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Assessment of WQI for the Al-Jubalia Water Treatment Plant

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ABSTRACT

The water quality index is an effective tool for determining water quality. All water treatment plants in the Basrah governorate source their water from the Shatt al-Arab River. A water quality index (WQI) for both raw and treated water for the Al-Jubalia water treatment plant is obtained in order to assess its acceptability as a source of residential water supply and the performance of water treatment facilities. From January to December 2019, the physicochemical parameters were observed for the calculation of WQI for the annual and four seasons: winter, spring, summer, and autumn. The pH, turbidity, electric conductivity, total alkalinity, total hardness, Ca, Mg, Cl, SO_4, TDS, Na, and K are the parameters that were considered in this study. In winter, spring, and summer, the results show that raw and treated water were unsuitable for home, industrial, and irrigation needs. In autumn, only the treated water was classified as good water according to WQI categories. As a result, the quality of the Al-Jubalia WTP treated water supply is unfit for human consumption.

Keywords: WQI, Al-Jubalia WTP, weight arithmetic index method, relative white, WHO, Iraqi standard, drinking water.

INTRODUCTION

Drinking water is closely related to the spread of disease. As indicated by the reports of the World Health Organization (WHO), more than 25 million people die every year due to diarrhea, and approximately one-third of this number are children under five years of age. This is attributed to the pathogens transmitted by water, studies and statistics in the America United States indicates that 59% of diseases are caused by contaminated drinking water (Alsaffawi et al., 2018). The reports of the United Nations Environment Program (UNEP) for the year 1999 also indicate that more than 80% of diseases and more than 33% of deaths in developing countries are caused by the contamination of drinking water sources. In Iraq, the reports from the Health Ministry confirm that there has been a clear spread of waterborne diseases from the nineties of the last century until now, due to the poor quality of drinking water, and the number of deaths in Iraq in 2001 reached nearly 90,000 children as a result of water pollution, and these increases are still continuing in their numbers and types. In Iraq, as for the environmental statistics reports for the year 2005, they indicated that nearly 920,000 cases of diarrhea were recorded for the patients visiting hospitals and health institutions who were less than five years old.

In the eighties and before, Iraq had efficient water systems where 95% of the population had access to potable water in urban areas and 75% in rural areas, but the deterioration of the service sector during the years of war and siege, as well as drought conditions and scarce revenues in the Tigris and Euphrates rivers, and the problems of managing and operating dams, negatively affected the quality of the water (Al-Musawi et al., 2012).

Because of the importance of this topic and its direct impact on human life, many studies have been conducted on the physical, chemical, and biological properties of drinking water and their comparison with the standard specifications, such as a study of the physical and chemical properties of selected drinking water stations in the Babil Governorate. The results showed that the studied parameters did not exceed the standard specifications, except for the dissolved salts and the concentration of calcium and sulfate ions, which exceeded the permissible standard limits (Al-Musawi et al., 2012). Moreover, the drinking water sources in the city of Baghdad were evaluated using the WQI as an effective tool for determining water quality. The results indicated that the water quality of the Tigris River in Baghdad is poor, which is reflected in the quality of drinking water (Ewaid et al., 2018). The quality of drinking water was also studied for four sites in Basrah city by using WQI for the studied parameters and compared with WHO limitations and Iraqi standard guidelines, which indicated that the quality of drinking water was poor in two sites and acceptable in the other sites, and this reflects the bad quality of raw water supplied to the treatment plants (Eassa and Mahmood, 2012).

Therefore, the aim of this study was to give a picture of the safety of drinking water supplied from AL-Jubila water treatment plant, as it is one of the large stations located in the center of the governorate that supplies water to many areas and evaluates its quality by using the WQI based on the Iraqi standard and WHO limitations.

WQI

On the basis of many water quality parameters, the water quality index delivers a single value that indicates total water quality at a certain location and time. The goal of the water quality index is to transform complicated water quality data into the information that can be understood and used by the general public. There are various other elements that affect water quality that are not included in the index, so a single number cannot convey the complete picture of water quality. On the other hand, a water quality index based on a few basic parameters might provide a rapid assessment of water quality. Water quality indices, in general, combine data from several water quality criteria into a mathematical equation that assigns a numerical value to the health of a waterbody (Yogendra and Puttaiah, 2008).

Study area

The study area is the Al-Jubila water treatment plant, located between longitude 47° 46’ 02.7”E and latitude 30° 36’ 05.3”N in the Basrah governorate center. Figure 1 explains the W.T.P. location.

Al Jubila WTP was constructed in 1936. It is located in the Al Jubila district. It takes raw water from the Shatt al Arab river and the R-Zero project. The capacity of Al Jubila WTP is 20000 m^3/day (Jeyad, 2005). The flow sheet of Al Jubila WTP is shown in Figure 2. Raw water is pumped into three rectangular rapid mix chambers, in which it is mixed with alum by using a mechanical method. The water then flows through a hydraulic action flocculation tank, and enters a singular concrete sedimentation tank. In this tank, suspended solid and flocculated particles are settled and removed by scrapers. The settled water is collected in a square concrete basin and then flows into six horizontal pressure filters. Each filter has

