83	30.9	106.5	ppm	Mg^{++}
200.0	88.9	102.4	258.9	112.6	275.9	258.5	104.2	272.0	215.6	ppm	Na^{+}
-	2.98	14.87	93.12	40.12	3.47	42.24	59.42	42.00	33.00	ppm	K^{+}
250.0	152.7	276.8	159.0	147.0	237.0	48.0	146.0	205.5	167.0	ppm	Cl^{-}
500.0	76.0	47.0	178.0	544.0	560.9	789.6	310.0	67.0	398.0	ppm	SO_4^{--}
-	86.4	431.0	547.2	774.0	882.0	852.0	482.0	986.0	834.0	ppm	HCO_3^{-}
-	2.51	2.84	3.15	2.78	3.98	2.92	2.86	2.43	2.64	-	SAR

Table No. (4) Average concentration of minor and heavy elements in Dora wells water samples for the months June, July and August 2019 for eight wells

Standard values WHO ppm	Tigris river water	8 Well	7 Well	6 Well	5 Well	4 Well	Well 3	2 Well	1 Well	unit	Element
0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Fe
0.5	ND	ND	ND	46	18	87	76	42	98	ppb	Mn
3.0	Nil	112	33	28	19	24	67	54	140	ppb	Zn
2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Cu
-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Co
0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Pb
0.003	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Cd
0.02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Ni
8.5-6.5	7.6	7.45	7.13	7.89	7.78	7.66	7.24	7.65	7.23		pH
0.75 dS/m	1.23	2.67	2.48	1.67	1.76	2.65	2.43	2.56	1.12	dS/m	EC
500.0	870	1370	1180	810	1100	1380	1200	1800	1600	ppm	TDS
50.0	92.0	126.0	139.0	135.0	167.0	214.0	151.0	260.0	220.0	ppm	Ca++
50.0	18.4	94.0	107.0	86.0	141.0	85.0	111.0	136.0	131.0	ppm	Mg++
200.0	83.9	128.0	105.0	87.0	105.0	119.0	124.0	117.0	120.0	ppm	Na+
-	24.0	72.0	46.0	45.0	65.0	43.0	55.0	18.9	24.0	ppm	K+
250.0	164.0	262.0	151.0	148.0	187.0	114.0	156.0	250.0	172.0	ppm	Cl^-
500.0	94.0	192.0	144.0	233.0	289.0	164.00	145.00	150.00	160.00	ppm	SO_4^{--}
-	114.0	587.0	427.0	689.0	895.0	978.6	346.0	765.0	643.0	ppm	HCO_3^-
-	1.95	2.65	2.03	1.33	1.95	1.14	2.54	1.06	1.16		SAR

Table No. (5) Average concentration of minor and heavy elements for water samples from Dora wells for the months September, October and November 2019 for eight wells

Standard values WHO ppm	Tigris river water	Well 8	Well 7	Well 6	Well 5	Well 4	Well 3	Well 2	Well 1	unit	Element
0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Fe
0.5	ND	63	76	257	398	167	86	105	81	ppb	Mn
3.0	ND	610	58	34	48	161	110	50	234	ppb	Zn
2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Cu
-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Co
0.01	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Pb
0.003	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Cd
0.02	ND	ND	ND	ND	ND	ND	ND	ND	ND	ppb	Ni
8.5-6.5	7.58	7.21	7.21	7.57	7.32	7.16	7.24	7.34	7.45	-	pH
0.75 dS/m	1.94	2.36	2.93	1.76	3.61	3.43	2.86	3.65	1.88	dS/m	EC
500.0	980	1287	976	864	1154	1940	1120	1963	1950	ppm	TDS
50.0	59.0	112.0	135.0	153.0	206.0	281.0	201.0	223.0	173.0	ppm	Ca++
50.0	36.0	126.0	88.0	67.0	143.0	88.0	92.0	132.0	125.0	ppm	Mg++
200.0	89.0	131.0	88.0	76.0	138.0	198.0	82.0	139.0	136.0	ppm	Na+
-	25.0	59.0	71.0	33.0	104.0	66.0	56.0	10.0	18.2	ppm	K+
250.0	154.0	257.0	156.0	138.0	187.0	134.0	275.0	258.0	200.0	ppm	Cl^-
500.0	95.0	192.0	196.0	154.0	179.0	171.0	188.0	102.0	199.2	ppm	SO_4^{--}
-	86.0	423.0	589.0	698.0	793.0	479.0	448.0	756.0	740.0	ppm	HCO_3^-
-	1.43	1.79	2.66	2.98	2.87	3.98	1.32	1.65	1.87	-	SAR

The reason for not finding concentrations of rare and heavy elements in the water samples taken from the wells under study, and consequently, not noticing any differences or local or temporal variations in the concentrations of the elements studied in the research, may be due to the absence of geological diversity of the earth's crust in the area of the Iraqi sedimentary plain. The soil of the Mesopotamian Valley in the area of the Iraqi alluvial plain, which was called the Mesopotamian Plain, is soil transported with the waters of the Tigris and Euphrates rivers, which formed the sedimentary soil of these areas, which was called the Iraqi alluvial plain (Buringh, 1960). The proximity of these wells does not cause the melting of the minor and heavy elements from the parent material and the rocks that the Tigris River passes through (Boyd, 2000, Jinwal.et.al.2009 and Ayotte.et.al.2011).

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