University of Thi-Qar Journal of agricultural research

Thi-Qar Journal of agricultural research

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 14, Issue 2 (2025) PP 27-37

https://jam.utq.edu.iq/index.php/main https://doi.org/10.54174/utjagr.v13i1.323

Evaluation of the Suitability of Al-Badaa River Water, North of Dhi-Qar Governorate, for Multi-Purpose Uses

Hussein Kh. Chlaib, Mohammed O. Toban, Isam Kareem Abbas, Hakeem R. Zachi

[1]Department of Soil Sciences and Water Resources, College of Agriculture, University of Sumer, Ira)

[2]Department of Animal Production, College of Agriculture, University of Sumer, Iraq

Email: hkchlaib@uos.edu.iq

Email : mohamed.odeh@uos.edu.iq

Email: esamkareem994@gmail.com

Email: haqam197600@gmail.com

Abstract

Al-Badaa River was chosen for the study as the main source of drinking water in the city of Al-Shatrah and the surrounding areas. Al-Badaa River water was studied when it entered Shatrah district. Three replicates were taken from the river water from the southern side of Al-Badaa Dam on 12/14/2022. Some physical and chemical properties (pH, Total Dissolved Salts (TDS), Calcium (Ca), Carbonate (CO_3), Bicarbonate (HCO_3), Turbidity (TUR), Electrical Conductivity (EC), Chlorine (Cl)) were measured. The pH value was 8.622, EC was 1080 meq/cm, TDS was 705 ppm, Cl was 17 meq/l, HCO_3 was 3.5 meq/l, and Ca value was 6.3 meq/l. The turbidity value was 36.42 FTU. Comparing the results with WHO specification shows that the levels of all studied properties did not exceed the permissible limits according to those specifications. Also, it was found that Al-Badaa River water is suitable for human use. In order to show the suitability of Al-Badaa River water for animal husbandry purposes, the obtained values were compared with international standard specifications for public USA veterinary services, the studied water quality was found to be very good for animal husbandry purposes and is excellent quality for irrigation.

Keyword: Al-Badaa River, WHO, Drinking use, Al-Shatrah, Specifications.

I. Introduction

Water is the origin of every living thing on the Earth. God Almighty said, "And We made from water every living thing." God Almighty is Truth. Water constitutes 71% of the Earth's cover. It is found as seas, oceans, rivers, lakes, groundwater, steam, water vapor, and many other forms. The quality of water varies from place to place. It is salty in seas, oceans, and some lakes, while fresh water, which constitutes 3% of the total water quantity, is found in rivers and some lakes. Groundwater, on the other hand, varies in quality depending on the characteristics of the aquifer and the area where it is found, Nassim (2007). The number of rivers on the surface of the blue planet is large. Known sources speak of the presence of between 165 and 170 major rivers, meaning they are navigable. However, this does not diminish the importance of the hundreds of thousands of smaller rivers spread across more than 170 geographic areas.

Since time immemorial, the oldest and most ancient civilizations have existed along rivers, such as the Mesopotamian civilization on the Tigris and Euphrates rivers, the Nile Valley civilization on the Nile, ancient Chinese civilization on the Yellow river and Yangtze river, the civilization of the Indus Valley on the Indus river, and ancient Indian civilization on the Ganges river, among others. Rivers have always been a fundamental pillar in the development of human civilizations. Rivers have shaped our lives by providing water, food, and transportation, and have been a source of culture

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 14, Issue 2 (2025) PP 27-37

https://jam.utq.edu.iq/index.php/main *https://doi.org/10.54174/utjagr.v13i1.323*

and civilizational development. Therefore, rivers are an integral part of our history and continue to provide life and benefits for future generations, highlighting their importance in our world today.

Due to the increase in population density and urban development, the amount of pollutants discharged directly or indirectly into rivers has increased, leading to physical, chemical and biological changes in the properties of the water. These pollutants come from several sources, including:

1- Sources from agricultural activities, including animal waste, fertilizers, pesticides, and soil particles (such as clay and silt) carried by water runoff as it erose away loose soil.

2- Natural sources, including dissolved minerals and decomposed plant matter.

3- Water generated from domestic, industrial, and commercial human activities, such as sewage and industrial wastewater.

4- Sources from other activities, such as construction, mining, contaminated groundwater, and landfills.

