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Study of Mineral Ratios in Drinking Water Sources in Muthanna Governorate and its Suitability for Human Use

L.M. Rasheed[1], Attallah Bani Hmood[2], Safaa Mustafa Hameed[3]

Department of Criminal Evidence Department, College of Science, Sawa University, Almuthana, Iraq[1].
Department of Medical Physics and Radiotherapy Engineering Technologies, College of Engineering Technology, Sawa University, Almuthana, Iraq[2].
**Department of Optics Technologies, College of Health & Medical Technology, Sawa University, Almuthana, Iraq[3]*

Abstract

The study aimed to assess the suitability of Al-Rumaytha River water for human use and evaluate the efficiency of drinking water provided by Al-Samawah Pump (1) and Al-Samawah Pump (2) on the river, using samples collected from January to June 2024. The study included measuring pH, electrical conductivity, total dissolved solids, total hardness, calcium, magnesium, chlorides, turbidity, sodium, and potassium. The results showed that the pH level tends to be alkaline in all months of the study. It was also found that the total hardness of drinking water was approaching the globally permissible maximum limit. The results also indicated that the values of magnesium, sodium, potassium, and turbidity in drinking water were within the specifications of the World Health Organization. As for the electrical conductivity and chlorides, they were high and exceeded the globally permissible limit.

Keywords: Turbidity, chlorides, potassium, drinking water

Introduction

The great importance of water for life cannot be overlooked, as it covers more than 70% of the Earth's surface and constitutes more than 60% of the bodies of plants and animals; hence, it is said that water is the secret of life. Obtaining potable water in our country is considered one of the fundamentals of health, social, and industrial development. Therefore, raw water sources must be located far from waste sources. It is also necessary to identify activities and operations near these sources and adopt sound methods for handling different water sources. Knowing that a clean appearance and palatable taste are not sufficient indicators of drinking water quality, some physical and chemical tests are conducted to determine the extent of water contamination (1).

God Almighty has blessed us with the Tigris and Euphrates rivers, and for various reasons that need not be mentioned, the need and interest in water sources in the country in general have increased recently.

The Al-Rumaitha River (a branch of the Euphrates River) is the primary source that the Al-Samawah Governorate relies on for supplying water and using it for various agricultural, industrial, and human purposes.

The Al-Rumaitha River is exposed to cases of pollution due to the discharge of organic and inorganic components from various sources.

These waste materials contain many chemicals and heavy metals, either dissolved or suspended, which affect the physical and chemical changes of this water. These waters also include various types of microorganisms, such as bacteria and parasites, that can cause many harmful diseases to humans. Therefore, it is necessary to identify the activities and operations near these sources and adopt rigorous methods to manage the various water sources. Knowing that a clean appearance and palatable taste are not sufficient indicators of the potability of drinking water, some physical and chemical tests are conducted to determine the extent of water contamination (1).

Studies conducted on industrial wastewater and urban waste discharged into rivers have shown their ability to alter the chemical and physical properties of water and negatively impact the aquatic environment. (2,3)

The Al-Rumaitha River is the primary source for supplying raw water to the water treatment facilities that feed the city of Samawah. These facilities follow chemical methods for filtration and disinfection and pump water through a network of pipes to the residential areas in the city. The current study aims to investigate the impact of waste on the physical and chemical changes in drinking water sources, to determine the characteristics and specifications of drinking water, and to assess the extent of pollution in the Al-Rumaitha River on the efficiency of the water treatment facilities located on it.

We relied on the average value of the analysis and measurement results, and the findings concluded that most cities are located near rivers, especially factories and hospitals. Therefore, it is expected that their various wastes, particularly chemical wastes, which are considered one of the most dangerous forms of pollution affecting human health, are discharged into these rivers.