Figure 1. Shows the location of the Al Jubila WTP

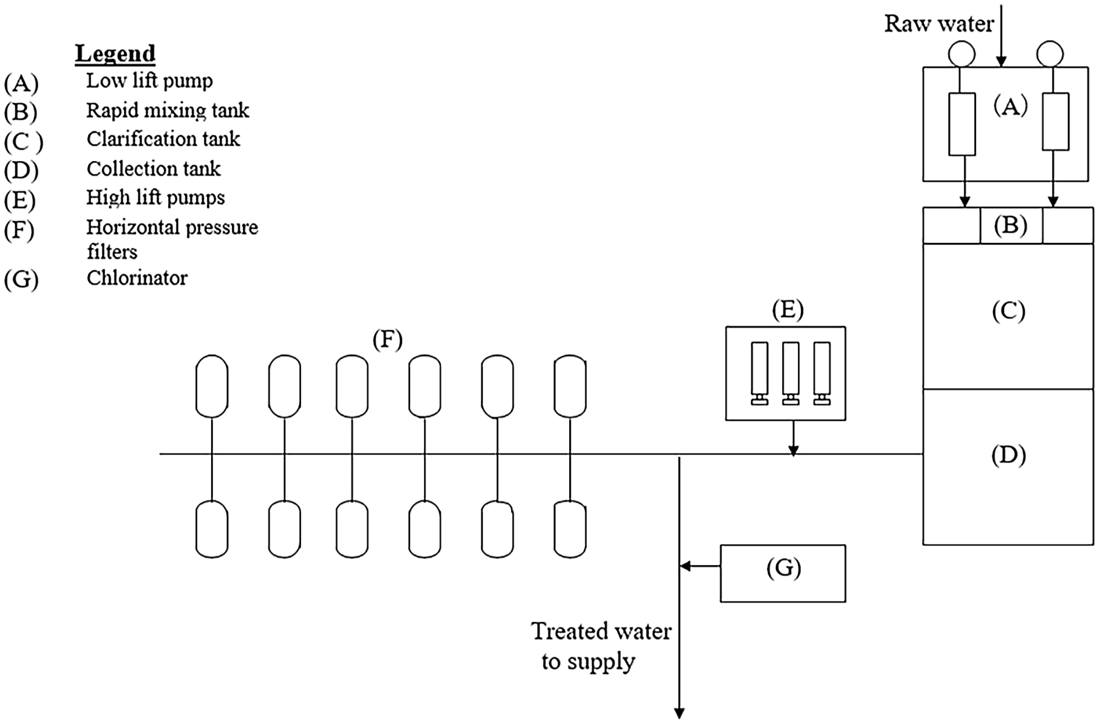

Figure 2. Al Jubila WTP flow sheet

a surface area of 18.75 m^2 and contains filter media to a depth of 1000 mm. The filter media consists of sand and gravel. The filters are cleaned by the backwash method. Chlorine is added to water by injecting a mixture of chlorine gas and water. Treated water is pumped into the distribution system using high-lift pumps. These pumps are also used for the backwash process of filters.

MATERIALS AND METHODS

The water samples from the Al-Jubila water treatment plant were collected. Two samples were taken each month during one year (from January to December 2019) from the raw and treated water. The collected samples were analyzed for twelve parameters: turbidity, PH, electrical conductivity (EC), alkalinity, total hardness, calcium (Ca^{++}), magnesium (Mg^{++}), sodium (Na^{+}), potassium (K), chloride (Cl^{-}), sulfate (SO_4^{--}), and total dissolved solid (TDS). All parameters were analyzed according to the standard APHA procedure (APHA, 1998).

WQI calculation

For the purpose of calculating the water quality index, 12 parameters (turbidity, pH, electrical conductivity (EC), alkalinity, total hardness, calcium (Ca^{++}), magnesium (Mg^{++}), sodium (Na^{+}), potassium (K), chloride (Cl^{-}), sulfate (SO_4^{--}), total dissolved solid (TDS)) were selected. The weight arithmetic index method was used for calculating the water quality index (Graimed and Farhan, 2016; House, 1990; Mohammed, 2013). The following steps are required to calculate the water quality index:

1. The quality rating scale for each parameter (Qi) was calculated by dividing the actual concentration of each parameter in the water (Ca) by the standard concentration (Cs) for the same parameter according to Iraqi standard limitations (ICS, 2009) multiplied by 100 as shown in Eq. (1).

$$Qi = \frac{Ca}{Cs} * 100 \tag{1}$$

where: Qi – the quality rating scale of its parameter;
Ca – the parameter representing the actual concentration;
Cs – the parameter representing standard concentration.

2. Then the relative weight for each parameter (Wi) is calculated, which is inversely proportional to the standard concentration (Cs) for the same parameter, as shown in Equation 2.

Table 1. Shows the classification of water quality based on WQI (Hassan, 2018; Iticescu et al., 2013)

Water quality	Excellent	Good water	Poor water	Very poor water	Unsuitable water for drinking
WQI	Less than 50	50–100	100–200	200–300	More than 300

$$Wi = \frac{1}{Cs} \tag{2}$$

where: Wi – is the relative weight of the parameter.

3. Finally, to compute WQI, the quality rating and the relative weight for each parameter were aggregated by using the equation below (Al-Imarah et al., 2017).

$$\mathrm{WQI} = \frac{\sum_{i=1}^{n} Wi * Qi}{\sum_{i=1}^{n} Wi} \tag{3}$$

where: WQI – water quality index;
n – the parameter's number ($n = 12$).

The computed WQI for raw and treated water was compared with Table 1, which is classified into categories as shown below.

RESULTS AND DISCUSSION

In this study, statistical analysis of chemical and physical parameters is shown in Tables 2 and 3 presenting the minimum, maximum, mean, and standard deviation calculations for raw and treated water, respectively, and comparing them with the WHO limitation and Iraqi standard guidelines.

The chlorination efficiency is influenced by the pH value (Boyacioglu, 2007). It is used to evaluate the acidity and alkalinity of water (Eassa and Mahmood, 2012). The results show that the pH values for raw and treated water are within the permissible limits according to Iraqi standards and WHO limitations, as shown in Fig. 3. The pH is one of the most significant parameters in the operation of a water treatment system. The pH of the water should be maintained throughout the treatment process and should not fall below 8 for satisfactory clarity and disinfection. In addition, the treated water injected into the distribution system should be monitored and controlled at all times to reduce the possibility of corrosion in water mains and domestic pipes. Otherwise, polluted water will be dispersed, causing problems with odor, taste, and appearance (WHO, 2011).

Figure 4 represents the TDS of the raw water and treated water during the study period. The water with a high dissolved solid content might have laxative or constipating effects (Eassa and Mahmood, 2012; Yue et al., 2010). The results of TDS for raw and treated water have exceeded the permissible limits of 1000 mg/l during the study period, the TDS values less than 1000 mg/l are classified as fresh water, while the values greater than 1000 mg/l are classified as brackish water (Eassa