This research aims to evaluate some of the physical and chemical properties of the Al- Badaa River water in the city of Al- Shatrah and its suitability for human use (drinking), animal consumption, and agricultural (irrigation) purposes, in accordance with local and international standards.

II. LITERATURE REVIEW

Al-Badaa Dam (Fig. 1) is located in the city of Al- Shatrah, north of Nasiriyah, and is considered one of the oldest dams in the governorate. It was named after the city of Al-Badaa, which is located there and was named for its natural beauty. This dam was built as part of a series of irrigation projects as a result of the numerous demands made to the Senate at the time, which prompted King Faisal I to insist on building this dam to end the drought that had afflicted the city of Al-Shatrah, which was one of the most important cities exporting various types of agricultural crops.

Work on the Al-Badaa Dam began by the British Banyswy Company in 1929. Bricks were manufactured in the same city, while building materials such as cement and other materials arrived by sea via the port of Basra, and were then transported to the governorates of Maysan and Kut across the river, and then up the river to finally reach the dam. Work on the dam was completed in record time and the entire project was completed in 1932. The dam gates were opened manually when the project was built. Later, an electronic system was established to automatically open and close the gates, so that when the gates were opened, the water would flow towards the areas of Al-Ghamogha, Al-Zughaibi and Bani Saeed. Al-Badaa Regulator was built on Al-Gharraf River. Construction began in 1928 and work was completed in 1931. The design discharge of the regulator was 300 m3/sec. It consists of 6 openings, each with two gates, one small and the other large. The regulator is operated manually and electrically.

River water contains many elements, chemical compounds and other substances, which exist in proportions that affect the water quality and its chemical, physical and biological properties.

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 14, Issue 2 (2025) PP 27-37
https://jam.utq.edu.iq/index.php/main https://doi.org/10.54174/utjagr.v13i1.323

Fig. 1. Al-Badaa Dam and River

Chloride is a negative chloride ion Cl^- and when combined with metals, it forms metal salts ,Al-Fadl (2009). (6) g of chloride are excreted from the human body daily. The presence of chloride in quantities beyond the permissible limits gives water an unpleasant taste. It negatively affects plants and aquatic organisms. The most important natural sources of chloride in surface water are sedimentary and igneous rocks, Hassan (2004).

pH is a measure of the acidity or basicity of water or a solution under normal conditions of pressure and temperature, Langmuir (1997). pH values ranging from 1 to 14. Values under 7 indicate that the solution is acidic, a reading of 7 indicates the neutral solution, and readings above 7 indicate that the solution is basic. The ideal pH range is 6 to 8. The pH is considered the controlling factor for most reactions within the aquatic environment. The taste of water and its ability to corrode rocks are affected by the pH value, Mazor (1990). Low or high pH levels can affect the suitability of the soil for agriculture, as this directly impacts plant growth. Therefore, determining the pH is one of the most important tests that can be performed to diagnose water problems, Al-Akeedi and Al-Essawi (1989).

The type and concentration of total dissolved salts (TDS) in water varies depending on the water source, whether it is rainwater, groundwater, river water, etc. The least amount of dissolved salts is found in rainwater, followed by river water, then groundwater, Al-Saadi et al., (2000). The TDS in a solution are the chemical elements and compounds without suspended materials and gases.

Many hydrogeological, hydrochemical, and agricultural applications require knowledge and measurement of electrical conductivity (EC). Similarly, many local and international standards rely on EC due to its relationship with salinity. The fastest way to determine water salinity is the EC, due to their relationship, Todd (1980). Water temperature is also a factor controlling EC, as a one-degree Celsius increase in water temperature increases EC by 2% , Detay (1997).

Turbidity is defined as a measure of the clarity of water, Health Canada (1996), where the presence of suspended materials in water will obstruct the passage of light through the body of water. Water can be turbid to varying degrees depending on the amount and proportion of suspended matter and floaters and organisms, the type, color, and particle size of these particles. Water turbidity affects the growth of aquatic plants and fish. Studies on fish ponds have shown

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 14, Issue 2 (2025) PP 27-37
https://jam.utq.edu.iq/index.php/main https://doi.org/10.54174/utjagr.v13i1.323

that turbid water causes some problems, as the lack of sunlight reaching the plant organisms causes a decrease in oxygen production. Turbidity is expressed in nephelometric turbidity units (NTUs), Kostamo (2008).