The physical and chemical properties of water:

A physical property is a characteristic that can be documented or measured without changing the internal composition of the material. Physical properties are used to observe and describe the material. Examples of these properties include solubility, specific heat, surface tension, and others. As for the chemical property, it is the property that can only be observed if a chemical change occurs that alters the internal composition of the substance. It is used to describe the behavior of the substance when exposed to certain materials such as air, water, acids, bases, and others [4]. Examples of chemical properties include acidity, hardness, electrical conductivity, and others.

Materials and Methods:

The study included field visits to the Al-Rumaitha River and the drinking water pumping stations covered in the study, as well as assessing the efficiency of these stations. The samples were collected using plastic containers made of polyethylene with a capacity of 2 liters. After cleaning them with acetone to remove impurities, they were rinsed with distilled water several times, dried, and then sealed to prevent contamination. The samples representing the raw water for the filtration stations were taken at the intake point from the water withdrawal site at different depths (10-20-30 cm).

Then the average depth was calculated due to the unavailability of depth and temperature measurement devices. As for the samples representing drinking water, they were taken from the end of the drinking water pumping stations. The samples were collected in two seasons: the first season (January - February - March) and the second season (June - July - August) of the year 2024, due to the variation in waste in the summer and winter seasons.

The materials used in chemical and physical tests A mercury thermometer graduated from (100-0) degrees Celsius to measure temperature. Pocket-sized pH meter for measuring pH levels Flame photometer device for measuring sodium and potassium elements in mg/L units YSI 556 device for measuring dissolved solids in mg/L Turbidity meter 550 device for measuring turbidity levels in units (NTU) (Nephelometric Turbidity Unit) Portable conductivity meter for measuring electrical conductivity in microsiemens/cm units As for total hardness, calcium, and magnesium, they were estimated according to the method described by (4) by titrating 50 ml of the sample with a standard EDTA solution (0.01) and using the Erich Rom black T indicator, expressed in mg/ml. While the fluorides were measured according to the method outlined by the American Public Health Association for measuring fluorides by titrating a 100 ml sample with a standard silver nitrate solution (0.141 molar) and using potassium chromate solution as an indicator, the results were expressed in mg/L (5). The globally permissible limit for chlorides is 200 mg/liter.

Results and Discussion

pH: The results of Table 1 and Figure 1 showed that the average pH values for all study sites were similar and within the slight alkaline trend for both seasons. This can be attributed to the presence of bicarbonate ions (6). Additionally, the continuous mixing of water due to river flow may lead to an increase in pH values towards alkalinity (7).

Table No. (1) Hydrogen ion concentration ratios at all study sites

pH value in the second season	pH value in the first season	Location
8.2	8.1	Water withdrawal
7.8	7.87	Pump number 1
8.1	8.1	Pump number 2
8.03	8.16	The average

