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Studying the Percentage of Water Pollution in the City of Fallujah and Determining the Efficiency of Filtering Plants in Purifying Drinking Water

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Abstract

This study was conducted on the water of the city of Fallujah in Anbar Governorate for the period from November 2020 to February 2021. It studies the levels of water pollution and the studied samples were taken from the water of the river, the station and home. The study included the measurement of a number of physical and chemical properties of water represented (PH, electrical conductivity, chloride and the concentrations of sodium, calcium, potassium, lithium, and barium ions, as well as measuring the concentrations of some heavy elements (copper, cadmium, iron, lead, chromium, cobalt, zinc, and nickel) comparing them with the standard specifications. The results of the study showed that the electrical conductivity values, the pH values and the chlorides were in conformity with the international standards, and that the concentration of sodium, calcium, potassium and lithium ions was in conformity with the standard specifications. Also the barium ion concentration was high, while the concentrations of some heavy elements such as copper, cadmium, Iron, lead, cobalt and zinc were identical. According to international standards, the concentration of chromium and nickel was high and had a toxic effect. A biological study was also conducted on the sample, where types of bacterial isolates were found in the river water. As for the tap water, after treatment, some bacteria species were found and had no satisfactory effects.

1-**Introduction**

Water is a necessary liquid for life and indispensable for all living things. The importance of water to humans comes directly after oxygenating the air, as its relationship with human creatures is determined in a direct relationship, due to its entry into various fields and uses (Al-Shiblawi & Jassem, 2019). Drinking water is also closely related to the spread of diseases. As the reports of the World Health Organization (WHO) indicated, more than 25 million people die each year due to diarrhea and attributed this to water-borne pathogens and studies in the United States

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of America indicate that 59% of diseases are caused by water pollution (K AL-Taay, A Abdulhafedh, & YT Alsaffawi, 2018). In Iraq, the Ministry of Health reports confirm that there is a clear spread of water-borne diseases in the nineties of the last century until now due to the poor quality of drinking water (A.-A. Y. Al-Safawi & Al-Ta, 2013). Contaminated water contains pathogens that transmit to humans many diseases such as polio, hepatitis, typhoid and cholera, which are inherent risks when contaminating drinking water (A. Y. Al-Safawi, Al-Maadidi, & Al-Singari, 2018). Based on the importance of this topic and its direct impact on human health, many studies have been conducted on the physical and chemical properties of drinking water compared with the approved standard specifications. For example, there was a study on the physical and chemical properties of selected drinking water stations in Babil Governorate. The results confirmed the studied characteristics of the standard specifications except for the dissolved salts and the concentration of calcium ions which exceeded the permissible limits(Hatim & Ibrahim, 2012). Also, physical and chemical properties of the water of the Jurf al-Sakhr liquefaction plant in the north of Babil Governorate were examined. The results of the study matched the standard specifications and proved the inefficiency of the plant in reducing pollution(Atheer Sayeb Naji Al-Azzawi, 2004). It was poor in two sites and acceptable in other sites (Issa, 2017). Also there were studies on the concentration of heavy metals in three water purification plants in Diwaniyah Governorate from the north of the city (the large Diwaniyah project "Project No. 6") and in the city center (Algeria water complex) and in the south of the city) Housing water complex. The results showed that the concentration of aluminum exceeded the permissible limits in all stages of drinking water treatment, while the concentrations of the rest of the heavy elements (nickel, cadmium and mercury) were few and fall within the limits of the Iraqi standard specifications(Ghawi, 2017). The efficiency of the liquefaction plant was also studied. There was also a study in the unified Kirkuk water project and evaluation of water treatment to compare the qualitative physical and chemical properties of water before and after treatment and comparing these characteristics with the Iraqi standard specifications. The study revealed a good efficiency of the plant in terms of removing turbidity and suspended matter. Besides, the results showed that a number of the qualitative characteristics of raw water are already within the required specifications, which indicates the validity of the water source for civilian uses(Zainulabdeen, 2018).