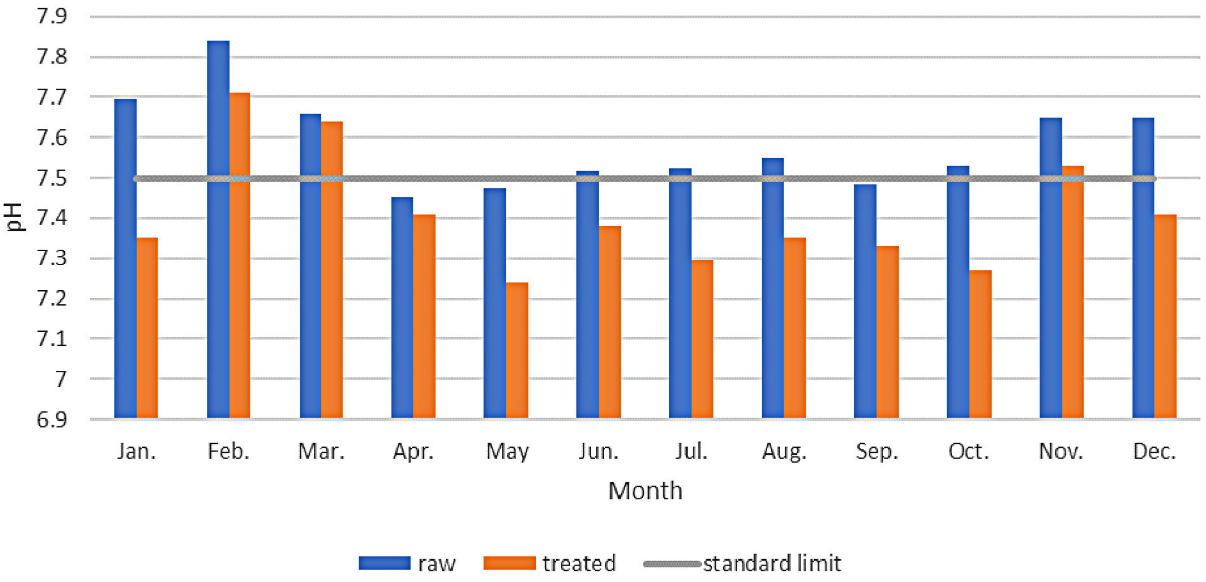

Figure 3. The pH concentrations in raw water, treated water, and the standard limit during the study period

and Mahmood, 2012; Udayalaxmi et al., 2010). The TDS values vary between (572 to 2690) mg/l with a mean (1632.7 mg/l) for raw water, and between (584 to 2704) mg/l with a mean (1713.7 mg/l) for treated water (Tables 2 and 3), respectively. The maximum value of TDS for raw and treated water was determined in summer season due to the decrease in water levels in Shatt Al Arab in the summer season. The high dissolved solid concertation in the surface water indicates that there are extensive anthropogenic activities close to the raw water source outlet. The TDS levels are affected by tidal movement, and the ebb tide on the river has been connected to a measurable increase in TDS concentration, as well as runoff with a certain amount of suspended matter content (Yisa and Jimoh, 2010), also because the existing WTPs are traditional and lack treatment equipment to minimize salinity, such as reverse osmosis.

Turbidity is caused by colloidal and extremely fine dispersions in bodies of water. Increased microbial counts, an elevated iron concentration, or increased turbidity, all of which affect taste, odor, and color in drinking water, are likely to cause deterioration in distribution network drinking water quality. Turbidity can provide a safe haven for pathogens and opportunistic microbes (Sehar et al., 2011). The maximum turbidity in water was measured in the spring, whereas the lowest turbidity was measured in the winter for raw water, as shown in Figure 5. Maximum and mean values of raw and treated water exceed the Iraqi standard and WHO limitations (Table 2 and Table 3). Due to home waste and urban runoff, there is a high level of turbidity. Thus, increasing seasonal turbidity was caused by the collection of massive amounts of sewage waste from the neighboring area, the growth of aquatic vegetation, or a

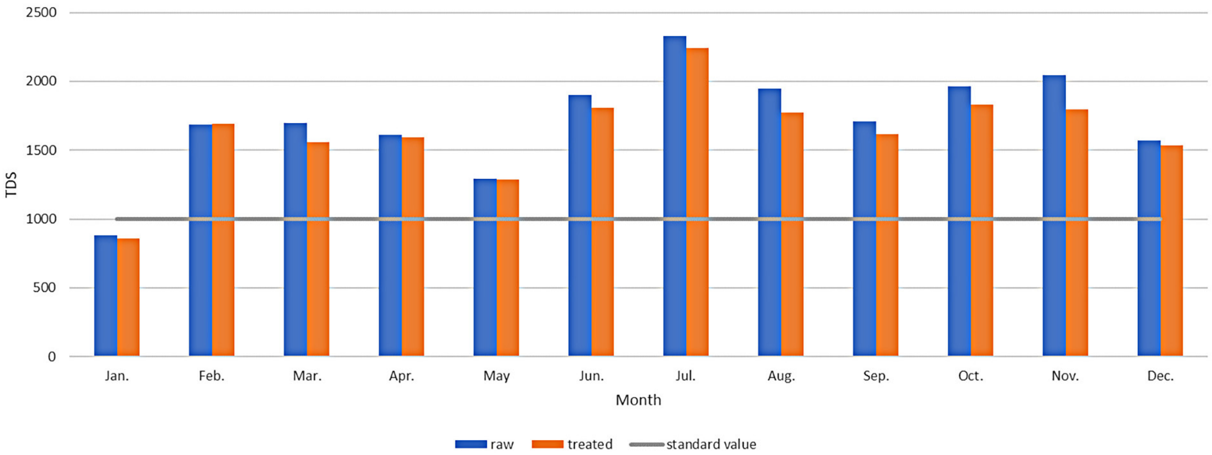

Figure 4. TDS concentration in raw and treated water, and the standard limit during the study period

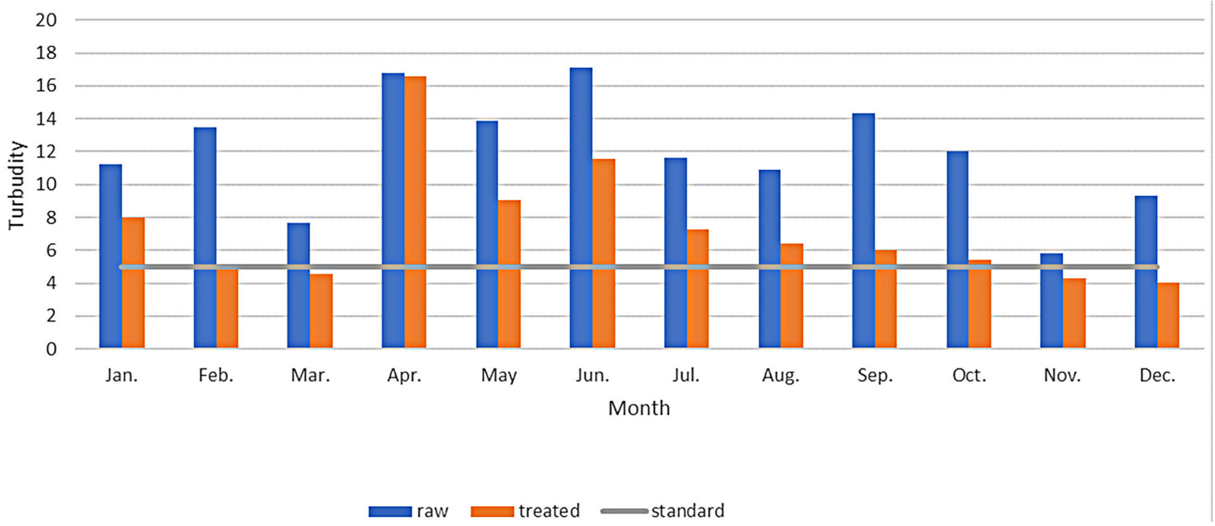

Figure 5. Turbidity concentration for raw and treated water, and standard limit during the study period

decrease in water level (Lateef et al., 2020; Verma et al., 2012). Moreover, the potential causes are excessive demand for water, particularly at high temperatures, and hot seasons, which causes plant operators to reduce settling time in sedimentation tanks, resulting in increasing particle levels in treated water (Almuktar et al., 2020).