Limestone and dolomite, which produce carbon and bicarbonates, are considered a natural source of basicity, as they are the source of sodium, calcium, and magnesium. The common or predominant form of basic compounds is bicarbonate. Calcium in the Earth's crust rocks conceders as the most abundant alkali elements. It is an important element for plants and animals. Calcium ions are produced from several sources, the most important of which are the dissolution of carbonate sedimentary rocks and gypsum, and the weathering of calcium-rich amphibole, pyroxene, and feldspar minerals, Hem (1970).

There are numerous studies that have addressed the evaluation of river water for various purposes in general, and the study and evaluation of Al-Badaa water in particular. We list the most important of these:

The suitability of Al-Gharraf River water in southern Iraq for various uses was evaluated using the Water Quality Index (Canadian model) by Al-Tamimi (2016). Four stations were selected along the river to collect water samples. The first station was located in Al-Hay city/Wasit Governorate, the second station was in Al-Rifai district, the third station was in Al-Shatra district, and the last station was located in Al-Islah district. The last three stations are located within Dhi Qar Governorate. Twenty-six variables with the greatest impact on water quality and suitability for use in drinking water, livestock production, and irrigation were studied to determine the Water Quality Index values. These variables are (air and water temperature, flow speed, pH, DO, BOD, chemical oxygen demand (COD), EC, salinity, Turbidity, TDS, TH, CO_3, HCO_3, total basicity, Ca, Mg, Cl, Na, and K ions, effective adsorption ratio of sodium and phosphate, effective nitrate, sulfate, trace elements (cadmium and lead), and fecal coliform bacteria. The WQI values for drinking water supply ranged between 19.87 and 26.98 for all stations, thus classifying them as the fifth poor category on the WQI scale.

Mohammed, 2018 studied some physical, chemical and biological properties of Tigris River water near Al-Shuhada Bridge and evaluated them for different purposes for the period 2012-2014. The values of (TH, Turbidity, pH, TDS, Cl, Na, Ca, Mg, Cd, BOD, CO_3, B, NO_3, Cr, Zn, Cu, HCO_3) were determined. Most of the values of physical and chemical properties were within the permissible limits, and there was an absence of most heavy elements such as cadmium.

Al-Ani and Siddiq (2019) conducted a study to evaluate Tigris River water for drinking purposes using the Water Quality Index. Turbidity, TDS, pH, DO, and biological oxygen demand (BOD) were studied. Water was collected from ten stations. The water from all the measuring stations was unsuitable for drinking. Except for some water characteristics, the fifth station showed good water quality according to the WQI.

Nomas and Hashim (2021) investigated Al-Badaa Canal Water Project by examining its structural properties and its importance in supplying water for human use in Basra Governorate. Laboratory tests of the physical and chemical properties of Al-Badaa Project's raw water (Turbidity, pH, EC, TDS, NO_3, Cl, SO_4, Na, K, Ca, Mg) showed that the values of these properties were within the permissible and standard limits according to the WHO's drinking water specifications. The study also compared the specifications of Al-Badaa project water with Shatt al-Arab water, where the Bada'a project water was of better quality than the Shatt Al-Arab water. The study also indicated the existence of problems facing Al- Bada'a Canal, namely the spread of natural plant growth and the high rates of evaporation and infiltration losses, which reached approximately (0.00024 and 0.1125) km^3/year, respectively, in addition to the canal passing through an oil-rich area and population encroachments on the canal.

Humaidy (2021) conducted a study to evaluate Al-Badaa Water Project/Basra Governorate, also showed its importance in improving water supply and demand. This study examined the hydrological characteristics of the project (quantitative and qualitative characteristics of water) and its suitability for drinking use. It also examined the most important problems (natural and human) facing the project, which have negatively impacted it and reduced water discharge to Basra Governorate. Laboratory tests conducted at five sites show that the water from Al-Badaa Canal is suitable for human

University of Thi-Qar Journal of agricultural research

Thi-Qar Journal of agricultural research

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 14, Issue 2 (2025) PP 27-37

https://jam.utq.edu.iq/index.php/main *https://doi.org/10.54174/utjagr.v13i1.323*

use according to World Health Organization standards. The study also revealed that the hydrological situation of the canal is linked to the hydrology of the Tigris and Al-Gharraf rivers. As a result, the canal's water discharge increases during wet years and decreases during dry years. The annual discharge rate of the canal during the period (2013-2020) reached approximately 349.48 million m^3/year. It also revealed that the canal's water transfer efficiency reached approximately 83.9%. However, the main water distribution network in the governorate does not have the capacity to absorb discharges exceeding 6 m^3/s due to problems in the water distribution network. As revealed by the water budget conducted for the domestic needs of Basra city, the amount of water suitable for human consumption does not exceed 173.2 million m^3/year (Al-Badaa Project water), while the actual needs during 2020 reached approximately 522.3 million m^3/year. Therefore, the water deficit for this year amounts to approximately 324.1 million m^3/year.