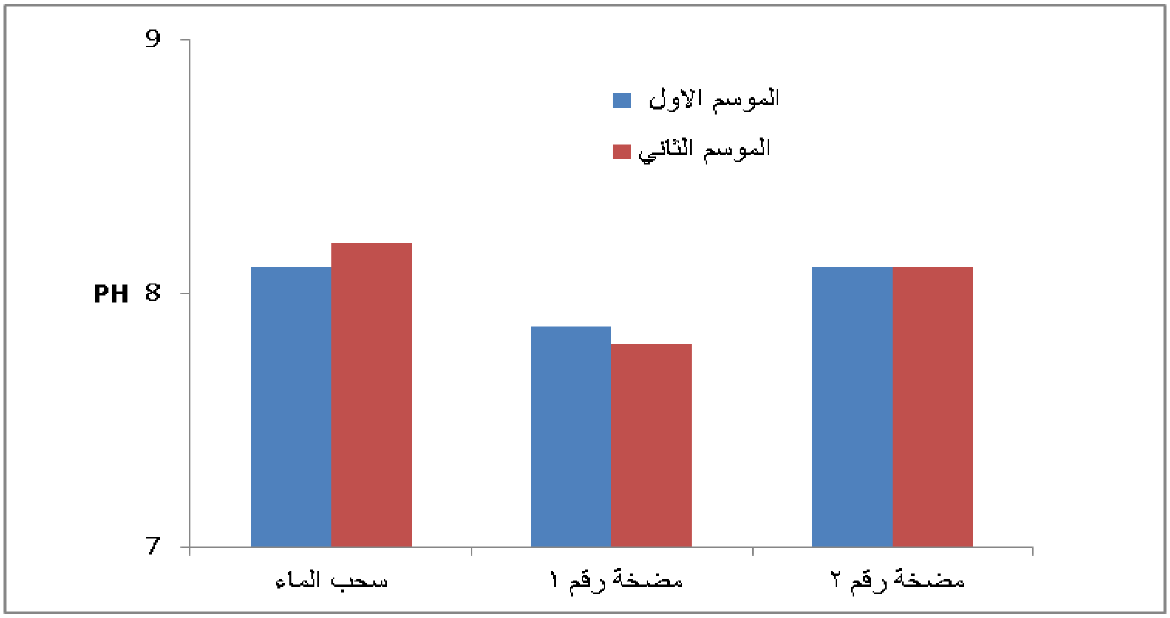

Figure 1: Hydrogen ion concentration at all study sites

Electrical Conductivity (E.C.):

Electrical conductivity is a numerical value that indicates the ability of water to carry an electric current. It depends on the concentration of dissolved ions present in the water and the water temperature. The salinity of the water used for irrigation, represented by electrical conductivity values in deciSiemens per meter, showed a significant variation between the two seasons. The average conductivity values in the first season were (4.1 dS/m), while in the second season, they were (3.4 dS/m), as shown in Table 2 and Figure 2. This variation in electrical conductivity values during the first season is attributed to rainfall, which can dissolve the salts present in the soil and wash them into the river water [8,9], With electrical conductivity values (in decisiemens per meter), this increase in electrical conductivity values can be attributed to rainfall, which can dissolve the salts present in the soil and wash them into the river water (4). The results indicated that there is no role for filtration and purification processes in reducing the conductivity values in drinking water samples in terms of lowering the ion concentration, which is consistent with the findings of Alia (13).

Table No. (2) Electrical Conductivity for All Study Sites

The second season	The first season	Location
3.23	3.92	Drawing water from the river
3.34	4.1	Pump number 1
3.45	4.32	Pump number 2