Water hardness is a characteristic of water that prevents soap from lathering and raises the boiling point of water. The amount of calcium or magnesium salts in the water, or both, determines its hardness (Eassa and Mahmood, 2012; Yisa and Jimoh, 2010; Sehar et al., 2011). The results of the analysis of water vary between 318 and 1170 mg/l with a mean of 793.7 mg/l for raw water and between 311 mg/l and 1162 mg/l with a mean of 760 mg/l for treated water (see Tables 2 and 3). Moreover, the maximum value of hardness for raw and treated water was in the summer season, so the results are exceeded the permissible limits of the Iraqi standard and WHO limitations, as shown in Figure 6. Seasonal changes in concentrations were generally greatest during the warmer months (June, July, and August) probably due to increased water demand caused by high temperatures. Furthermore, the principal raw water supply, the Shatt Al Arab River, exhibited a decrease in water quality indices during warmer months (Almuktar et al., 2020).

The capacity of water to neutralize a strong acid is measured by total alkalinity. Salts of carbonates and bio carbonates, as well as free hydroxyl ions, are the most common sources (Eassa and Mahmood, 2012; Sehar et al., 2011), To reduce the corrosive effects of acidity, moderate amounts of alkalinity are desired in a water supply (USEPA, 2012). The results show that total alkalinity values exceed the WHO limitations and Iraqi standard guidelines (see Tables 2 and 3). Figure 7 shows that the maximum values for raw and treated water were highest during the summer season (2107.3 mg/l and 1991.6 mg/l), respectively. Sewage and other human activities are the sources of alkalinity in the water (Udayalaxmi et al., 2010).

Figure 8 represents the EC of the raw water and treated water during the study period. The capacity of water to carry electric current is measured by its electrical conductivity. It denotes the total amount of dissolved salts (Sehar et al., 2011; Singh and Kumar, 2014). Temperature, ionic concertation, and the sorts of ions present in water all affect electrical conductivity. As a result, EC provides a qualitative assessment of water quality (Udayalaxmi et al., 2010). The results of EC exceed the permissible limits of Iraqi standards and WHO limitations (see Tables 2 and 3). These high levels of EC are related to climatic conditions such as precipitation and evaporation rates that will affect rivers and the fact that marine water from the Arabian Gulf is interring for a distance in the Shatt Al Arab River; thus, the Shatt Al Arab water is influenced by marine water (Al-Muhyi, 2016).

Sulfate is naturally found in water as a result of gypsum and other common minerals' leaching (Sehar et al., 2011). The sulfate concentrations that are too high, have a bitter taste and can cause laxative effects in some people (Eassa and Mahmood, 2012). Drinking water with high sulfate content can cause dehydration and diarrhea,

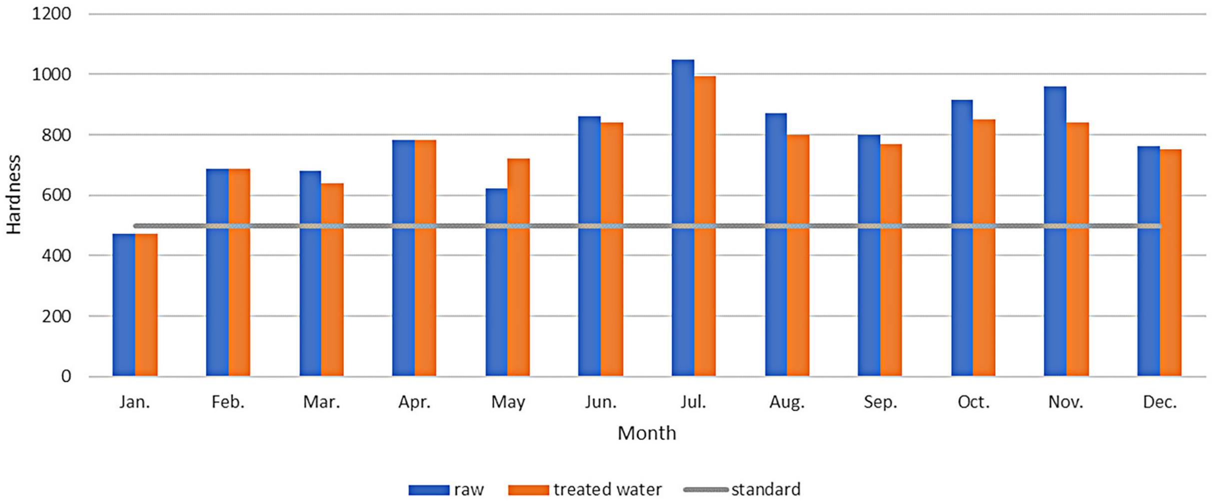

Figure 6. Hardness concentration for raw and treated water, and standard limit during the study period