Chlaib and Jassim (2022) also studied fluctuations in the physical and chemical properties of Al-Garraf River water for the period from December 2019 to April 2020. The study showed an increase in the value of chlorine and electrical conductivity and a decrease in the pH, while there was no change in the concentrations of magnesium and calcium during the monitoring periods.

Almahmood and Hamidy (2022) studied the qualitative characteristics of raw tap water from Al-Badaa Canal in Basra during 2020, comparing the physical and chemical properties according to the Iraqi specifications for drinking water quality. The study focused on ten elements (total hardness TH, Turbidity, pH, EC, TDS, Cl, SO_4, Na, Ca, Mg) to determine water quality and calculate the Water Quality Index (WQI). The results indicated that all or most of the water characteristics were above the Iraqi standard limits for drinking water, with the exception of pH. According to the WQI, during the winter and summer seasons, the water quality falls between poor and non-potable, while during the spring and autumn seasons, the water quality falls between poor and very poor.

Chlaib et al. (2023) studied the impact of Qalaat Sukkar city on the water quality of Al-Garraf River. Several samples were taken of the river water as it enters the city and several samples as it exits the city. A sample was also taken of the water from the distillation project that discharges into the river. Turbidity, pH, TDS, Cl, Ca, EC, DO, CO_3, and HCO_3 were measured. The study showed that the river water was polluted. pH, TDS, and Cl values were within the internationally permissible limits, while the turbidity, Ca, and HCO_3 values exceeded the limits permitted by the World Health Organization. The study showed that Qalaat Sukkar city adds some pollutants to Al-Garraf River.

III. MATERIALS AND METHODS

Study area

The study area (Al-Badaa River) is located in Al-Shatra District, Dhi Qar Governorate, southern Iraq. Samples were taken from the middle of the river near Al-Badaa Dam (Fig. 2). Al-Badaa River is one of the branches of Al-Gharraf River

Sampling method

Seven samples were taken from the middle of the river on December 14, 2022. The samples were placed in tightly sealed 250 ml bottles (plastic) and kept in a refrigerator at a suitable temperature until analysis and measurements were conducted.

Materials and equipments

Chloride ion measurement

Chloride in water was determined using the Mohrs method.

University of Thi-Qar Journal of agricultural research

Thi-Qar Journal of agricultural research

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 14, Issue 2 (2025) PP 27-37

https://jam.utq.edu.iq/index.php/main *https://doi.org/10.54174/utjagr.v13i1.323*

pH measurement

A pH meter was used to measure the acidity.

Electrical specific conductivity measurement

Electrical conductivity was measured using an EC meter.

Total dissolved solids measurement

The amount of dissolved solids was measured using a TDS meter.

Turbidity measurement

Turbidity was measured using a turbidity meter.

Carbonate and bicarbonate measurement

The titration method was used to measure carbonate and bicarbonate.

Calcium measurement

Carbonate and Bicarbonate were measured using the titration method.

For more details about work methods see, Al-dobayany and Al-Atabi (2019).

.

Fig. 2. Google Earth map representing the study area location/ southern Iraq

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 14, Issue 2 (2025) PP 27-37

https://jam.utq.edu.iq/index.php/main *https://doi.org/10.54174/utjagr.v13i1.323*

VI. RESULTS AND DISCUSSION

The study results, which included many chemical and physical properties of the water of the Bada'a River in the Shatra District, Table (1), showed that the pH value was 8.622. This is due to the increased amount of salts in the water, which makes it alkaline. As the water's salt content increases, its pH increases, making it alkaline, Al-Asadi (1983).