3.4	4.1	The average

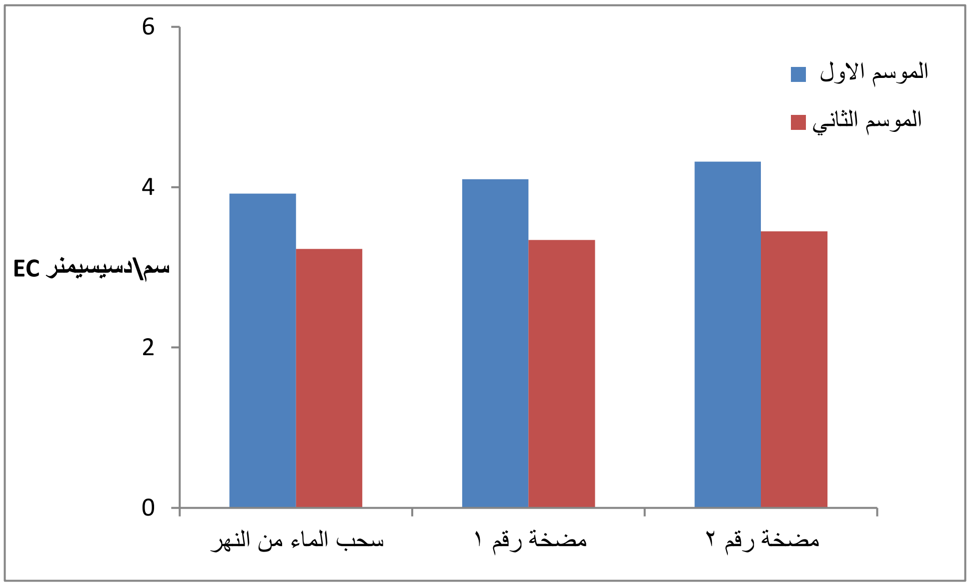

Figure 2: Electrical conductivity for all study sites

Turbidity: Table 3 and Figure 3 show that the average turbidity values during the first season were 6.23 NTU. (NUT) During the first season, it was (6.23 NUT), while during the second season, it was (4.42 NUT). The water withdrawal site from the river is characterized by high turbidity values in both seasons, which can be attributed to the increased movement of water coming from upstream, leading to more mixing of the water and consequently higher turbidity values (9,10) in summer. In contrast, lower turbidity values were observed in drinking water, which can be attributed to the appropriate amount of alum added in relation to the turbidity levels, as well as the balance between the production capacity of the filtration stations and the water consumption by citizens, allowing sufficient time for water to settle in the sedimentation basins. It is worth noting that the globally permissible limit is (1-5 NTU).

Table (3) represents the turbidity for all study sites.

The second season	The first season	Location
7.46	10.7	Drawing water from the river
3.6	4.4	Pump number 1
2.2	3.6	Pump number 2
4.42	6.23	The average

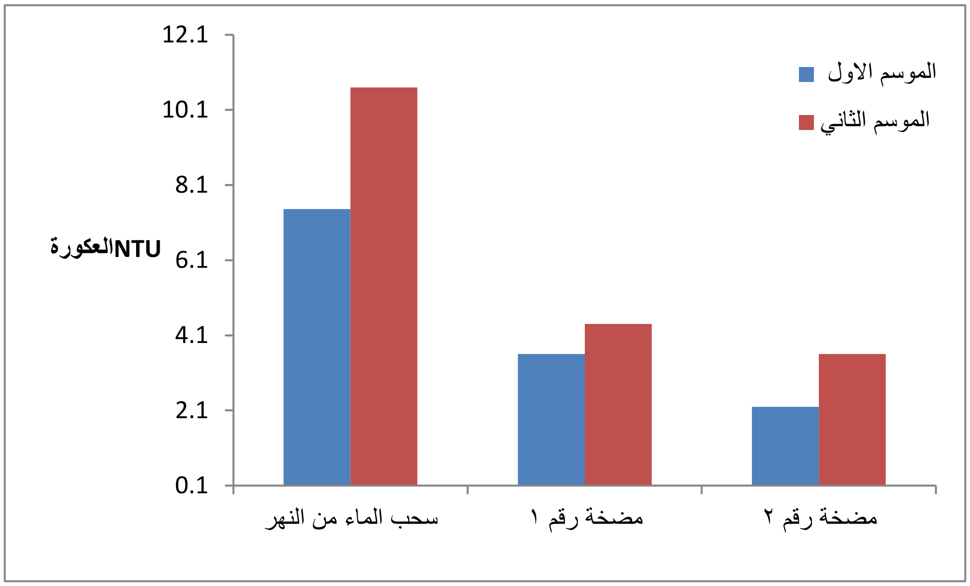

Figure 3 shows the turbidity for all study sites.

Turbidity: It is the scattering and absorption of light, not a measurement of the amount of suspended solids. And the highest permissible value ranges between (1-5) NUT.

As for total hardness, magnesium, sodium, potassium, and calcium, they were within the permissible limits according to the World Health Organization's drinking water standards (11). However, it was observed that the chloride values, which are caused by pollution due to the dissolution of organic and inorganic salts or through the discharge of irrigation water used for agricultural purposes and other industrial waste, exceeded the permissible limit of 200 mg/L. The average values in the two seasons were 267 mg/L, as shown in Tables 4 and 6 and Figures 4 and 6. It is noteworthy that high concentrations of chlorides are associated with heart and kidney diseases, as well as high blood pressure.