2- Materials and methods

Instruments

No	Device name in English	Specifications	the manufacture company
1	**Conductivity Meter**	**BC 3020**	**Trans**

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2	**PH Meter**	**BP 3001**	**Trans**
3	**Flame photometer**	**AnIso 9001 Gertified co**	**Adarsh**
4	**(AAS) Atomic absorption spectrophotometer**	**Phoenix-986**	
5	**Sensitive balance**		**Metter Toledo**
6	**Refrigerator**		**Fiocchetti**
7	**Incubator**		**Hirayama**

Samples used:

Materials used:

-1 **Barium chloride BaCl2**.

2- K2CrO4 potassium chromate guide.

1. A sample of water from the Euphrates River for the city of Fallujah.
2. A sample of water from the water purification plant for the city of Fallujah.
3. Sample of house water for the city of Fallujah.

Bringing the samples

Samples were taken from the Euphrates River to the city of Fallujah during the period from November 2020 to February 2021 using cans made of polyethylene with a capacity of one liter. The samples were collected from the water of the Euphrates River and the water of the station after conducting a chemical and biological treatment of the water that reaches Houses (tap water), and at a specific time (eight o'clock in the morning) as zero hour.

Measurements

Electrical conductivity measurement:

The electrical conductivity measurements were made using the Conductivity Meter for each of the Euphrates River sample for the city of Fallujah, a sample of the station water and a sample of the house water during the month of November 2020, for information, December 2020, and January 2021

PH measurement:

Measurements of the pH function were carried out using a pH Meter for each of the Euphrates River sample for the city of Fallujah with a sample of the station water and

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a sample of the house water during the month of November 2020, December 2020, and January 2021.

Measurement of element concentrations:

The concentrations of some water elements (calcium, potassium, sodium, lithium, and barium) were measured using a Flame Imation photometer for each of the Euphrates River sample for Fallujah. This is in addition a sample of the station water and a sample of house water during the month of November 2020, December 2020 and January 2021.

Chloride concentration measurement:

A chloride ion measurement was performed for each of the Euphrates River water sample for Fallujah, a sample of the station water, and house water during November and December of 2020 and January and February of 2021. The correction method was followed with silver nitrate to estimate the chloride ion.

Measurement of concentrations of heavy elements:

Heavy metals (Cr, Co, Fe, Cu, Pb, Cd, Zn, Ni) were measured for each of the river, station and house samples using the Atomic Absorption Spectrophotometer of the station after treatment and house water during the period from November 2020 to January 2021. The results of the tests were compared with the limits permitted by the World Health Organization (WHO).

3-Results and discussion

The values of electrical conductivity were obtained in the following table for the water of the Euphrates River, the station and the house for the city of Fallujah during

Period	river water sample	station water sample	home water sample
2020/11	1020 ms	1077 ms	1018 ms
12/2020	964 ms	1000 ms	968 ms
2021/1	974 ms	981 ms	965 ms

the November 2020, December 2020, January 2021 and the February 2020.

Table No. (1) the values of electrical conductivity

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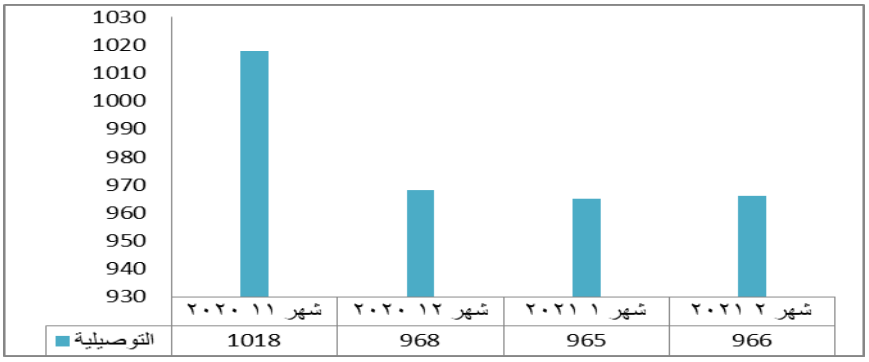
2021/2	964 ms	977 ms	966 ms