TABLE 1. Values of the chemical and physical properties of the studied water samples of Al-Badaa River

Physical and Chemical Properties	Value	Measuring Unit
PH	8.622	-
EC	1080	µs/cm
TDS	705	ppm
Cl(meq/1)	17	meq/1
HCO_3(meq/1)	3.5	meq/1
CO_3(meq/1)	0	meq/1
Ca(meq/1)	6.3	meq/1
TUR(NTU)	36.42	NTU

Electrical conductivity (EC) was also studied, and its value was 1080 µs/cm. This value is related to the amount of salts as well as the salt content of the lands that embrace the river, SDWF (2008). TDS in the river water was also estimated at 705 ppm. This value is attributed to a slight increase in ion concentration, Al-Asadi (1983) and human activities such as agricultural land drainage, sewage, and industrial wastewater, WSC (2007). According to Bouwer (1978) classification (Table (2), the river water was classified as being of good quality

TABLE 2. Bouwer (1978) classification of water.

Water Quality	TDS (ppm)
Good	<1000
Moderate saline	10000-1000
Saline	35000-10000
Very Saline	>35000

The chlorine value was 17 meq/1. Sewage discharges, pollution, and chemical industrial waste add chlorine concentrations to the water.

The atmosphere, minerals and sedimentary rocks are the sources of bicarbonates, in addition to their primary sources,. The bicarbonate value was 3.5 meq/1, this value related to the high pH. The calcium value measured in the river water was 6.3 meq/1. This is attributed to the type of salts that make up the soils surrounding the river, as Iraqi soils are calcareous in nature, Buringh (1960).

The average turbidity value in the water samples was 36.42 FTU. These low values are due to colloidal materials, silt, clay, humic substances, organic debris, and various plants and animals present in the water.

When comparing the results of the current study of water samples for the characteristics (Ca, Cl, HCO3, TDS) with their acceptable limits according to the WHO (1995) specifications, it was found that the limits of all the previous characteristics did not exceed the permissible limits as shown in Table (3),) and this means that the water of Al-Badaa River in the study area is unpolluted water.

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 14, Issue 2 (2025) PP 27-37

https://jam.utq.edu.iq/index.php/main *https://doi.org/10.54174/utjagr.v13i1.323*

TABLE 3. WHO (1995) specifications for water quality according

Unit	Ca	Cl	HCO_3	TDS
ppm	75	250	125-350	500-1000

Water Quality Assessment for Drinking Purposes

The water quality analysis process included only the basic elements, and therefore was relied upon to assess the suitability of the Bada'a River water for human uses (drinking purposes) after comparing it with the WHO (2004) specifications, and the specifications of the Iraqi Environmental Protection and Improvement Department for 1998 (Table 4). It was found that the water samples studied fell within the permissible limit values, which means that the Bada'a River water is suitable for human drinking.

TABLE 4. Specifications proposed by WHO (2004) and the Iraqi specifications for the year 1998

Iraqi specifications 1998	specifications WHO 2004	Character
1000	1000	TDS
75	75	Ca
250	200	CL
6.5-8.5	7.5-8.5	pH

The results of the studied physical properties were also compared with the Drinking water standards and science (2006) Table (5). pH is consistent with the limits of the American specifications and the WHO specifications and differs slightly with the European and Iraqi specifications, while the turbidity values are exceeds the limits of all specifications.

TABLE 5. International physical specifications for drinking water

Character	Specifications			
	American	European	Iraqi	WHO
pH	6.5 -9.5	6.5 – 8.5	6.5 – 8.5	6.5 - 9.2
Turbidity (NTU)	< 5	1	5>	2.5 - 5

Water quality assessment for irrigation and animal using

To determine the suitability of Al-Bid'a River water for animal husbandry, the chemical analysis results were compared with the USA Public Veterinary Services' standard specifications, Crist and Iower (1972) in Al-Azzou (2003), Table 6, based on the TDS. It was found that Al-Bid'a River water in Al-Shatrah District is suitable for drinking by all animals.

TABLE 6. Standard specifications for USA public veterinary services according to the TDS values, Crist and Iower (1972)

Animals	TDS (ppm)
Domesticated birds	2860<
Horses	6435 <
Cattle (for milk)	7150<
Cattle (for meat)	10000<

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 14, Issue 2 (2025) PP 27-37

https://jam.utq.edu.iq/index.php/main *https://doi.org/10.54174/utjagr.v13i1.323*

To know the suitability of the studied water for animal consumption, the chemical analyses results of the water samples were compared with the specifications of, Altoviskig (1962), Table (7). It was found that the quality of the water was very good in terms of its suitability for animal consumption.