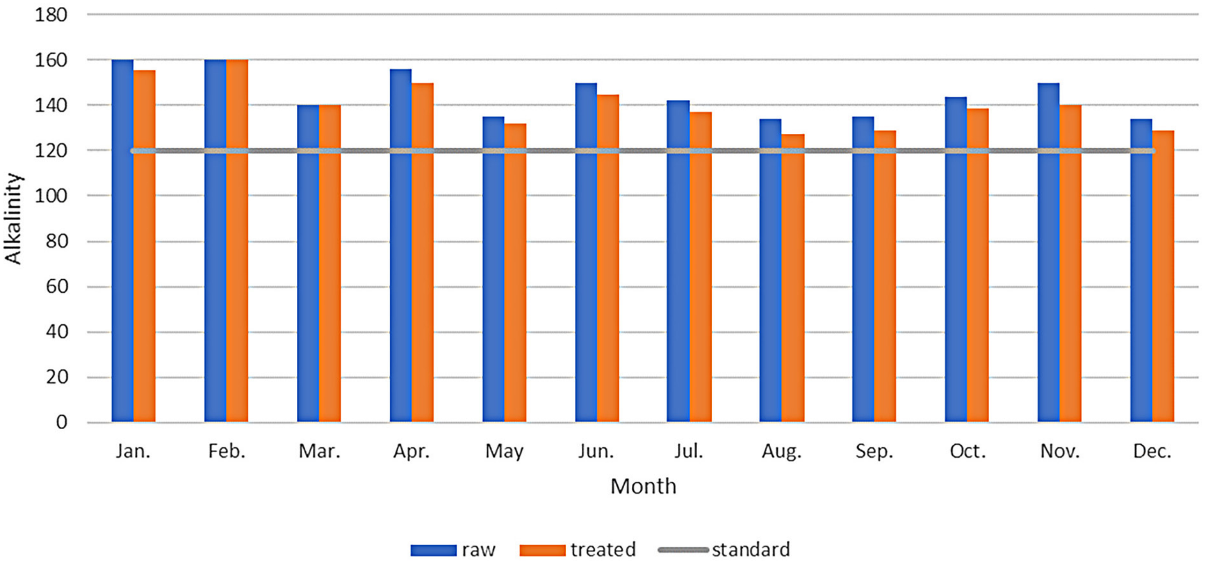

Figure 7. Alkalinity concentration for raw and treated water, and standard limit during the study period

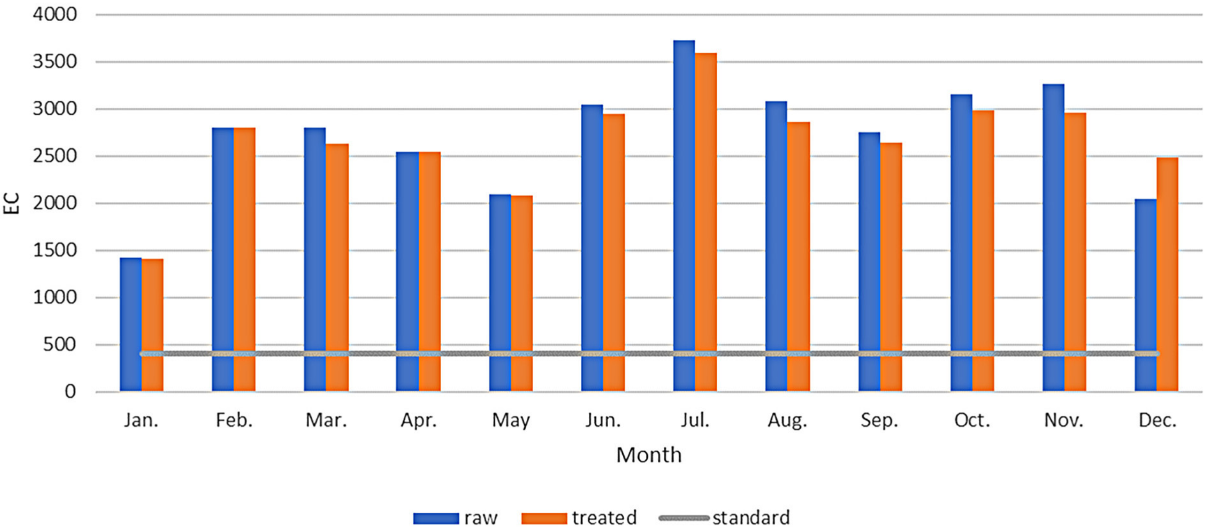

Figure 8. Electrical conductivity for raw and treated water, and standard limit during the study period

and children are more vulnerable to sulfate than adults (Kumar and Dua, 2009). The value of sulfate for raw and treated water exceeded the WHO limitation and Iraqi standard guidelines, as shown in Figure 9. The high level of sulfate is due to the discharge of industrial waste and home sewage.

High calcium levels in blood can cause blood vessel problems in the kidneys (Eassa and Mahmood, 2012; Djidel et al., 2020). The results show the minimum values for raw and treated water were 65 mg/l and 62mg/l, respectively. The maximum values were 237 mg/l and 234 mg/l, with a mean of 161.3 mg/l for raw water and 154.62 mg/l for treated water. Therefore, these results exceed the WHO limitation and the Iraqi standard guidelines (see Tables 2 and 3). Moreover, all the results during the study period exceeded the standard limits, as shown in Figure 10.

Magnesium is the mineral that produces hardness in water. Furthermore, higher amounts have an effect on human health, resulting in encephalitis (Eassa and Mahmood, 2012; Udayalaxmi et al., 2010). The magnesium concentration in raw water ranged from 40 mg/l to 150 mg/l, with a mean of 95.3 mg/l, and the concentration in treated water ranged from 38 mg/l to 141 mg/l, with a mean of 91.4 mg/l (see Tables 2 and 3). These results exceed the permissible value for WHO limitation and Iraqi standard guidelines, as shown in Figure 11.

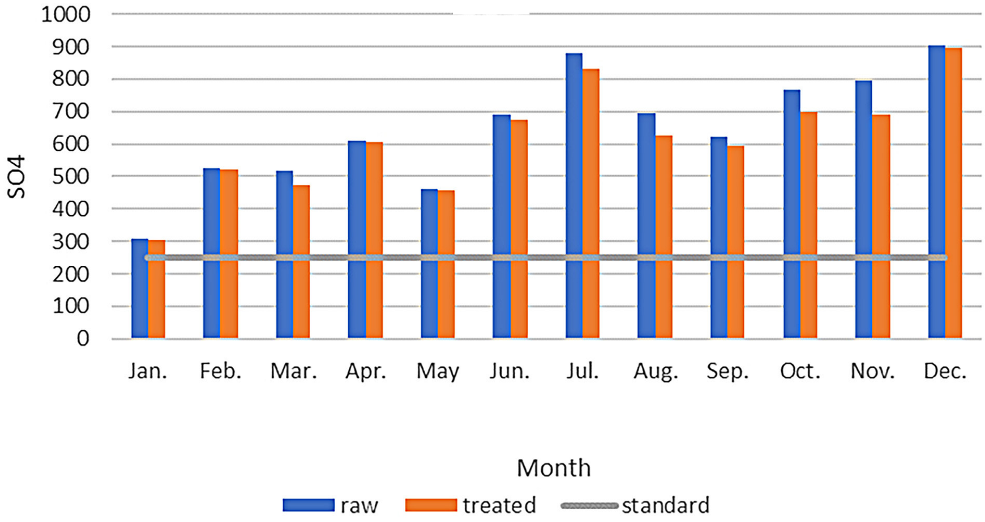

Figure 9. SO_4 concentration for raw and treated water, and standard limit during the study period