The electrical conductivity is the total amount of dissolved substances and represents a measure of the ability of aqueous solution to conduct electricity(Venkatesharaju, Ravikumar, Somashekar, & Prakash, 2010). It is strongly correlated with the amount of salts, dissolved ions and the precipitation of soluble soils in the river water in addition to the dissolved solids (Abbas & Hassan, 2018; Farhood & Ali, 2020). Its measurements of the waters of the Euphrates River were made for the city of Fallujah during the period from November 2020 to February of 2021. The obtained results showed that the value of the electrical conductivity of the river water sample for November 2020. It reached to 1020 Ms, which is an acceptable value because it is within the permissible range according to the drinking water specifications of the World Health Organization (300-1500), As for the electrical conductivity value of the station water sample (1077 Ms). It also an acceptable value, and the electrical conductivity of the house water sample reached (1018 Ms), which is also acceptable.

The electrical conductivity measurements for the month of December of 2020 for the river water sample were 964 Ms and the value of the electrical conductivity of the station water was 1000 Ms. The electrical conductivity values of the house water sample reached 968 Ms and all are considered acceptable values because they are within the permissible range according to WHO

Figure (2) The seasonal changes in the electrical conductivity values of the house water sample during the study period (November 2020 - February 2012).



•The following results were obtained when measuring the pH of Fallujah water for house water, river water, and station water for November 2020, December 2020, January 2021 and February 2021.

Table No. (3) the pH values

Period	river water	station water	home water
2020/11	6.64	7.78	6.68
12/2020	7.70	7.90	7.99

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2021/1	6.95	7.8	7.00
2021/2	6.8	7.71	6.9

The measurement of the pH of the samples taken from the Euphrates River for the city of Fallujah in the Anbar Governorate and station and the house were carried out for a period of the study using a pH measuring device. The pH of water during November 2020 is 6.64, and that this result falls within the permissible range according to the specifications of drinking water of WHO, and therefore it is considered an acceptable value, and that the pH value of the station water for the month of November (before the descent of Rain) was 7.78. This value is higher than the pH value of river water and it is considered an acceptable value because it is within the permissible range according to WHO. As for the measured pH value of the house water sample, it reached 6.68, which is an acceptable value also because it is within the permissible range according to the global health determinants of drinking water.

The pH measurements were made for December 2020, where the pH value of the river water sample was 7.7. The measured pH value of the station water sample was 7.9, while the pH value of the house water sample was 7.95 which are aWcceptable because they are within the permissible range according to the drinking water specifications of WHO. Most of the Iraqi references indicated that the pH values of Iraqi rivers water are often neutral and close to light basic (Abbas Mortada Ismail, 2012; Abdulwahab & Rabee, 2015).

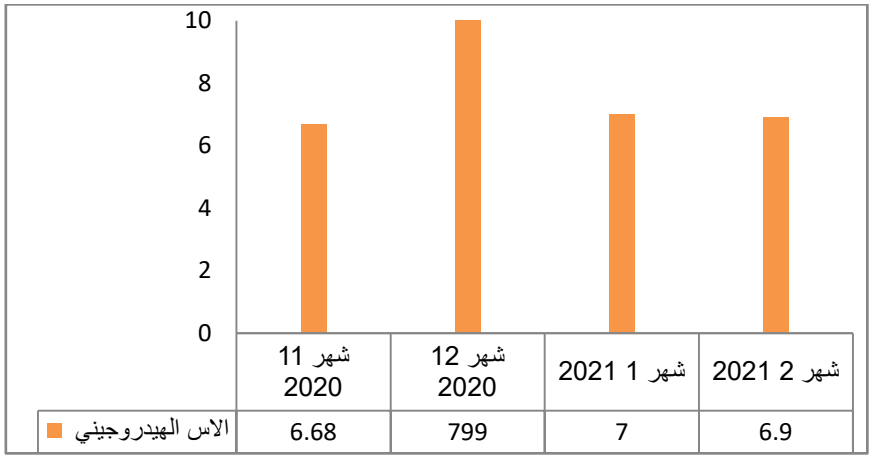

Figure (4) Seasonal changes in the pH values of the house water sample during the study period (November 2020 - February 2012(

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•The concentrations of some elements (calcium, sodium, potassium, lithium and barium) were measured in the water of the Euphrates during Novemeber 2020, December, January and February 2021, by taking samples from the water of the Euphrates River for the city of Fallujah, the water of the station and the water of the house.