The problem of toxicity:

When adopting the classification (12) [Ayers33}, the studied waters cause toxicity problems under surface irrigation conditions. The danger of toxicity from chloride ions lies in the fact that it is an ion that is not adsorbed by soil colloids because it is a negative ion that remains in the soil solution and is absorbed by plants. Consequently, it can accumulate in various parts of the plant. It has been found that some plants can tolerate high concentrations of chloride ions in irrigation water under surface irrigation conditions. We find that the water under study, except for tap water, causes a toxicity problem.

Table number (4) season one

Potassium	Sodium	Magnesium	Calcium	Total Hardness	Location
5.4	168	21.4	125	189.6	Drawing water from the river
4.7	154.3	17.6	90.3	176.5	Pump number 1
4.7	150.3	17.6	90.3	146	Pump number 2
4.9	157.5	18.8	101.8	170.7	The average

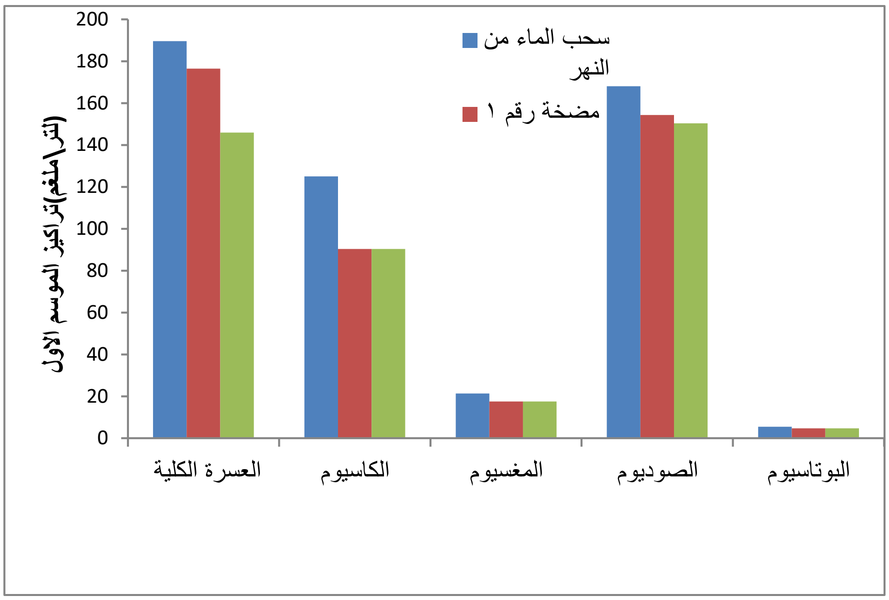

Table (4) Concentrations of the first season

Table (5) Focus of Season Two

Potassium	Sodium	Magnesium	Calcium	Total Hardness	Location
6	253.3	24.3	123.3	368.6	Drawing water from the river
5	190.6	16.4	114.8	352	Pump number 1
5	192.3	16.4	114.8	325.6	Pump number 2
5.3	212	19	117.6	348.7	The average