TABLE 7. Animal consumption water classification, Altoviski (1962)

Ions	Very Good	Good	Allowed to be Used	Can be used	Maximum
Ca	350	700	800	900	1000
Cl	900	2000	3000	4000	6000
TDS	3000	5000	7000	10000	15000

The suitability of Al-Badaa River water for agricultural purposes was determined using two international specifications. The first specifications are, Ayers and Westocot (1994) specifications, which is based on the EC and the TDS (Table 8). It was found that Al-Badaa River water is of good to average quality for agricultural use. The second specifications (Table 9) are the Scofield specifications, which are according to Cl concentration of in the water. It was found that the quality of Al-Badaa River water is of excellent quality for agricultural purposes.

TABLE 8. Ayers and Westocot (1994) specifications of water for agricultural purposes

	Irrigation water class		
	Good	Moderate to Good	Poor
EC (mmhos/cm)	0.7<	0.7-3.0	3.0>
TDS (ppm)	450<	450-2000	2000>

TABLE 9. Scofield classification of irrigation water

Chloride limits (ppm)	Water Condition Description
142<	Excellent
250-142	Good
425-250	Permissible
710-425	Questionable
710>	Unsuitable

V. CONCLUSIONS

The current study concludes that the water of the Al-Badaa River in Al-Shatrah District is of good quality, as the values of (TUR, Ca, HCO_3, pH, TDS, and Cl) were consistent with World Health Organization and Iraqi specifications, making it suitable for human consumption and suitable for irrigation and animal drinking.

IV. RECOMMENDATIONS

The researchers recommend the following:

1. Conduct periodic measurements of the Bada'a River water, in addition to studying the concentrations of (Mg, SO_4, Na, TH, NO_3, PO_4, etc.).

2. Avoid diverting sewage or fertilizer water and discharging it into the river.

3. Water resources must be controlled and protected from pollution.

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 14, Issue 2 (2025) PP 27-37
https://jam.utq.edu.iq/index.php/main *https://doi.org/10.54174/utjagr.v13i1.323*

IIV. REFERENCES

A. A. H. Hamidi. 2021 "*Evaluation of the Bada'a water project and its importance in developing water supply and demand in Basra Governorate*", doctoral diss., College of Education, University of Basra, Basra, Iraq.

Al-Akeedi, W. K. H. (1990). Soil Management and Land Use.

Al-Ani , I. A. and Sidek, T. (2019) Assessing the water quality of Tigris River for drinking purposes using water quality index approach. *ARID International Journal for Science and Technology. 2(3): 32-44. https://doi.org/10.36772/arid.aijst.2019.232*

Al-dobayany, H. Kh. Ch. and Al-Atabi, R. Gh. N. (2019). Geochemical and Fertility Survey of Some Soils of Al- Shatra and Al-Rifai Cities in Dhi Qar Governorate/Southern Iraq. 1st. ed., Dar Al-Sadiq Cultural Foundation for Publishing and Distribution, Babylon, Iraq.

Al-Fadl, Kh. M. I. (2009). Laboratories Management and Environmental Research.

Al-Mahmoud, H. Kh. H. and Hamidi, A. A. H. (2022). Qualitative characteristics of raw liquefaction water based on Al-Badaa Canal in Basra. *Arabian Gulf Journal. 50(2):417-440*.

Al-Saadi, H. A., Kassim, T. I., Al-Lami and Salman, S. K. (2000). Spatial and seasonal variations of phytoplankton populations in the upper region of the Euphrates River, Iraq. *Limnologica - Ecology and Management of Inland Waters. 30(1):83-90. DOI: 10.1016/S0075-9511(00)80049-3.*

Altovisiki, M. E. (1962). Hand Book of Hydrogeology. Geogoelitzet, Moscow, USSR, 614p.

Ayers, R. S. and Westcot, D. W. (1994). Water Quality for Agriculture. (Rev.1), FAO Irrigation and Drainage Paper 29, Rome, 130 p.

Bouwer, H. (1978). Groundwater Hydrology. International student edition. McGraw-Hill Kogakusha, Ltd., Tokyo, Japan, 480 p.

Buring, P. (1960). Soils and Soil Conditions in Iraq. Ministry of Agriculture, Baghdad, Iraq, 322 p.