Table No. (5) the measurement of the concentrations of elements during the eleventh month of 2020.

Samples	Concentrations of elements per unit PPm				
	Ca	Na	K	Ba	Li
river water sample	131	52.7	5.4	540	0.5
station water sample	136	53.7	5.8	571	0.5
home water sample	138	52.4	5.5	561	0.5

Table No. (6) the measurement of the concentrations of elements during the twelfth month 2020

Samples	Concentrations of elements per unit PPm				
	Ca	Na	K	Ba	Li
river water sample	50.8	45.4	4.5	553	0.00
station water sample	64.1	47.4	4.2	576.9	0.00
home water sample	63.00	45.9	4.2	575.4	0.00

The concentration of elements (Na, Ca, k, Li, Ba) in the water of the Euphrates River for the city of Fallujah was measured during the period from November before the rains for the year 2020 using a flame emission spectrometer. It was found that the concentration of the sodium element in the river water was 52.7 PPm. Its concentration in the plant water sample is equal to 53.7 PPm and its concentration in the house water sample (52.4 PPm). According to the parameters set by the WHO, the values obtained are considered acceptable. The percentage of calcium element concentration in the river water sample is 131 ppm and the percentage in the station water sample 136 ppm)and in the house water sample (138 ppm). These values are considered acceptable because they are within the permissible range according to the determinants of the WHO.

The concentration of potassium was also measured and it was found that the percentage in the river water sample is 5.4 ppm. Its concentration in the station water sample is 5.8 ppm while in the house water sample is (55 ppm). These percentages are less than the permissible range according to the determinants of WHO but can be considered acceptable.

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As for the element barium, it was found that its concentration in the river water sample is equal to 540 ppm and its percentage in the sample of the station water is 571 ppm. In the house water sample, it was 561 ppm. These ratios are considered very high and are not within the permissible range according to the drinking water specifications of WHO, therefore, is considered unacceptable. In addition, the concentrations of lithium were calculated for each of the river, station and house water sample, and we found that the values are equal to 0.5 ppm which are very few values and have no effect.

The concentration of elements (Na, Ca, k, Li, Pa) was measured in the waters of the Euphrates River for the city of Fallujah during December after the rain for the year 2020 using a flame emission spectrometer. It was found that the concentration of sodium in the river water was 45.4 ppm. Its concentration in the station water sample is equal to 47.4 ppm and the percentage in the house water sample is 45.9 ppm. According to the parameters set by WHO, the values obtained are considered acceptable, and the percentage of calcium concentration in the river water sample is 50.8 ppm. The percentage in the station water sample is 64.1 ppm and in the house water sample 63.00 ppm. Thus, we noticed a decrease in calcium concentration compared to the month of November due to rain, which led to a decrease in calcium concentrations. These values are considered acceptable because they are within the permissible range according to the determinants of WHO. The potassium percentage in the river water sample is 4.5 ppm and its concentration in the sample of the station water is equal to 4.2 ppm. In the house water sample, it is equal to 4.2 ppm which is of the permissible range according to the specifications of the WHO, but it can be considered acceptable. However, barium concentration in the sample of river water is 553 ppm)and the station water is 576.9 ppm. In the sample of house water, it is 575.4 ppm. These ratios are considered very high and are not within the permissible range according to the drinking water specifications of WHO. Thus, it has a negative impact on the health of the consumer, so the rates are considered unacceptable. In addition, the lithium were measured for each of the sample river, station and house water, and we found that there was no clear concentration of the element lithium.