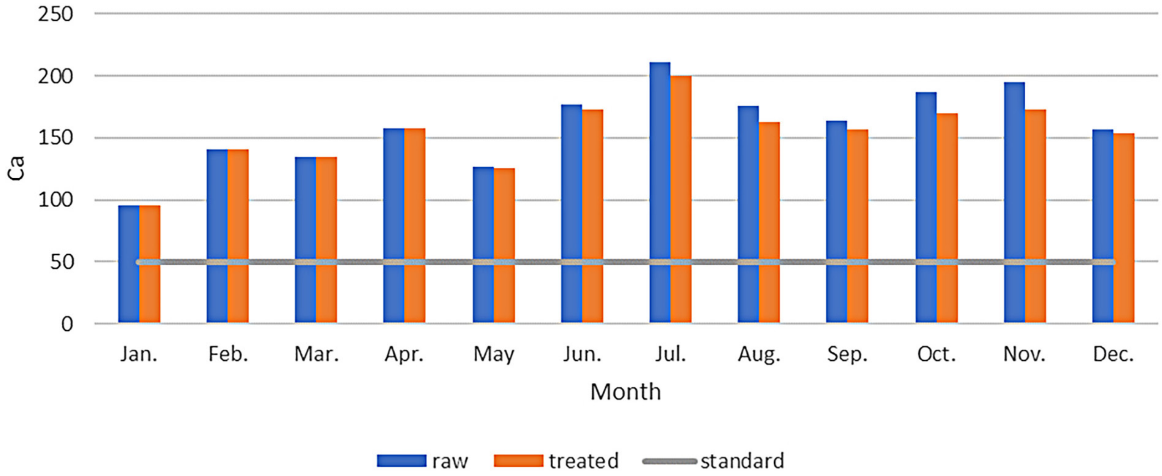

Figure 10. Ca concentration for raw and treated water, and standard limit during the study period

The high concentration of ionic potassium is dangerous for the people with renal illness or other disorders, including heart disease, coronary artery disease, hypertension, diabetes, or those taking medication that interferes with normal potassium processing. Excessive potassium exposure could have serious health consequences (WHO, 2011). The mean K^+ concentration in raw and treated water was 7.5 mg/l and 6.9 mg/l, respectively, which are within WHO limitations and Iraqi standard guidelines, as shown in Figure 12.

Figure 13 represents the sodium concentration of the raw water and treated water during the study period. Because of the efficiency with which adult kidneys drain sodium, sodium salts are not acutely poisonous. Accidental sodium chloride overdoses, on the other hand, have resulted in acute consequences and death. Nausea, vomiting, convulsions, muscle twitching and rigidity, and cerebral and pulmonary oedema are all possible side effects. Excessive salt consumption exacerbates chronic congestive heart failure, and the negative consequences of high sodium levels in drinking water have been reported. Furthermore, at levels greater than 200 mg/l, sodium may alter the flavor of drinking water (WHO, 2011). The sodium concentration of water was found to vary between 84 mg/l and 488 mg/l with a mean of 283.8 mg/l for raw water and between 81 mg/l and 478 mg/l with a mean of 269.8 mg/l for treated water, which exceeds the allowable limit for WHO and Iraqi standard guidelines (see Tables 2 and 3). The release of soluble compounds during weathering is the principal source of sodium in

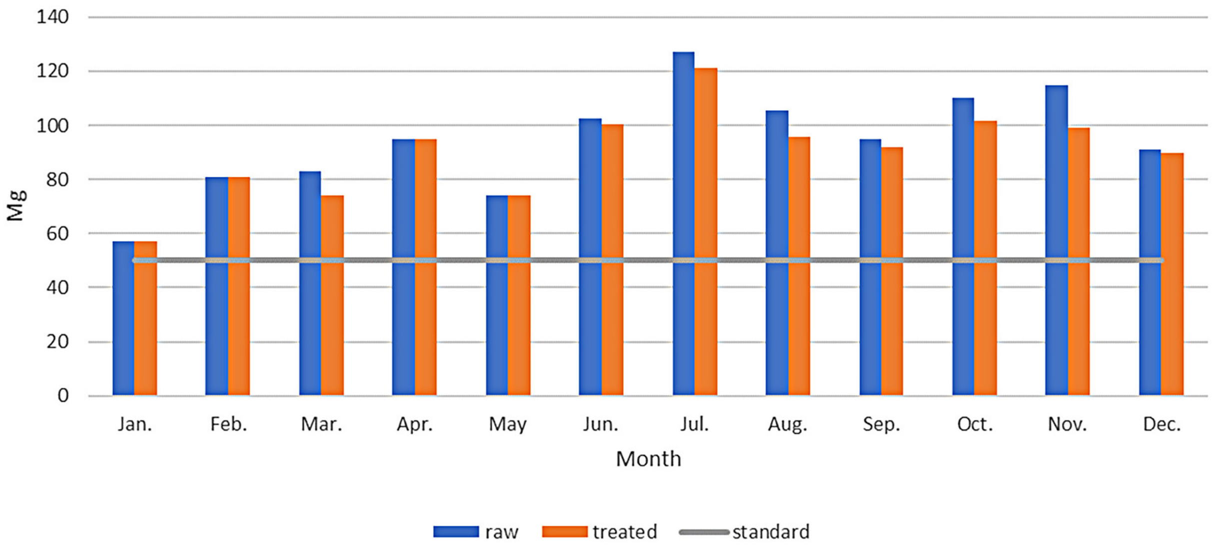

Figure 11. Mg concentration for raw and treated water, and standard limit during the study period