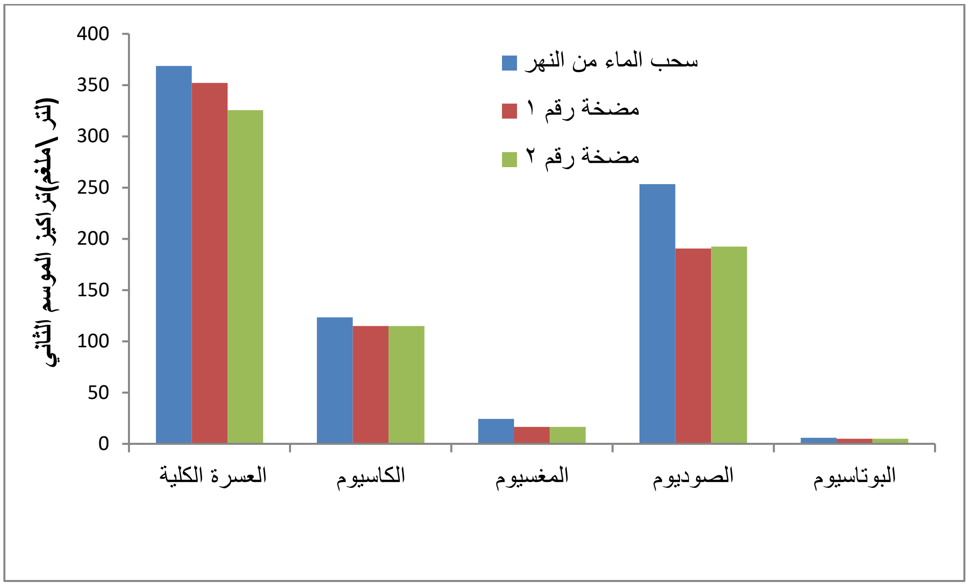

Figure (5) Concentrations of the second season

Table No. (6) Chloride Concentration

The second season	The first season	Location
301	272	Drawing water from the river
260	236	Pump number 1
278	256	Pump number 2
279.6	254.6	The average

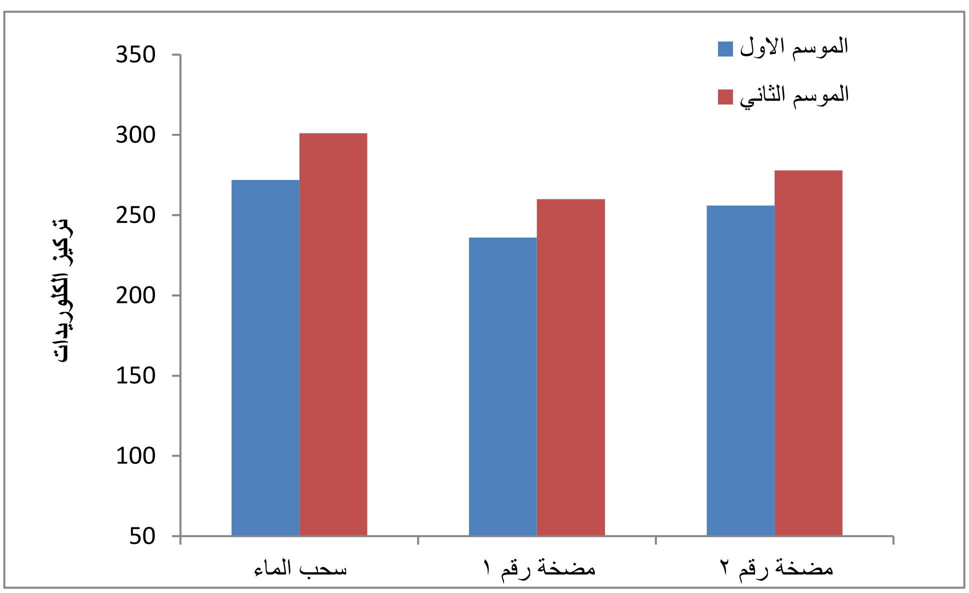

Figure 6 represents the chloride ratios for all the sites included in the study.

Recommendations:

We first recommend raising community awareness about specific terms, such as turbidity, hardness, and some chemical elements that, if they exceed the permissible limits, can cause health problems. Secondly, we advise maintaining the cleanliness of the sites from which water is taken periodically to avoid the accumulation of any aquatic plants or foreign materials, as well as ensuring health monitoring of water sources. Thirdly, the chemicals used in disinfecting drinking water should comply with standard specifications.

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