The toxicity of barium lies in its compounds, all of which are toxic. Low doses of barium ions act as a muscle stimulator and high blood pressure. High doses affect the nervous system and lead to cardiac arrhythmias, weakness, tremors, anxiety, paralysis and shortness of breath.

•The following results were obtained when measuring the concentration of chlorine ion for the water of Fallujah city for each of the house water, river water and station water for the eleventh month of 2020, the twelfth month of 2020, the first month of 2021 and the second month of 2021

.Table No. (7) shows the values of chlorine ion concentrations for the period from November of 2020 to February 2021

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Element concentrations in PPm			Samples
home water	station water	river water	
88	90	86	2020/11
87	88	90	12/2020
95	97	98	2021/1
93	94	93	2021/2

The chloride ion concentration in the water of Fallujah city was measured during the period from November of the year 2020 using the scaling method with silver nitrate to estimate the chloride ion, where it was found that the chloride concentration in the river water is (86 PPm) and its concentration in the water sample of the station is equal to (90 PPm) and its concentration In the house water sample (88 PPm), according to the parameters set by the World Health Organization (WHO), the values obtained are considered acceptable. As for the month of December, the concentration of chloride ion in the river water sample was (90 ppm), its concentration in the station water sample (88 ppm) and in the house water sample (87 ppm. .(

The concentrations of some heavy elements (chromium, iron, cobalt, lead, zinc, nickel, cadmium, copper) were measured in the water of the Euphrates during the eleventh and twelfth months of 2020, the first and second months of 2021, by taking samples from the water of the Euphrates River for the city of Fallujah. And plant water and house water.

Table No. (9) the measurement of the concentrations of some heavy elements for the eleventh month of 2020.

Element concentrations in PPm			Element
home water	station water	river water	
0.553	0.0506	0.163	Cr
0.00	0.00	0.189	Co
0.00	0.00	0.007	Fe
0.015	0.00	0.015	Cu
0.003	0.00	0.00	Pb
0.00	0.00	0.00	Zn
0.171	0.157	0.266	Ni
0.007	0.007	0.007	Cd

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Through the results of the obtained measurements, it was found that the concentration of the element (Cr) in the Euphrates water sample is 0.163 ppm, and according to the WHOr parameters, this percentage is considered higher than the permissible limit, so these ratios are considered unacceptable. Co) was found to be equal to 0.185ppm, which is also high and considered unacceptable. Also, the concentration ofFe is equal to 0.007 ppm, which is a small percentage less than the permissible limit according to global health determinants and is considered acceptable, and the ratio of (Cu) concentration equals 0.015 ppm. This ratio is very close to the permissible limits, so it is considered acceptable, and the concentration of the element (Pb) is equal to 0.00 ppm if it has no effect with regard to the river water. The component (Cd) is 0.007 ppm, which is a ratio close to the standard specifications for drinking water so it is acceptable. The element (Zn) equals 0.00 ppm, so it has no effect. As for the element (Ni) 0.266 ppm, which is a very high percentage, it is considered unacceptable according to the drinking water specifications of the WHO.

The results of the measurements of heavy elements in the plant's water sample showed that the concentration of element (Cr) is equal to 0.506 ppm, which is a high percentage and is considered unacceptable according to the drinking water specifications of the WHO. The ratio of the elements (Co), (Fe), (Cu) and (Pb) And (Zn) equals 0.00 ppm, which means that the ratios of these elements have no effect. In addition, the ratio of Ni is equal to 0.157, which is a high percentage and is considered unacceptable according to the WHO, and the ratio of Cd element equals 0.007, which is close to the limits of Drinking water specifications are therefore acceptable.