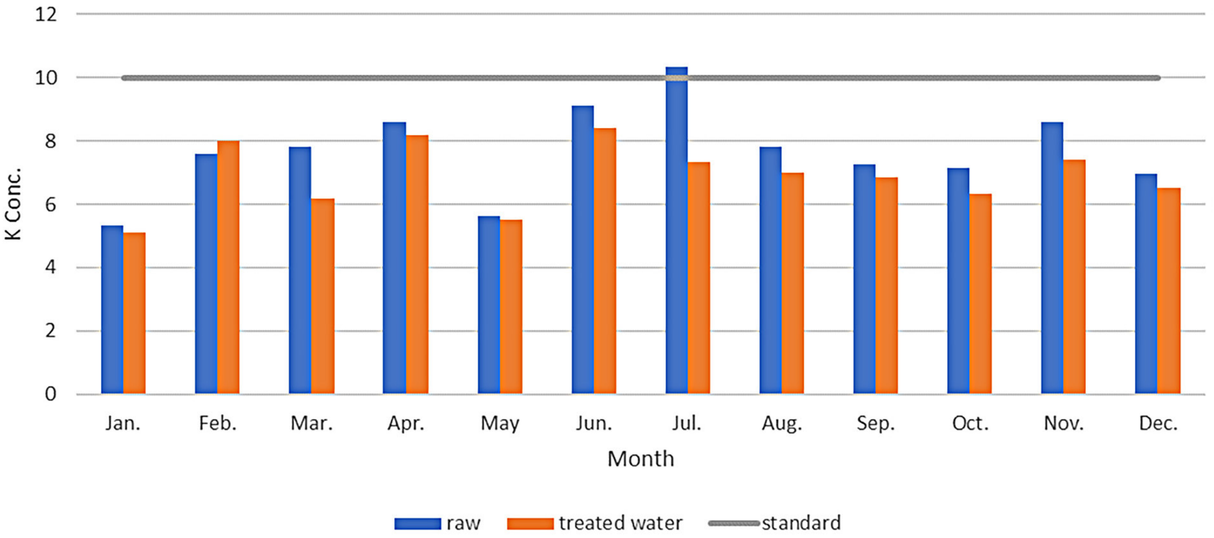

Figure 12. K^+ concentration for raw and treated water, and standard limit during the study period

natural water (Udayalaxmi et al., 2010), also the salty water that enters the Shatt Al-Arab from the Arabian Gulf during the tidal period.

Water with high chloride content can be unpleasant to drink and should not be consumed (Sehar et al., 2011). The results of the test for chloride show that the minimum values for raw and treated water were (150 mg/l and 148 mg/l) respectively (see Tables 2 and 3), which is within the permissible limits, while the maximum values were (760 mg/l and 750 mg/l), respectively, which exceeds both the WHO limit and the Iraqi standard guidelines, as shown in Figure 14. The level of chloride in the water is an indicator of sewage pollution (Eassa and Mahmood, 2012; Yisa and Jimoh, 2010).

WQI results

To determine the annual water quality index for the Al-Jubaila water treatment plant (Annual WQI), the average annual value was calculated for each parameter of the raw and treated water, and the process was repeated for the remaining 12 parameters, as shown in Tables 4 and 5. After applying the calculations of WQI, it was found that the value of the annual water quality index for raw water is 159.83 (Table 4), the annual water quality index for treated water is 112.56 (Table 5), and according to Table 1, it appears that the quality of raw and treated water is poor.

Then the water quality index was calculated based on the seasons of the year by calculating

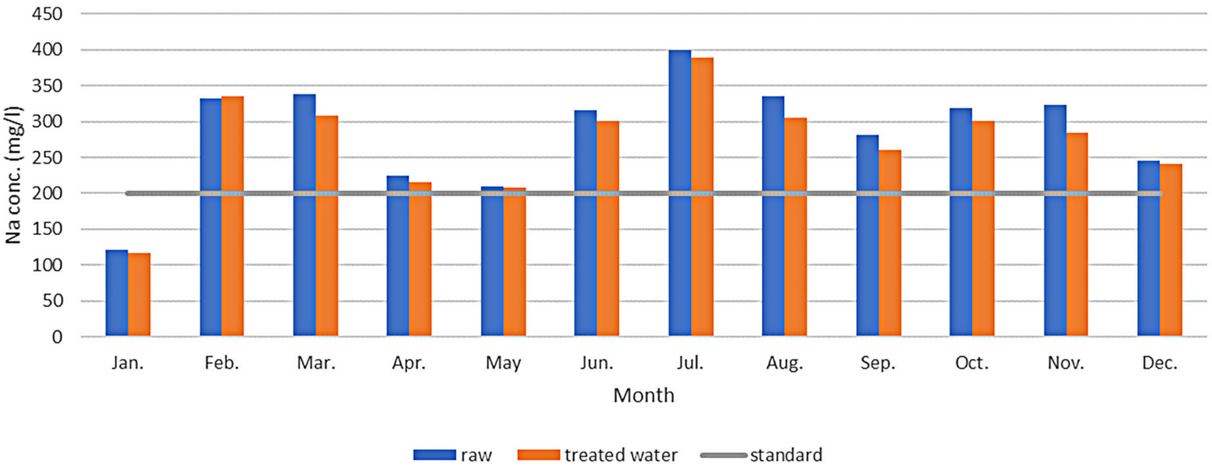

Figure 14. Cl concentration for raw and treated water, and standard limit during the study period

Table 2. Summary results of raw water chemical and physical analyses

Parameters	Minimum	Maximum	Mean	S.D.	Standard value (ICS, 2009; WHO, 2011)
pH	7.22	7.85	7.6	0.15	6.5-8.5
Turbidity	5.8	20.7	12.4	3.45	5 NTU
EC	942	4315	2718.9	815.78	400 µS/cm
Alkalinity	124	160	142.7	10.74	120 mg/l
Total hardness	318	1170	793.7	217.42	500 mg/l
Ca	65	237	161.3	43.70	50 mg/l
Mg	40	150	95.3	26.50	50 mg/l
Cl	150	760	434.7	158.41	250 mg/l
SO_4	156	981	626.9	215.11	250 mg/l
TDS	572	2690.0	1632.7	497.2	1000 mg/l
Na	84	488	283.8	104.2	200 mg/l
K	3.5	10.7	7.5	1.8	10 mg/l

Table 3. Summary results of treated water chemical and physical analyses

Parameters	Minimum	Maximum	Mean	SD	Standard value (ICS, 2009; WHO, 2011)
pH	6.88	7.8	7.4	0.2	6.5-8.5
Turbidity	3.5	16.6	7.26	3.2	5 NTU
EC	926	4290	2649.17	789.0	400 µS/cm
Alkalinity	120	160	137.72	11.3	120 mg/l
Total hardness	311	1162	760.00	200.1	500 mg/l
Ca	62	234	154.62	39.9	50 mg/l
Mg	38	141	91.14	24.5	50 mg/l
Cl	148	750	416.34	149.8	250 mg/l
SO4	147	971	594.07	199.8	250 mg/l
TDS	584.0	2704.0	1713.7	534.6	1000 mg/l
Na	81	478	269.8	98.9	200 mg/l
K	3	10	6.9	1.6	10 mg/l

the average seasonal value for each parameter of raw and produced water and repeating the process for the remaining 12 parameters. The results were as follows: Winter (144.07, 100.33), Spring (165.17, 130.42), Summer (165.6, 121.69) and Autumn (161.18, 98) for raw and treated water respectively as shown in Figure 15.