Chlaib, H. Kh., Al Kaaby. I. N., Saheeb, A. A., Ali, J. H. (2023). Study of Qalat Sukkar influence on Al-Gharraf River's water quality. *Indian Journal of Ecology. 50 Special Issue (22):175-180.*

Chlaib, H. Kh., Jassim Th. J. (2022). Study the monthly changes in the physical and chemical properties of Al-Garraf River water in Qalat Suker city, Des. 2019-April, 2020, a sustainable study. *University of Thi-Qar journal of agricultural research. 11(1):1-19. https://doi.org/10.54174/UTJagr.Vo11.N1/01*

Detay.M. (1997). Water Well-Implementation, Maintenace Restoration. John Wiley & Sons, Baffins Lane. Chichester. London, 394 p.

Drinking Water Standards and Science. (2006). Drinking Water Standards and Science. London.

Hassan, F. M. (2004). Limnological features Diwanyia River, Iraq. *Journal of Um-Salama for Science. 1(1):1-6.*

Hem, J. D. (1970).Study and Interpretation of the Chemical Characteristics of Natural Water. U.S. Geological Surveys water Supply paper 2254, 246 p.

ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 14, Issue 2 (2025) PP 27-37

https://jam.utq.edu.iq/index.php/main *https://doi.org/10.54174/utjagr.v13i1.323*

Kostamo, J. (2008). Detecting Microbial Contaminants in Drinking Water. In: Advanced Studies in Environmental Microbiology and Biotechnology Ecological Sanitation and Manure Treatment as Tools to Improve Water Hygiene. Edited by, Tanski, H. H., University of Kuopio , Finland, pp.19-23.

Langmuir, D. (1997). Aqueous Environ Mental Geochemistry. Prentice Hall. USA, 600 p.

M. Al-Asadi. 1983 "*The system of distributing some nutritious salts in the Shatt Al-Arab and a number of its branches in the city of Basra*", master thesis, College of Science, University of Basra, Basra, Iraq.

M. M. H. Al-Tamimi. 2016 "*Evaluation of the validity of Al – Gharraf River water southern of Iraq for various uses by using the water quality index (Canadian Model)* ", master thesis, College of Science, University of Dhi Qar, Dhi-Qar, Iraq.

Mazor. E. (1990). Applied Chemical and Isotopic Ground Water Hydrology, Wiley, New York , 274 p.

Mohammed, N. A. (2018). A study of some physical, chemical and biological properties of Tigris River water near Al-Shuhadaa Bridge and its evaluation for different purposes for the period (2012-2014). *Al-Ustadh Journal. 2(226):389-424.*

Nomas, H. B. and Hashim, A. A. (2021), Al Bada canal water project: its construction aspects and importance for drinking water supply projects of Basrah Province. *University of Wasit, Journal of the College of Education. 44(1):205-230 DOI: https://doi.org/10.31185/eduj.Vol1.Iss44.2288*

O. N. Al-Ezzo. 2003 "*Hydrogeology of Sino area, northwestern Iraq*", master thesis, College of Science, University of Mosul, Mosul, Iraq.

Safe Drinking Water Foundation (SDWF). (2008). TDS & pH Safe Drinking Water Foundation, 6 p.

Scofield, C. S. (1936). The Salinity of Irrigation Water. Smithsonian Institution, annual report. 1934-35: pp. 275-287.

The Federal-Provincial Subcommittee on Drinking Water of the Federal-Provincial Committee on Environmental and Occupational Health. (1996). Guidelines for Canadian Drinking water Quality, 6th ed. The Minister of Health , Canada Communication publishing Group , Ottawa ,Canada K1A 0S9:90 p.

The Iraqi Environment Protection and Improvement Department. (1998). Environmental Legislation for Drinking Water and Standard Methods for its Testing and Analysis. Ministry of Health, Baghdad, Iraq, 50 p.

Todd, D. K. (1980). Ground Water Hydro logy. John Willey, New York, 535 p.

Water Systems Council (WSC). (2007). Well Care Information for You about Total Dissolved Solids (TDS). Well care program of Water System Council (WSC). Well Care Publishing, 4 p.

World Health Organization (WHO). (1996). International Standard for Drinking Water. Geneva, Switzerland, 70 p.

World Health Organization (WHO). (2004). International Standard for Drinking Water. Geneva, Switzerland.