The results of the measurements of heavy elements in the house water sample showed that the component ratio (Cr) is equal to 0.553 ppm, which is a high value higher than the permissible limit according to the drinking water specifications of the WHO, so it is considered an unacceptable value. Zn is equal to ppm0.00, and the ratio of (Cu) element is equal to 0.015 ppm, which is lower than the permissible limit, so it can be considered acceptable, and the ratio of the component (Pb) is equal to 0.003 ppm, where this value is considered acceptable as it is not less than the permissible limit. Ni equals 0.171 ppm and this value is higher than the permissible value, so it is considered unacceptable, and the element (Cd) equals 0.007 ppm, which is a value close to the permissible value, so it is considered an acceptable value

Table No. (10) the values of the concentrations of some heavy elements for the twelfth month of 2020

Element	Element concentrations in PPm		
	river water	station water	home water
Cr	0.6	1.084	0.739
Co	0.00	0.00	0.004
Fe	0.00	0.00	0.00

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Cu	0.00	0.00	0.00
Pb	0.00	0.00	0.00
Zn	0.00	0.00	0.00
Ni	0.219	0.254	0.280
Cr	0.006	0.006	0.007

Through the results of the measurements that were obtained and conducted in December of the year 2020, the percentage of the element (Cr) in the Euphrates River water sample for the city of Fallujah is 0.6 ppm. According to the parameters of the WHO, this percentage is considered to be higher than the permissible limit. Therefore, this percentage is considered unreasonable. The concentrations of the elements (Co, Fe, Cu, Zn, Pb) was found to be 0.006 ppm, so these elements have no effect. This percentage is close to the standard specifications for drinking water, so it is acceptable while Ni is 0.219 ppm, which is a very high percentage, so it is unacceptable according to the drinking water specifications of the WHO.

The results of the measurements of heavy metals in the station water sample showed that the concentration of the element (Cr) equals 1.084ppm, which is a very high percentage and is considered unacceptable according to the specifications of drinking water of the WHO. Aslo, Co, Fe, Cu, Zn, Pb equal to 0.00 ppm, so these elements have no effect, and the percentage of element (Ni) equals 0.254 ppm, which is a high percentage and is considered unacceptable. Also, element (Cd) equals 0.006 ppm, which is close to the permissible value according to the specifications of drinking water, so it is considered acceptable.

The results of the measurements of heavy metals in the house water sample showed that the ratio of element (Cr) is equal to 0.739, which is a high value that is higher than the permissible limit according to the specifications of drinking water, so it is considered an unacceptable value. CO is 0.004 ppm, where this value is considered acceptable, while Fe, Cu, Zn, equal to 0.00 ppm with no effect. Also, ratio of the element (Ni) is equal to 0.280 ppm and that this value is higher than the permissible value so it is considered unacceptable. Cd is equal to 0.007, which is close to the allowable value according to the allowable value, so it is considered an acceptable value according to the World Health Organization.

The high concentrations of chromium and nickel have harmful effects on human health. These elements are considered highly toxic and have a long half-life. They are non-degradable and have the ability to bioaccumulate in different parts of the body of the organism when these elements are present in the body of the organism in proportions exceeding the limit of the recommended cause of a state of poisoning due to the merging of these elements with enzymes and proteins in the body of the organism. They form toxic and stable compounds that break down these vital

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molecules, causing a hindrance in their functional performance(Appiah-Opong et al., 2021; Woody, 2007).