Seasonal water quality index results showed that most values ranged between 100 and 200, according to Table 1. The quality of the water is classified as poor, except for the value of treated water in the autumn season, which is classified as good. The poor water quality is due to the decrease of the Shatt al-Arab level in the summer season resulting from the lack of rain and the high rate of evaporation due to the high temperature. Moreover, the high demand for tap water in the summer with an amount that exceeds the design capacity of the plant causes a rise in the turbidity of the produced water, since the water quality index depends on turbidity and pH (Toma, 2013), as shown in Tables 2 and 3.

Table 4. Annual water quality index for raw water

No.	Parameter	Ca	Cs	Wi	qi	Wi·qi
1	pH	7.6	7.5	0.1333	100.86	13.45
2	TDS (mg/l)	1713.7	1500	0.0007	114.24	0.08
3	EC (μS/cm)	2718.9	1000	0.0010	271.89	0.27
4	TH (mg/l)	793.7	500	0.0020	158.74	0.32
5	Ca (mg/l)	161.3	150	0.0067	107.54	0.72
6	Mg (mg/l)	95.3	100	0.0100	95.28	0.95
7	K (mg/l)	7.5	12	0.0833	62.41	5.20
8	Na (mg/l)	283.8	200	0.0050	141.90	0.71
9	AlK (mg/l)	142.7	200	0.0050	71.34	0.36
10	Cl (mg/l)	434.7	350	0.002	124.19	0.35
11	SO_4 (mg/l)	626.9	400	0.0025	156.72	0.39
12	Turb. (NTU)	12.4	5	0.2000	247.52	49.50
			$\sum_{i=1}^{n} Wi = 0.4524$		$\sum_{i=1}^{n} Wi * Qi = 72.3$	
$\text{WQI} = \frac{\sum_{i=1}^{n} Wi * Qi}{\sum_{i=1}^{n} Wi} = 159.83$						

Table 5. Annual water quality index for treated water

No.	Parameter	Ca	Cs	Wi	qi	Wi·qi
1	PH	7.4	7.5	0.1333	98.22	13.10
2	TDS (mg/l)	1632.7	1500	0.0007	108.85	0.07
3	EC (μS/cm)	2649.2	1000	0.0010	264.92	0.26
4	TH (mg/l)	760.0	500	0.0020	152.00	0.30
5	Ca (mg/l)	154.6	150	0.0067	103.08	0.69
6	Mg (mg/l)	91.1	100	0.0100	91.14	0.91
7	K (mg/l)	6.9	12	0.0833	57.64	4.80
8	Na (mg/l)	269.75	200	0.0050	134.88	0.67
9	AlK (mg/l)	137.7	200	0.0050	68.86	0.34
10	Cl (mg/l)	416.3	350	0.0029	118.96	0.34
11	SO_4 (mg/l)	594.1	400	0.0025	148.52	0.37
12	Turb. (NTU)	7.3	5	0.2000	145.24	29.05
			$\sum_{i=1}^{n} Wi = 0.4524$		$\sum_{i=1}^{n} Wi * Qi = 50.92$	
$\text{WQI} = \frac{\sum_{i=1}^{n} Wi * Qi}{\sum_{i=1}^{n} Wi} = 112.56$						

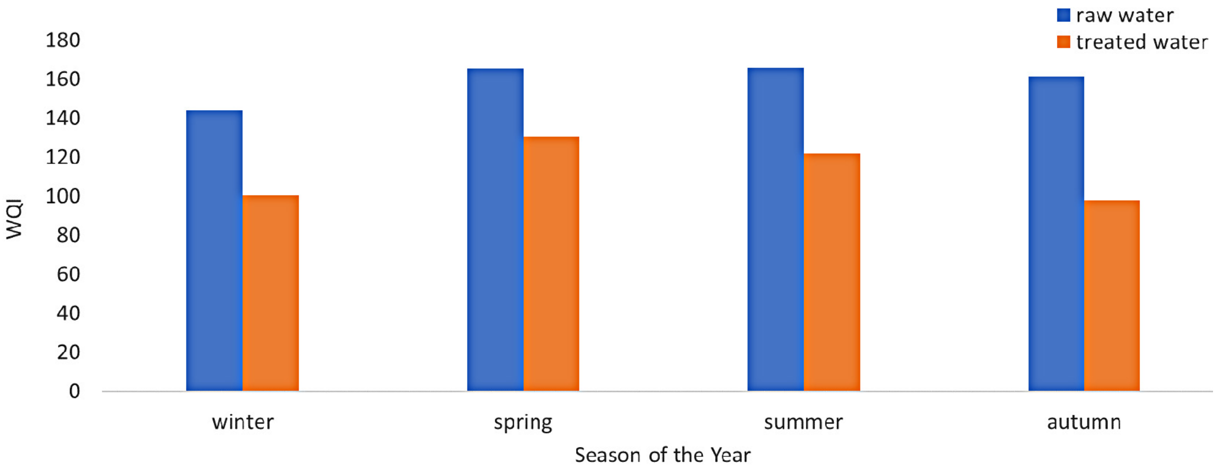

Figure 15. Seasonal WQI for raw and treated water of Al-Jubalia WTP

CONCLUSIONS

The goal of any water treatment plant is to produce safe and drinking water with a good taste, and has been found from the study that raw and treated water were classified as poor water according to WQI classification. Two focus factors should be covered in order to provide a clear picture of the decline of the Basrah's water supply quality:

1. The quality of the raw water that feeds the water treatment plants in Basrah.
2. The treatment procedures used in these plants.

In terms of the first point, the majority of the Basrah's WTPs source 70% to 100% of their raw water from Shatt al-Arab and up to 30% from the R-Zero canal. As a result, the Shatt al-Arab river may be regarded as the primary supply of raw water for most WTPs in Basrah. The amount of dissolved salts in the Shatt al-Arab river is reported to be very high. This is because of the large volume of pollutants discharged into it. It is also influenced by the Arab Gulf tidal phenomena, which causes water quality to deteriorate. As a result, it has a negative impact on the raw water of the Basrah WTP's, as stated in Table 2. Secondly, due to the low quality of the raw water and the conventional nature of the Al-Jubalia WTP, it does not deal with soluble components in the water. As a result, the quality of the Al-Jubalia WTP treated water supply is unfit for human consumption. This station will be modified with filter membranes or ion exchange units to reduce the excessive quantities of dissolved salts.

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