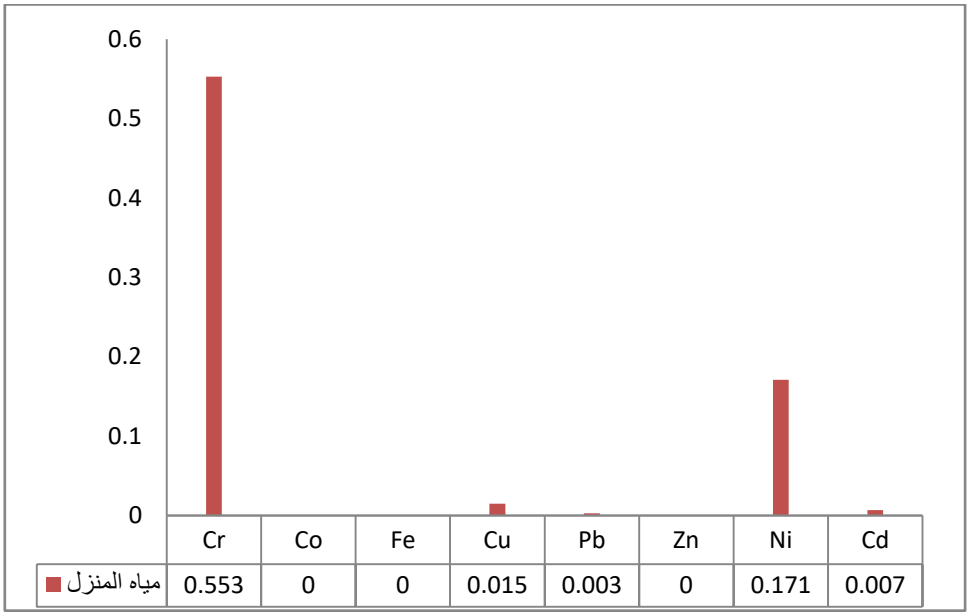

Figure (11) Concentrations of heavy metals in the house water sample for the month of November of the year 2020

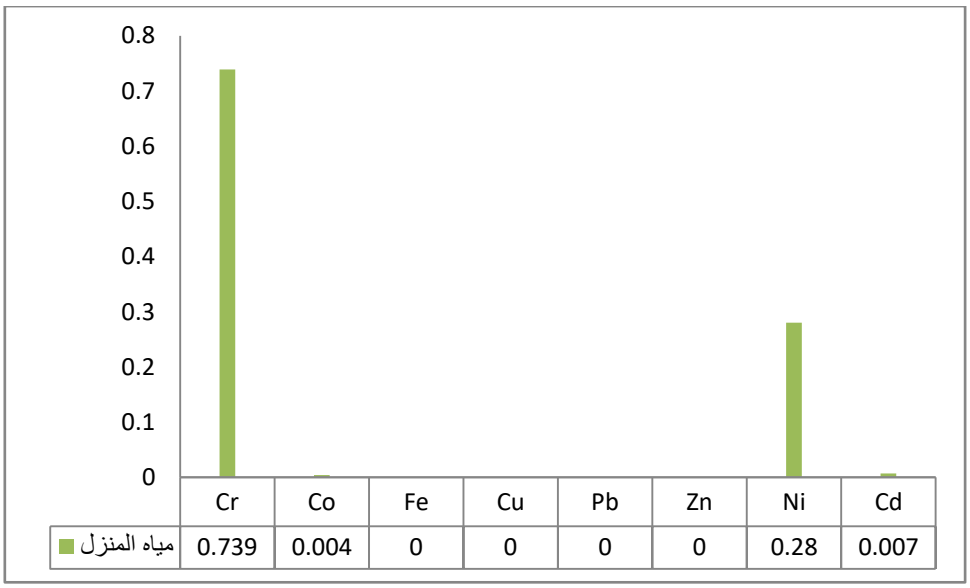

Figure (12) Concentrations of heavy metals for a home water sample for the month of December of the year 2020

4. Conclusions

1. Through the results, we obtained for the values of the pH function as well as the values of electrical conductivity and chloride ion concentration for each of

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the river, station and house waters were all within the permissible limits according to the specifications of drinking water of WHO.

2. By measuring the concentration of the elements for each of the water of the river, the station and the house, it was found that the concentration of barium element is very high in the water. Therefore, a study must be made to find out the formula for its presence in the water.
3. By measuring the concentration of heavy metals in river, station and house water, it was found that the concentrations of chromium and nickel were high and dangerous.
4. Recommendations

The study recommends the following:

1. Studying the proportion of barium and its effect on human health.
2. Providing the station with a laboratory for physical, chemical and biological tests to conduct tests for water in all stages of filtration on a daily basis. This is to ensure the production of water within international health standards.
3. Conducting a study on the high concentrations of heavy metals in drinking water and their impact on human health and finding ways to treat heavy metal contamination of water.
4. We recommend conducting monitoring work on water purification stations.

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